Essays on Gradual Wage-Price Adjustments, Monetary Unions and Open Economy Macrodynamics

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Inauguraldissertation
zur Erlangung des Grades eines Doktors
der Wirtschaftswissenschaften
an der Fakultät für Wirtschaftswissenschaften der
Universität Bielefeld

Vorgelegt von
Christian Proaño Acosta

Bielefeld, Dezember 2007

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To Roberto and Cecilia, my parents

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General Introduction and Outline of the Dissertation

During the last decade, DSGE (Dynamic Stochastic General Equilibrium) models based on the work by Erceg, Henderson and Levin (2000), Smets and Wouters (2003) and Christiano, Eichenbaum and Evans (2005) have become the workhorse theoretical framework in the mainstream academic literature on monetary economics. The formulation of forward-looking, rational economic agents and their intertemporal optimization problems under general equilibrium represent the core of this new modeling approach. However, this new theoretical framework has not remained unchallenged. On the one hand, its limited capability to explain many "puzzles" observable in empirical data has led a number of researchers, among them in particular Mankiw (2001), Estrella and Fuhrer (2002) and Solow (2004), to raise serious doubts about the implications for economic policy advice based on such models. On the other hand, the assumed rationality of the economic agents – since the work by Lucas (1976) the central feature of mainstream neoclassical economics – has also been relativized in recent years. Indeed, recent research has highlighted the importance of *learning*, on the one hand – where the rational expectations solution is only the extreme case to be fulfilled in the long run – and of *agent heterogeneity*, on the other hand, for the behavior of the economic agents and for the dynamics of the economy.

Alternatively, Chiarella and Flaschel (1996, 2000) have proposed a theoretical macroeconomic framework which provides a more descriptive framework for the study of the macrodynamics of modern economies. This alternative framework is based on non-clearing goods and labor markets (and therefore of under- or over-utilized labor and capital stock), adaptively adjusting economic agents, and on the assumption that wages and prices react only gradually to disequilibrium situations in both the goods and labor markets. In addition, the inflation expectations are assumed there to be of cross-over type in both wage and price inflation adjustment equations, permitting thus the modeling of not rational but instead model-consistent expectations concerning the wage-price dynamics in the economy.

This dissertation will follow this second theoretical approach or “modeling philosophy”. Underlying all chapters of this dissertation will thus be the notion that the macroeconomy adjusts in a gradual manner to existing disequilibrium situations in the goods, labor and financial markets. Since rational expectations and the resulting self-fulfilling adjustment paths will not be the determinants of the dynamics of the economy, the bounded rationality of the economic agents will be implicitly assumed.

Under this perspective, this dissertation will handle the role of gradual wage and price inflation adjustments and monetary policy in currency unions and open economies both theoretically and empirically. This dissertation consists of two parts: In Part I the role of wage and price inflation adjustments and of labor market rigidities in closed economies and monetary unions is analyzed. In contrast, in Part II the focus is set on the interplay between nominal exchange rate fluctuations and the dynamics of wage and price inflation in an open economy framework.

Throughout Part I, the dynamics of closed economies and currency unions such as the European Monetary Union will be at the center of the empirical and theoretical analysis. As it will be stressed in this part of the dissertation, the characteristics of wage and price inflation are of central importance for the stability of closed economies, and even more, for economies which are members of monetary unions. This is due to the fact that with the entrance into a monetary union such as the EMU the participant economies do not only lose their ability to conduct an independent monetary policy to react to exogenous shocks. Additionally, due to the disappearance of country-specific nominal exchange rates, their capability to correct internal and external imbalances through real exchange rate adjustments is also significantly diminished. Due to this twofold loss of flexibility to handle exogenous shocks, other macroeconomic channels such as the mobility of the production factors and wage and price flexibility become more important as macroeconomic stabilizing mechanisms. However, given the fact that the degree of labor market mobility existing across the EMU Member States is still quite low compared for example with the U.S. economy, the adjustment process of these economies is likely to take place primarily through the dynamics of wage and price inflation at the national level.

A central issue in the first part of this dissertation will be the explicit modeling of role of labor market rigidity in the dynamics of wage and price inflation. This is due to the fact that the labor markets play a central role not only for the determination of wage and price inflation, but also for the speed and extent of the transmission of monetary policy impulses. Their importance will become particularly clear when the conduction of monetary policy within a monetary union with asymmetric labor markets will be investigated.

In Part II of this dissertation the interaction of nominal exchange rate fluctuations and the gradual adjustment of wages and prices in an open economy will be analyzed. The modeling of the nominal exchange dynamics, as well as its role in the dynamics of the economy, will also concern non-standard situations: On the one hand, the consequences of agents heterogeneity in the foreign exchange market for the macroeconomic stability of two interacting open economies will be investigated. On the other hand, the effects of currency and financial crises in emerging market economies with a high degree of liability dollarization, and the role which the gradual adjustments of wages and prices play in the recovery process following the breakdown in aggregate investment, will be studied.

As it will be demonstrated, the characteristics of wage and price inflation dynamics, as well as the dynamics of the nominal exchange rate, will be central for the macroeconomic dynamics and stability of the system where the latter is not simply imposed by the rational expectations assumption.

Outline of the Dissertation

This dissertation is organized as follows. Chapter 1 will focus in more detail on the dynamics of the national inflation rates of the euro area countries prior to and after the introduction of the euro. By means of univariate and panel unit root tests, the absolute and relative convergence of these time series will be investigated and different "convergence groups" will be characterized. Beyond this, the main determinants for the arise of inflation rate differentials in the euro area countries will be identified by means of single-equation GMM and pooled TSLS estimations.

In Chapter 2 the baseline semi-structural macroeconomic model will be described and its stability properties towards variations in the structural parameter values of the model will be analyzed. Its empirical relevance will be demonstrated on the basis of GMM estimations with time series of the U.S., Germany, UK, France and the Euro

Area.

In Chapter 3 the theoretical model discussed in Chapter 2 will be modified in order to analyze in an explicit manner the role of labor market rigidity for the dynamics of output and inflation by means of the incorporation of a search and matching function. After discussing the modified model, alternative monetary policy rules will be evaluated concerning their efficiency in the control of different macroeconomic variables such as wage and price inflation, as well as output and employment.

Chapter 4 will extend this new theoretical framework into a two-country model of a monetary union. Within this new framework the design of optimal monetary policy in a common currency area will be investigated. The issue of optimal country-weighting in the loss function of the currency union's central monetary authorities will be there particularly addressed.

The determination of the nominal exchange rate under heterogenous expectations and its role in the macroeconomic dynamics of two large economies will be the focus of the analysis of Chapter 5. For this, a simple specification of the nominal exchange based on the existence of chartists and fundamentalists in the foreign exchange market will be incorporated into an open-economy two-country extension of the theoretical framework discussed in Chapter 2.

The role of the nominal exchange rate for the stability of the economy is also the focus of the analysis of Chapter 6, where the dynamics of the economy and the role of monetary policy as well as of wage and price level adjustments in countries with a large share of unhedged debt denominated in foreign currency are investigated.

Finally, this dissertation is closed with the summarization of its main findings and the discussion of possible future research directions.

Part I

Gradual Wage-Price Adjustments and Monetary Policy in Closed Economies and Monetary Unions

1. Inflation Rate Differentials and Business Cycles Fluctuations in the Euro Area

1.1 Introduction

With the culmination of the monetary unification process by the Member States of the European Monetary Union (EMU) represented by the abolition of their national currencies and the adoption of the euro, the degree of wage and price flexibility at the national level became particularly important for the macroeconomic stability of the participating economies as well as for the EMU as a whole. Indeed, in the absence of country-specific nominal exchange rates and monetary policy conduction implied by a monetary unification, the country-specific wage and price developments are likely to gain a much more important role as macroeconomic adjustment mechanisms to internal and external imbalances through their effect on the real exchange rates and therefore on the competitiveness of the different economies. Their ability to fulfill this function, however, depends to a significant extent on their degree of persistence and therefore on their capability to react in a quick and sufficient manner to those shocks.

From this perspective, the high degree of persistence of most of the national inflation rate differentials of the EMU Member States observed in the years posterior to the introduction of the euro has raised serious concerns among researchers and policy makers alike: Because the differences in the national inflation rates seem not to be caused primarily by accordant developments in the productivity in those economies, the relative competitiveness of the member countries might be suffering from significant shifts which might bring about serious consequences for the future developments of output and employment in the medium run.

The main purpose of this chapter is to analyze the dynamic behavior of the national inflation rates in the euro area and the linkage between their dispersion and persistence to the country-specific business cycles prior and after the monetary unification from an empirical perspective. This study is organized as follows: In section 1.2 the main theoretical explanations for the existence of inflation differentials in a common currency area, with special focus on the EMU are briefly discussed. In section 1.3 the convergence process of the national inflation rates prior to the introduction of the euro as well as their dynamic behavior after that date is analyzed by means of econometric convergence and stationary tests. Structural inflation adjustment equations as well as inflation differential equations for selected EMU countries are estimated and discussed in section 1.4, in order to find structural explanations for the observed persistent inflation differentials in the EMU. Section 1.5 draws some concluding remarks from this chapter.

1.2 Inflation Differentials within Monetary Unions: Main Causes and Consequences

According to the Optimum Currency Areas (OCA) theory developed after the work by Mundell (1961), McKinnon (1963) and Kenen (1969), a high mobility of the factors of production, and especially of labor, is a central pre-condition for countries to be adequate candidates for a common currency area. Only in a currency union with high interregional factor mobility asymmetric shocks do not represent a threat for the internal stability of the former. This is because the regional labor markets are able to absorb these shocks in a quick and efficient manner by reorganizing the distribution of the labor force within the regions. In such a case, the currency union's central monetary authorities will thus be able to focus on the currency union's external balance, once the internal balance is assured by the high interregional labor mobility. In the new macroeconomic environment resulting from a monetary unification and the related disappearance of the country-specific nominal exchange rates, other macroeconomic characteristics such as the mobility of the production factors and the degree of wage and price flexibility become even more relevant as macroeconomic adjustment mechanisms to asymmetric shocks at the national level.

The empirical evidence concerning the mobility of the factors of production in the European Monetary Union is twofold: While the factor capital has become highly mobile across the EMU members, the degree of labor mobility in the EMU has remained much lower primarily due to the language and cultural barriers among the EMU Member States, as pointed out by Bertola (2000) and Braunerhjelm, Faini, Norman, Ruane and Seabright (2000). Concerning the euro area countries, De Grauwe and Vanhaverbeke (1993, p.124) find that, "at the national level, there is almost no labor mobility but significantly more exchange rate variability". This result corroborates the intuition by Meltzer (1986), whereafter in a monetary union as the EMU more of the adjustment to asymmetric shocks will take the form of real exchange rate changes than of labor mobility.[1]

In the absence of the country-specific nominal exchange rate channel, effective adjustments of the real exchange rate to macroeconomic internal or external imbalances at the national level can only take place through wage and price adjustments. In a monetary union with low labor mobility as the EMU, thus, "inflation differentials are [...] the product of an equilibrating adjustment process within a monetary union and, as such, are not only unavoidable, but also desirable."[2] Now, while the full equality of the inflation rates of monetary union members is an undesirable situation which would hinder the individual adjustment of the different economies to asymmetric shocks, a similar dynamic behavior of the national inflation rates is desirable due to a variety of reasons. In the first place, similar national inflation rates imply also similar real interest rates, and therefore more uniform monetary policy impulses across the monetary union. In the second place, similar inflation rates imply stable bilateral real exchange rates among the monetary union's members, and therefore also a balanced competitiveness development among them. Furthermore, similar inflation rates are likely to lead to similar inflationary expectations in the member countries, making the control of inflation at a currency area wide level easier for the central bank. On the contrary, if the national inflation rates differ from each other persistently and subsequently the national inflation differentials are upwardly or downwardly biased from the monetary union's average level, an unstable macroeconomic development of the monetary union members might occur, as it will be discussed in the next sections.

[1] While a *currency union* does not involve the existence of a single market, i.e. it does not rule out the existence of trade barriers, tariffs, etc. between the currency union members, a *monetary union* characterizes indeed a single market with a common currency. However, since the EMU is the focus of this study, I will not stick to this differentiated definitions but will rather use both terms interchangeably.

[2] ECB (2005, p.61). See ECB (2003) and Fritsche, Logeay, Lommatzsch, Rietzler, Stephan and Zwiener (2005) for an extensive discussion of the main causes for inflation differentials in the European Monetary Union.

At this point it should be stressed that the entrance in a monetary union implies for the joining countries a radical regime change in their macroeconomic environment for a variety of reasons which go way beyond the loss of an independent monetary policy to react to exogenous shocks and the disappearance of the country-specific nominal exchange rates. With the entrance in a monetary union, macroeconomic patterns such as the wage bargaining processes or the inflationary expectations formation in a country valid before it joined the monetary union are likely to change after the adoption of the new common currency, in the sense of the Lucas's (1976) Critique. Additionally, due to the nominal exchange rate risk- and transaction costs reduction resulting from the monetary unification, to the subsequent higher economic integration and international trade among the monetary union members as well as to the higher regional production specialization, countries that enter a currency union are likely to experience dramatically different business cycles as before.

In the following section I briefly review the main structural and cyclical factors which, at least theoretically, could explain the existence of inflation rate differentials (and their persistence) in a monetary union,[3] and discuss the possible consequences of the existence of persistent inflation differentials for the macroeconomic behavior of monetary union members.

1.2.1 Structural Factors

Tradable and Non-Tradable Goods Price Level Convergence: Due to the important process of real convergence and the high economic integration resulting from the monetary unification, many observers have interpreted the persistent inflation differentials among the EMU member countries mainly as a consequence of the Balassa-Samuelson (BS) effect[4] resulting from the catching-up process of low to high income EMU members.

In the Balassa-Samuelson framework, the production structure of the economies can be clearly differentiated between tradable and non-tradable goods, and labor is assumed

[3] Here I do not focus on additional methodological issues concerning the composition of basket of goods of the Harmonized Consumer Price Index (HCPI). As discussed in Alberola (2000, p.60), the differences in the weights of the goods in the representative basket of the EMU members, while containing some information, are not fundamental for the explanation of the extent and persistence of inflation differentials in the euro area.

[4] Balassa (1964) and Samuelson (1964).

to be perfectly mobile within a country across these two sectors. Under conditions of perfect competition, profit maximization in both sectors implies

$$p^{\mathrm{T}} f'_{\mathrm{T}}(L) = w = p^{\mathrm{N}} f'_{\mathrm{N}}(L) \tag{1.1}$$

where p^{T} and p^{N} denote the price of tradable and non-tradable goods and $f'_{\mathrm{T}}(L)$ and $f'_{\mathrm{N}}(L)$ denote the marginal product of labor in the tradable and non-tradable goods sectors. Expressing eq.(1.1) in growth rates delivers

$$\pi^{\mathrm{T}} + \alpha^{\mathrm{T}} = \pi^{\mathrm{N}} + \alpha^{\mathrm{N}} \tag{1.2}$$

where α^{T} and α^{N} denote the growth rate of labor productivity in the tradables and non-tradables production sector, respectively. Under the assumption of perfect goods market integration across the countries of a monetary union and the absence of arbitrage possibilities, the inflation rate of the tradable goods is the same across the member countries, so that

$$\pi_i^{\mathrm{T}} = \pi^{\mathrm{T}} \quad i = 1, \ldots N.$$

This, however, does not necessarily hold for the inflation rate of the non-tradable goods in the different economies. If the aggregate price level can be expressed as a Cobb-Douglas function of both tradable and non-tradable goods, the aggregate inflation rate in country i can be expressed as

$$\pi_i = (1-\gamma)\pi_i^{\mathrm{T}} + \gamma\pi_i^{\mathrm{N}} = \pi_i^{\mathrm{T}} + \gamma(\alpha_i^{\mathrm{T}} - \alpha_i^{\mathrm{N}}).$$

Since the production of tradable goods is usually more capital intensive and therefore gains more from technological process than the non-tradable goods production, a higher growth rate of labor productivity in the first production sector is to be expected. When labor productivity increases in the tradable goods sector, wages in that sector can rise without leading to an increase in the price tradable goods. Nevertheless, due to the assumed intersectoral labor mobility, the nominal wage in the non-tradable sector is likely to increase to the same extent, despite of the lower productivity growth in that sector. The result is an increase in the non-tradable goods prices and therefore also in the general price level.

For the inflation differentials between two countries i and j, or between country's i inflation rate π_i and the monetary union's average π_{mu}, it follows

$$\pi_i - \pi_{\mathrm{mu}} = \gamma(\alpha_i^{\mathrm{T}} - \alpha_i^{\mathrm{N}} + \alpha_{\mathrm{mu}}^{\mathrm{T}} - \alpha_{\mathrm{mu}}^{\mathrm{N}}). \tag{1.3}$$

This implies that the difference between the national and the monetary union's average inflation rates arise from the sector and country differences in productivity. According to eq.(1.3), the existence of inflation differentials is caused solely by different structural factors concerning the production schemes between two countries, or alternatively, by the differences between their economic development.

However, despite of its apparent high explanatory power for the existence of inflation rate differentials in a monetary union, the Balassa-Samuelson model exhibits a variety of conceptual and empirical shortcomings. At the conceptual level, in the first place, it is possible that a catching up effect might take place with productivity growth equally high in both the tradable and non-tradable sectors. In this case the explaining content of the BS model would vanish, since the catching up effect would occur without exerting any pressure on the aggregate price levels. In the second place, the differentiation of the production structure of an economy between a tradable and a non-tradable goods sector is in the actual world almost impossible, due to the high integration of goods at all stages of the production process. In the third place, the BS model assumes constant production elasticities in both sectors, while in reality they are likely to be endogenously determined. Additionally, on empirical grounds, the econometric studies by Alberola (2000), Sinn and Reutter (2000), Ortega (2003) and Lommatzsch and Tober (2004) find that the Balassa-Samuelson effect is not able to explain the inflation differentials in the euro area due to the size and persistence of the latter, since "it appears that the actual [inflation differentials] between groups of countries have been significantly larger than what the BS model would imply."[5]

Exchange Rate Pass-Through: The extent of the exchange rate pass-through on the aggregate domestic price levels of the different countries and therefore on the inflation differentials between them depends on the degree of openness of their economies and on their production profile, i.e. on their dependence on foreign intermediate and energy goods. Obviously, the influence of external factors on the price level varies with the measure of the price level which is used. Concerning producer prices and the GDP deflator, these are affected by external effects only to the extent up to which foreign intermediate goods are used in the production of domestic final goods. If on the contrary the consumer price index (CPI) is analyzed, as done in the majority of empirical

[5] ECB (2003, p.34). See also De Grauwe (1996), Alberola and Tyrväinen (1998), De Grauwe and Skudelny (2000) and for similar findings.

studies on inflation dispersion such as Busetti, Forni, Harvey and Venditti (2006), nominal exchange rate fluctuations affect the development of the CPI additionally through the share of foreign goods in the consumer basket. Inflation dispersion measures based on the national CPI will thus be biased by the import price dimension. Since the CPI depends to a higher extent on exogenous, foreign shocks (through the role of the import prices) than the GDP deflator or the producer price index. In this regard ECB (2003, p.18) finds that "import prices tend to account for the inflation differentials of most countries with a relatively high degree of openness and/or dependency [with the Netherlands being a notably exception]".

Degree of Inflation Persistence: As discussed for example in ECB (2003), while the existence of national inflation rate differentials across the EMU Member States is inevitable and even more, desirable as an adjustment mechanism to asymmetric, country-specific shocks, a high degree of persistence of these inflation differentials above or below the monetary union's average might, through its cumulative effect, lead to significant shifts in the relative competitiveness positions of the monetary union's members. Indeed, while persistent inflation rate differentials arising from corresponding differences in the productivity levels of the respective countries might not be a source of macroeconomic instability but rather an expression of the catch-up mechanism of less developed to more developed economies, persistent inflation rate differentials arising solely from the persistence in the price setting behavior by firms might represent a danger for the medium run sustainability of the currency area.

As it will be shown below, the degree of inflation persistence within the member economies is likely to explain an important share of the inflation differentials within a currency union: When nominal wages and prices are sticky and react only in a delayed and slow manner to exogenous shocks, differences in the inflation rates of the member countries of a monetary union might be of greater magnitude and longer duration than in the case where wages and prices are flexible and the degree of inflation persistence is low. As stated in ECB (2005, p.63), "since the late 1980s there has been evidence of an ongoing increase in the cyclical synchronization of euro area countries. [...] At the same time, inflation differentials in the euro area appear to be very persistent, in the sense that many countries have systematically maintained either a positive or a negative inflation gap against the euro area average since the introduction of the euro".[6]

[6] A further possible explanation for the different degree of inflation differentials persistence in the

1.2.2 Business Cycle Related Factors

Business Cycle Synchronization: Besides the structural factors discussed above, a main determinant of the inflation rate of a country is its actual position within its business cycle, that is the extent of the actual excess aggregate demand. A high excess aggregate demand is likely to lead, due to capacity constraints and the eventual price-setting power of the firms, to an increase in the growth rate of the price level. On the contrary, the growth rate of the price level is likely to fall with a low excess aggregate demand due to the reluctance from side of the firms to carry the burden of storage costs in case of overproduction. In a monetary union consisting of different countries, differences in the actual position of the different economies within their respective business cycles are likely to explain to an important extent the existence of inflation differentials among them.

The characteristics of the national business cycles are in turn likely to be affected by the monetary unification of the participating countries to a significant extent. Nevertheless, both at the theoretical and the empirical level, there is still no consensus on whether countries within a monetary union are likely to have *more* or *less* synchronized national business cycles. On the one hand, according to Kenen (1969), Eichengreen (1990), Krugman (1993) and Krugman and Venables (1996), a higher economic integration is likely to increase the degree of regional production specialization in the monetary union countries, and therefore the disparity in the regional economic development in the presence of high interregional labor mobility and asymmetric, industry-specific shocks, reducing the correlation between their business cycles. In this regard Frankel and Rose (1998, p.1014) state that "Increased trade results in greater specialization if most trade is inter-industry. [...] If much trade is *within* rather than between industries, these specialization effects may be small."[7] On the other hand, according to Frankel and Rose (1998) and Rose and Engel (2002), more international trade is likely to result in more highly correlated business cycles. Rose and Engel (2002, p.1084) show, by regressing the pairwise correlations of detrended real GDP between the euro area countries on a variety

U.S. and the euro area could be delivered by the empirical findings of Flaschel and Krolzig (2006) and Proaño, Flaschel, Ernst and Semmler (2006): Thereafter the degree of wage and price flexibility to labor and goods market pressures, respectively, is higher in the U.S. than in the euro area. This could explain why, compared to the inflation rate differentials across U.S. regions, the inflation differentials in the euro area feature a much higher degree of persistence.

[7] According to Deroose, Langedijk and Roeger (2004, p.8), "depending on the definition, intra-industry trade is about twice as important within the euro area than inter-industry trade".

of macroeconomic variables as well as currency union dummies, that "countries that are members of a common currency union tend to have more highly synchronized business cycles; the correlation is perhaps .1 higher on average for currency union members than for non-members. [However,] while economically and statistically significant, the size of this effect is small in an absolute sense." The European Commision (2004, p.29), in turn, shows, by calculating the output gap correlation among EMU members, other European countries and the U.S., that "cyclical synchronization has tended to be much higher between euro-area Member States than between the euro area and other EU-countries (EU-3) or the USA."

Country-Specific Shocks: Besides of the influence of the regular business cycles fluctuations on the inflation gaps between the different countries, the occurrence of asymmetric, country-specific shocks is also likely to affect, at least temporarily, the relative dynamic behavior of the national price levels in a monetary union, due to the increased adjustment role of respective wages and prices in the absence of the country-specific nominal exchange rate.

In both cases, the resulting dynamic behavior of wages and prices is likely to affect the country's level of economic activity through a variety of channels, being the real interest rate and the competitiveness channels the most important ones. Now, while the competitiveness channel is likely to act in a stabilizing manner,[8] the real interest channel is likely to operate in the opposite direction. Thereafter high inflation rates caused by an overheating economic activity lower the real interest rate, boosting furthermore aggregate investment and therefore aggregate demand.

1.3 Inflation Differentials in EMU: Convergence and Stationarity Analysis

The convergence of the national inflation rates – and therefore the reduction of the national inflation rate differentials – to a similar (and low) level was considered by the EMU architects a prerequisite for the monetary unification and a necessary condition for the future sustainability of the EMU: Indeed, one of the convergence criteria for

[8] high inflation rates caused by an excessive aggregate demand lead to a real appreciation of the prices of the domestic goods and a subsequent loss of competitiveness which in turn, through a reduction of the net exports, cools down the level of economic activity.

joining the European Monetary Union established by the Maastricht Treaty 1992 was "the achievement of a high degree of price stability; this will be apparent from rate of inflation which is close to that of, at most, the three best performing Member States in terms of price stability".[9]

In line with the Maastricht criteria of nominal convergence, during the years previous to Stage Three of EMU (the culmination of the monetary unification process with the introduction of the euro), a significant convergence process of the national inflation rates to a similar low level (and therefore also a significant reduction in their dispersion) could be observed in all eleven candidate countries, as shown in Figures 1.1 and 1.2.[10] As it can be observed in Figure 1.1, the standard deviation of inflation rate differentials among the EU-12 group fell from 0.03 in 1991 to 0.01 in 1999, at the time of the introduction of the euro. However, while a reduction in the dispersion of the inflation differentials might reduce eventual asymmetric effects of the common one-size-fits-all monetary policy of the ECB across the EMU members, this measure does not tell much about the individual development in the respective countries. More importantly, it does not deliver much insight into the consequences for the differentials in the national price *levels* resulting from the inflation rate differentials. Indeed, as discussed in De Grauwe (1996), the criterion of convergence of the inflation rates, as postulated by the Maastricht Treaty, might not be sufficient to ensure the future sustainability of a monetary union as the EMU, since a "convergence in yearly inflation rates can hide increasing divergences of trends in price levels, when the same countries have small

[9] The convergence criteria are established in article 121 § 1 and in protocol 21 of the Treaty on European Union (url: http://europa.eu.int/en/record/mt/top.html). The other convergence criteria established therein are

- "the sustainability of the government financial position; this will be apparent from having achieved a government budgetary position without a deficit that is excessive as determined in accordance with Article 104c(6);
- the observance of the normal fluctuation margins provided for by the Exchange Rate Mechanism of the European Monetary System, for at least two years, without devaluing against the currency of any other Member State;
- the durability of convergence achieved by the Member State and of its participation in the Exchange Rate Mechanism of the European Monetary System being reflected in the long-term interest rate levels."

[10] Throughout this analysis we will focus on the EU-11 group and will leave Greece aside due to the widely-known lack of reliability of the Greek macroeconomic data prior to its joining to EMU.

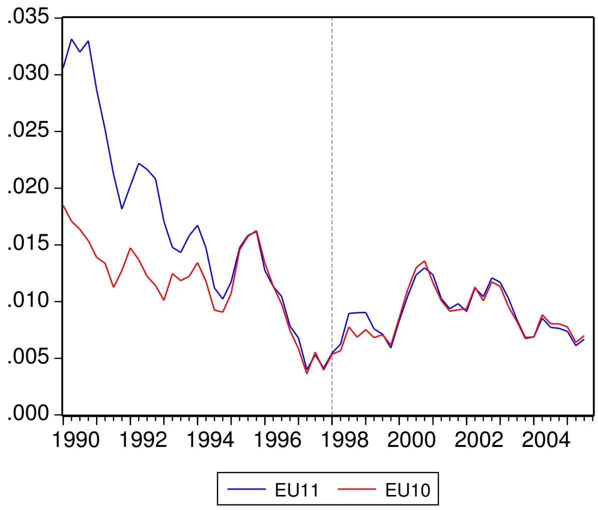

Fig. 1.1: Inflation Differentials: Unweighted Standard Deviation of EU-12, EU-11 (EU-12 less Greece) and EU-10 (EU-11 less Portugal)

but consistently higher inflation rates than other countries."[11] Not the convergence but instead the non-persistence of a one-sided divergence is what is determining for a balanced medium run macroeconomic development of the member countries of a monetary union as a group. As stated before, different countries may have from time to time inflation rates different from the currency union's average as a result of the national adjustment to asymmetric shocks. Nevertheless, when these differentials remain persistently positive or negative over a long period of time, they might lead to ongoing shifts in the relative competitiveness position of the member countries.

Figure 1.2 shows the dynamic path of the national inflation differentials with respect to the EMU average for selected Member States. As it can be observed there, the national inflation rates have been persistently above or below the EMU average not only at EMU Stage II (what could be attributed to a wage and price rigidity which could have slowed down the nominal convergence process), but, more problematically, also after the official introduction of the euro (EMU Stage III) in January 1999. This pattern is also observable if the gaps between the national inflation rates and the levels determined by the Maastricht convergence criterion, that is, the average of the three

[11] In section 3.3 this issue is addressed by means of half-lives analysis of the national inflation differentials.

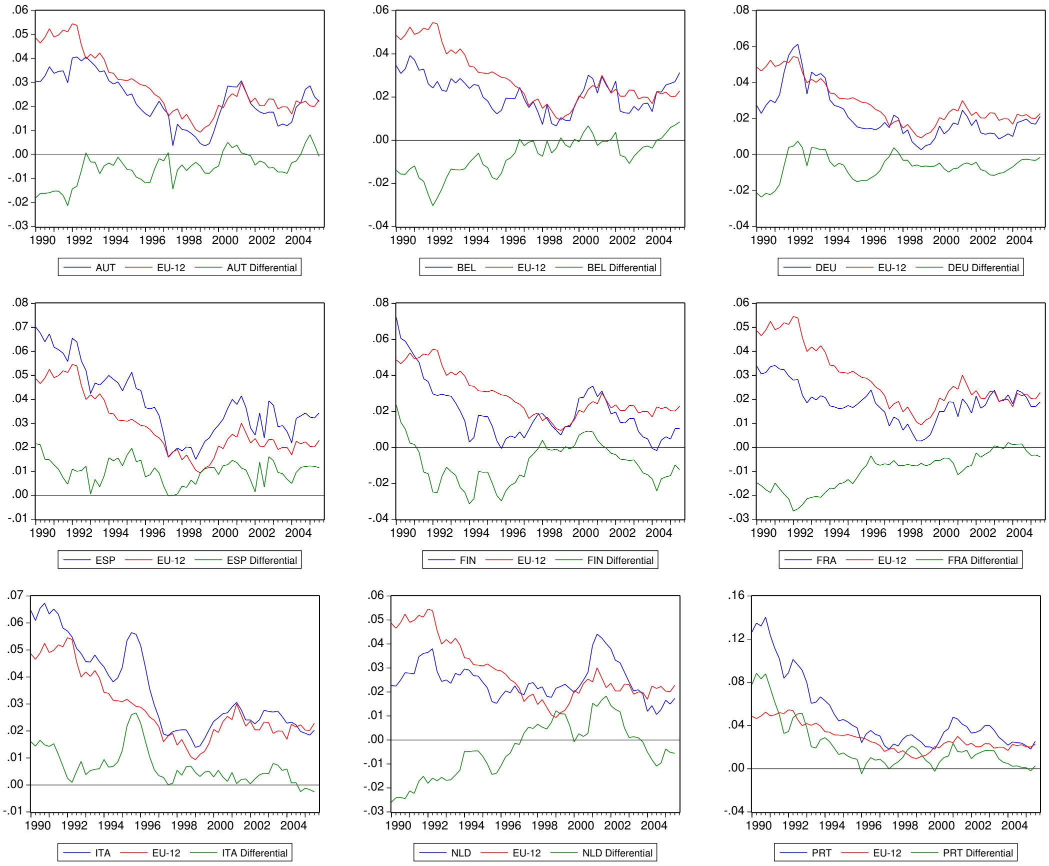

Fig. 1.2: Inflation Differentials (to EMU Average) of selected EMU Countries

lowest inflation rates of the EMU Member States, are taken into account, as shown in Figure 1.3.

In order to provide a graphical notion of the cumulative effects of persistently above- or below-average inflation rates for the relative medium run competitiveness of the EMU members, Figure 1.4 shows the cumulated inflation and nominal unit labor costs differentials of selected EMU member countries. As it is clearly observable there, while the significant persistence of these two macroeconomic indicators also *after* the monetary unification 1999 has lead to a clear significant enhancing in the competitiveness of Germany and Austria, it has lead to the opposite result in Spain, Ireland and the Netherlands.

Whether this development has been caused by the drop out of punishing mechanisms

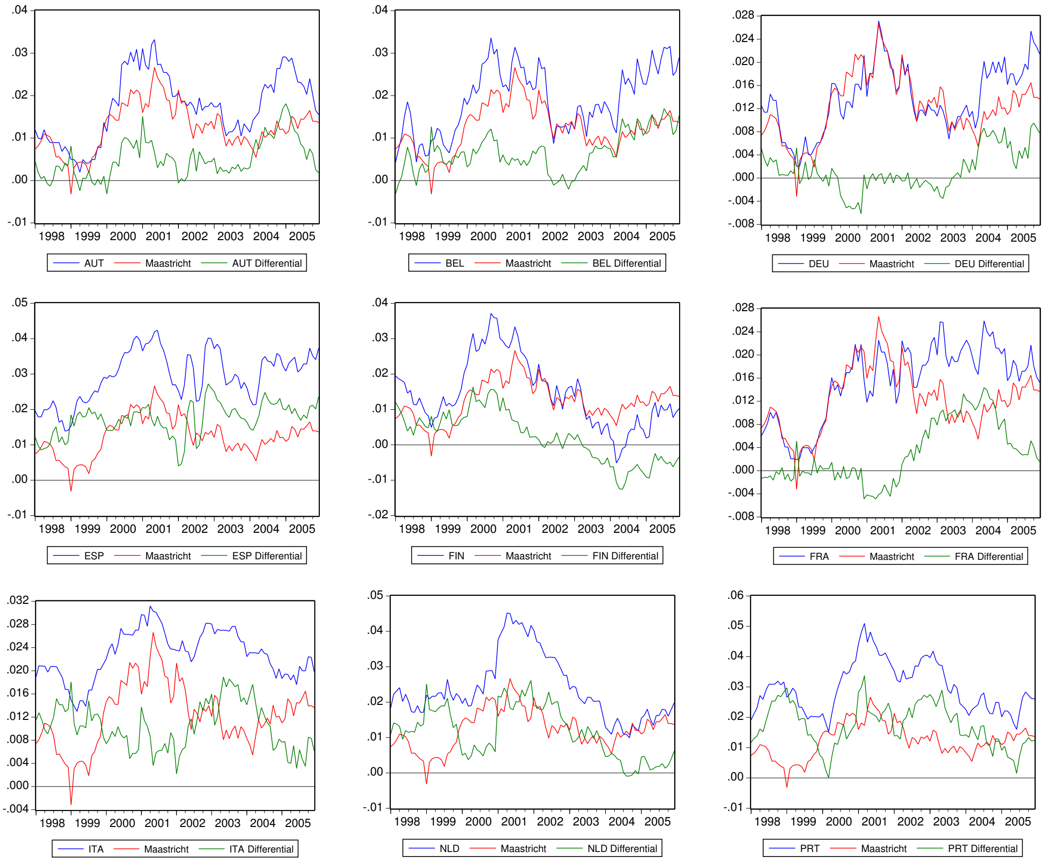

Fig. 1.3: Inflation Differentials (to Maastricht Convergence Criterion)

for countries not fulfilling the Maastricht criteria after their joining to EMU, and the resulting “non cooperative” behavior of some EMU countries after 1999 or, on the contrary, it has been the result of other structural problems such as a high degree of nominal rigidities, or whether it is only the reflection of the macroeconomic adjustment mechanisms acting in a monetary union, is an issue which will be addressed in section 1.4.

In the analysis of this section, on the contrary, the possible β–convergence of the national inflation rate differentials to the EMU average is investigated.[12] In Barro and Sala-i Martin (1991) and Barro and Sala-i Martin (1992)’s terms, β convergence is

[12] The concepts of β- and the σ convergence date back on Barro and Sala-i Martin’s (1991) analysis on cross country economic growth convergence.

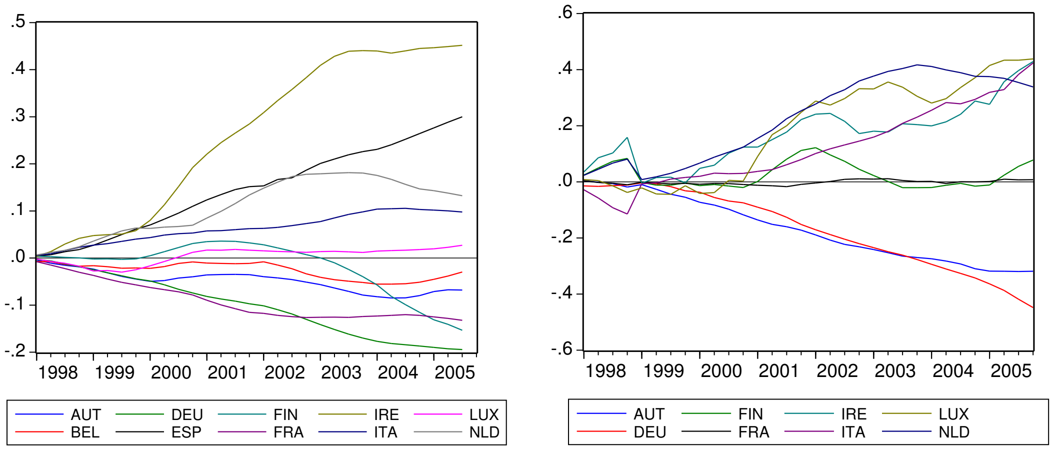

Fig. 1.4: Cumulated Inflation and Nominal Unit Labor Costs Differentials of selected EMU countries

present if different cross-sectional time series show a mean reverting behavior to a common level . σ convergence, the other convergence criterion, concerns on the contrary the reduction of the overall dispersion of the time series.

Following previous empirical studies on inflation differentials as Mentz and Sebastian (2003), Beck and Weber (2005) and Busetti et al. (2006), we use unit root and stationary tests to investigate the dynamic behavior of the national CPI inflation rate diffentials (to the EMU average) prior to and after the monetary unification. However, while Mentz and Sebastian (2003) employ the Johansen procedure to test for possible cointegrating relationships between the *levels* of the national inflation rates, here the eventual process of convergence and stationary of the national inflation differentials to the euro area average is investigated – obviously, the presence of a cointegrating relationship between the levels of the national inflation rates, as investigated in Mentz and Sebastian (2003) would imply a convergent/stationary behavior of their differences –. Busetti et al. (2006) also follow a similar strategy by performing unit root and stationarity tests on the bilateral inflation differentials of all EMU countries. Indeed, as discussed in Harvey and Carvalho (2002), the Augmented Dickey-Fuller (ADF) or the Phillips-Perron unit root tests are adequate to test whether two time series tend to *converge* to a similar level after being hit by an exogenous shock. Stationarity tests as for example proposed in Kwiatkowsky, Phillips, Schmidt and Shin (1992), on the contrary, are suitable to test whether those series *have converged*, that is if they tend to remain at similar levels after a similar shock.

The strategy can be summarized as follows: For the sub-period prior to the creation of the EMU (EMU Stage II), univariate unit root tests on the national inflation differentials are performed in order to check for statistical evidence on the convergence process. For the subperiod after the monetary unification (EMU Stage III), stationary tests on the same time series are calculated. This separate hypothesis testing on the two subperiods makes particular sense due to the regime change discussed by Frankel and Rose (1998), whereafter due to the change in the behavior of the economic agents resulting from a monetary unification, previously valid parameters are likely to lose explanatory power for the macroeconomic developments after the monetary unification.

The data set used in this section stems from the OECD Main Economic Indicators database. In order to have a representative sample size, monthly data of the national Consumer Price Indices is used (since monthly data is not available for Ireland, we do not include this country in our analysis).[13] The national inflation rate $\pi_{i,t}$ is measured as the annual percentage change in the CPI, the deviation of country's i national inflation rate from the euro area's aggregate inflation rate at time t is denoted $\varphi_{i,t} = \pi_{i,t} - \pi_t^{mu}$.[14]

1.3.1 Univariate Convergence and Stationarity Tests

The simplest univariate representation of the Data Generating Process (DGP) of the national inflation differentials is an AR(1) process expressed as

$$\varphi_{i,t} = \rho\varphi_{i,t-1} + \alpha + \delta t + \epsilon_{i,t}, \tag{1.4}$$

where α denotes a time-invariant drift term and t represents a linear time trend. The reformulation of eq.(1.4) as an AR(p) process in error-correction form which additionally incorporates lagged differences of $\varphi_{i,t}$ in order to control for eventual serial correlation, delivers

$$\Delta\varphi_{i,t} = \phi\varphi_{i,t-1} + \sum_{j=1}^{p_i} \gamma_{i,j}\Delta\varphi_{i,t-j} + \alpha^* + \delta^* t + \epsilon_{i,t}, \tag{1.5}$$

[13] The use of the Harmonized Consumer Price Indices (HCPI) – available only from 1995 – would, despite of being the "more correct" variable, have reduced significantly the number of available observations and therefore also the explanatory power of the performed unit root tests.

[14] The analysis of the inflation rate *differentials* with respect to the euro area average instead of the simple *levels* controls additionally for cross-section dependence, see Beck and Weber (2005, p.7).

with $\phi = \rho - 1$, $\alpha^* = (1 - \rho)\alpha$ and $\delta^* = (1 - \rho)\delta$, which is the equation normally used by standard Augmented Dickey-Fuller (ADF) unit root tests.[15] Hereby the null hypothesis $H_0 : \rho = 1$ is tested against $H_1 : \rho < 1$.[16] It should be easily observable that for $\rho < 1$, a mean reverting behavior in the levels of the inflation rate differentials would be observed. The specific value of ρ, furthermore, provides some information about the speed of convergence of the analyzed time series.

An important question arises in this respect when the analysis concerns specifically inflation differentials, namely whether a constant should be included or not in eq.(1.5). Busetti et al. (2006) state that when testing for inflation differentials, the focus should be on absolute convergence, with the consequence that no constant should be included in the test. In our view, such specification strategy is likely to bias the test results, since a certain behavior of the time series, namely relative convergence, is a priori factored out. Especially concerning the observed persistence in the national inflation rates, the (eventual) value of the constant could also contain some information about their degree of persistence. Due to this reason we believe that a constant should be included when testing for unit root in a first stage and only be excluded from a new computation in the second stage if it is statistically insignificant under the normal distribution.

With respect to the inclusion of a deterministic linear (!) time trend in (1.5), it should be clear that its statistical significance in eq.(1.5) would imply trend-stationarity for the inflation rate differential, because $\delta^* > 0$ also implies that $\rho < 0$, since $\delta^* = (1 - \rho)\delta)$. A trend-stationary inflation differential of country i implies that a) from the beginning it will diverge upwards or downwards the euro area average if the national inflation rate lied close to the monetary union's average or b) after having reached the currency area average at a certain point, it would diverge (upwards or downwards) again, depending on whether at the starting point country i's inflation differential was below or above the currency area average. These two implications would speak against the inclusion of a linear time trend in the convergence tests equations.[17]

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[15] To check for the robustness of the ADF test results, we perform also Phillips-Perron unit root tests, which correct in a different, non-parametric manner as the ADF tests for serial correlation. Those statistics are reported in the appendix of this chapter.

[16] As stated before, Mentz and Sebastian (2003) follow an alternative though equivalent strategy: using the Johansen procedure, they test for cointegrating relationships between the levels (not the differentials) of national inflation rates. Obviously, in presence of cointegration between the inflation rate levels, the differentials between them would be stationary.

[17] Nevertheless, due to the regime change caused by the monetary unification discussed in Frankel

Concerning the second subperiod, the Kwiatkowsky et al. (1992) (KPSS) test was used in order to check for the stationary of the national inflation rate gaps after the introduction of the euro. The main difference between the KPSS test and the unit root tests discussed in the previous section is the definition of the null hypothesis: While in the first mentioned tests the null is the existence of a unit root, in the KPSS under the null the analyzed time series is stationary. To test for this hypothesis, Kwiatkowsky et al. (1992) use the residuals of the OLS regression of the analyzed series y_t on the set of exogenous variables X_t,

$$\varphi_t = X_t'\delta + u_t \tag{1.6}$$

where X_t can consist of a constant or a constant and a deterministic time trend. Under the null of the KPSS test, y_t is assumed to be level or trend stationary. Now, for my analysis of national inflation rate differentials, not only the eventual stationarity of the time series, but also the *level* around which these time series can be considered to be stationary is important: a stationarity around a nonzero level would imply a persistence in the inflation rate differentials, and therefore a sustained gain or loss of relative competitiveness towards the other Member States, depending whether the nonzero level is below or above zero. As it will be discussed below, such a dynamic behavior of the national inflation differentials in the EMU will be confirmed for many countries by the econometric estimation results.

Table 1.1 contains a variety of interesting and somewhat concerning results. In the first place, concerning the univariate ADF unit root tests results,[18] we find in the first subsample from 1990:1-1997:12 a very differentiated picture of the absolute convergence process of the inflation differentials among the EMU countries. Indeed, when the ADF tests are computed without the intercept, as proposed by Busetti et al. (2006), only for Portugal, the country with the most remarkable disinflation process besides Greece, the H_1 hypothesis of absolute convergence cannot be rejected at the 5% significance level. At the 10% level, this hypothesis cannot be rejected additionally for Austria, Germany, Spain and the Netherlands, and with some tolerance, Italy. If not absolute, but relative or conditional convergence is tested by including an intercept in the ADF tests, we find statistically significant coefficients also for Finland. For the remaining countries,

and Rose (1998), such theoretically plausible outcomes are not likely to occur, since the linear time trend might lose validity for the dynamics of the inflation rate gaps due to the possible change in the behavior of the economic agents.

[18] Alternatively, we computed Phillips-Perron unit root tests with nearly the same results. These univariate and panel Phillips-Perron tests can be found in the appendix of this chapter.

Tab. 1.1: National Annual Inflation Rate Differentials (to EMU average): Univariate ADF Unit Root Tests

	Subsample: 1990:1 - 1997:12						1998:1 - 2005:12	
	No Intercept		With Intercept				No Intercept	
Country	ϕ	p-val*	ϕ	p-val*	const.	t-stat	ϕ	p-val*
AUT	-.0544	.0544	-.1333	.0788	-.0010	.0557	-.0770	.0981
BEL	-.0164	.3063	-.0545	.4977	-.0006	.2110	-.1062	.0827
DEU	-.0366	.0688	-.0387	.5327	-3.8E-5	.8977	-.0206	.3366
ESP	-.0437	.0566	-.1110	.2232	.0008	.1473	-.0050	.6062
FIN	-.0313	.1115	-.0834	.0344	-.0013	.0082	-.0218	.3336
FRA	-.0082	.3939	-.0224	.8256	-.0002	.6118	-.0266	.3046
ITA	-.0264	.1332	-.0442	.5729	.0002	.4885	-.0569	.1568
LUX	-.0233	.2326	-.0828	.4700	-.0008	.2085	-.1612	.0495
NLD	-.0256	.0778	-.0229	.7862	4.7E-5	.8985	-.0400	.1452
PRT	-.0217	.0499	-.0218	.6408	6.1E-6	.9933	-.0300	.1977

Note: * denotes MacKinnon (1996) one-sided p-values.

Belgium, France and Luxembourg, we find a completely different dynamic behavior of their national inflation differentials: For these economies, the null of a non-convergent dynamic behavior of the national inflation differentials cannot be rejected at standard confidence levels, even when a linear trend is included (not reported in Table 1.1).

In order to investigate the degree of persistence in the national inflation rate differentials half-lives are computed with the empirical estimates of $\hat{\phi} = \hat{\rho} - 1$ according to

$$\tau_i = \frac{\ln(0.5)}{\ln(\hat{\rho}_i)}.$$

Table 1.2 shows the speed of convergence of the inflation differentials of the EMU Member States: While during the 1990s the speed of convergence of the national inflation differentials was on average nearly two years, or 24 months,[19] in the second subsample posterior to the monetary unification (EMU Stage III) the average speed of convergence of the inflation gaps in the EMU was nearly eighteen months, or one and a half years. For comparison Beck and Weber (2005) calculate half-lives for the interregional inflation rate differentials in the U.S., Canada and Japan between six months and one year. The EMU thus, compared with these economies – the other monetary union comparable in size and economic characteristics –, seems to exhibit a much higher degree

[19] hereby we do not take into account Belgium, France and Luxembourg, the countries for which the null of a non-convergent behavior could not be rejected at standard confidence levels.

Tab. 1.2: Inflation Differentials to EMU Average: Computed Half Lives

Country	AUT	BEL	DEU	ESP	FIN	FRA	ITA	LUX	NLD	PRT
					Subsample: 1990:1 - 1997:12					
τ	12.39	41.91	18.58	15.51	21.79	84.18	25.90	25.90	26.72	31.59
					Subsample: 1998:1 - 2005:12					
τ	8.65	6.173	33.30	138.2	31.44	25.71	11.83	3.94	16.97	22.75

of persistence in its inflation rate differentials, which could, if this behavior remains unchanged in the following years, represent a problem for the conduction of monetary policy and the balanced macroeconomic development of the EMU Member States, as discussed before.

Respecting the stationarity of the inflation gaps in the subperiod posterior to the monetary unification, we find that while the null hypothesis of stationary cannot be rejected for Austria, Belgium Germany, Spain, Luxembourg and Portugal, only for Belgium and Luxembourg the stationarity of their inflation differentials *around the zero level* cannot be rejected. For all other mentioned countries, we find that the respective inflation differentials are stationary around a *nonzero* level.

Tab. 1.3: National Annual Inflation Rate Differentials (to EMU average): KPSS Stationarity Tests.

					Subsample: 1998:1 - 2005:12					
Country	AUT	BEL	DEU	ESP	FIN	FRA	ITA	LUX	NLD	PRT
LM-stat	.1711	.2509	.2288	.2351	.9628†	.7103†	.4635†	.1827	.6268†	.4017
const	-.0023	-.0008	-.0061	.0097	-.0052	-.0043	.0029	.0009	.0039	.0099
t-stat	.0000	.0893	.0000	.0000	.0030	.0000	.0000	.0809	.0000	.0000

Note:† denotes rejection at the 5% level according to Kwiatkowsky et al. (1992, Tab.1).

According to the KPSS test results shown in Table 1.3, we can categorize the EMU countries in three subgroups:[20] a below-average inflation group, an above-average inflation group, and a subgroup with non-stationary inflation behavior. In the first one, consisting of Austria, Belgium and Germany, the national inflation rate differentials are stationary around a below-average level. In the second subgroup, composed by Spain, Luxembourg and Portugal, the inflation rate differentials rather fluctuate around an

[20] The categorization of ECB (2003, p.7) of the EMU countries in high and low inflation countries is in line with our results.

above-average level. In the third subgroup, consisting of Finland, France, Italy, and the Netherlands, the null hypothesis of stationary inflation rate differentials around a constant level can be rejected at the 5% level: all countries in this subgroup, even Italy and the Netherlands after showing pronouncedly positive inflation rate differentials between 1998 and 2003, show increasingly negative inflation rate differentials in the past three years.

Additionally, stationarity tests for the national inflation differentials *to the Maastricht criteria consistent levels* were computed, that is, to the average inflation of the three countries with the lowest inflation rates. Indeed, since other candidates to join EMU as Bulgaria and Romania still have to fulfill the Maastricht convergence criteria, it would be interesting to investigate whether the countries already members in EMU would still fulfill such EMU entrance criteria.We thus redefine the national inflation differentials not relative to the EMU average, but relative to the average of the three countries with the (at each period) highest price stability.

Tab. 1.4: National Annual Inflation Rate Differentials (to Maastricht Criterion): KPSS Stationarity Tests.

Sample: 1998:1 - 2005:12										
Country	AUT	BEL	DEU	ESP	FIN	FRA	ITA	LUX	NLD	PRT
LM-stat	.4829†	.5599†	.5494†	.5884†	1.006†	.7275†	.1219	.4169†	.5046†	.2155
const	.0051	.0066	.0001	.0172	.0022	.0031	.0104	.0084	.0114	.0173
t-stat	.0000	.0000	.0000	.0000	.0030	.0000	.0000	.0000	.0000	.0000

Note:† denotes rejection at the 5% level according to Kwiatkowsky et al. (1992, Tab.1).

Table 1.4 shows the results of the KPSS stationarity tests: As it can be observed, for nearly all countries the null hypothesis of stationary inflation differentials around the level consistent with the Maastricht criteria can be rejected. If the EMU countries where to enter the EMU now, nearly none of them would fulfill the convergence criteria of the Maastricht Treaty.

1.3.2 Multiple Series Convergence and Stationarity Tests

Besides investigating the dynamic behavior of the national inflation differentials through single equation tests, we use multiple series or panel tests. As discussed in Breitung and Pesaran (2005), the panel approach has additional advantages with respect to the univariate analysis of the previous section, since it allows to extract more information from the cross sectional dimension, if the analyzed time series are expected to exhibit a similar behavior. Additionally, this procedure allows to identify convergence "clubs" or subgroups, by the statistical test of a similar autoregressive term.[21]

We use two different types of panel unit root tests for our analysis: the multivariate versions of the ADF and Phillips-Perron tests (the latter reported in the appendix) as proposed by Maddala and Wu (1999) and by Choi (2001) and the Breitung (2000) test.

The Breitung (2000) test for example is a two-step procedure which is based on the following equation

$$\Delta\varphi_{i,t} = \phi\varphi_{i,t-1} + \sum_{j=1}^{p_i} \beta_{i,j}\Delta\varphi_{i,t-j} + X'_{i,t}\delta + \epsilon_{i,t} \quad \text{with} \quad i = 1, 2, \ldots N,\ t = 1, 2, \ldots, T. \tag{1.7}$$

where $X'_{i,t}$ contains as exogenous terms an intercept and a linear trend. As it can be observed in eq.(1.7), the Breitung test allows for a different cross-sectional lag order, but assumes that the autoregressive coefficient (ϕ) is cross-sectionally equal, so that the null of a unit root process

$$H_0 : \phi = \phi_i = 0,\ \forall\ i.$$

is tested against $H_1 : \phi < 0$. In the first step of the Breitung procedure, $\varphi_{i,t}$ and $\Delta\varphi_{i,t}$ are regressed on the lagged terms $\Delta\varphi_{i,t-j}$ to correct for autocorrelation.

In the second step, the (standarized) residuals $\bar{\varphi}_{i,t}$ and $\Delta\bar{\varphi}_{i,t}$ are used to calculate the standarized proxies $\tilde{\varphi}_{i,t} = \bar{\varphi}_{i,t}/s_i$, which are transformed and (eventually) detrended according to[22]

$$\begin{aligned} \Delta\varphi^*_{i,t} &= \sqrt{\frac{T-t}{T-t+1}}\left(\Delta\tilde{\varphi}^*_{i,t} - \frac{\Delta\tilde{\varphi}^*_{i,t+1} + \ldots + \Delta\tilde{\varphi}^*_{i,t+T}}{T-t}\right) \\ \varphi^*_{i,t-1} &= \tilde{\varphi}^*_{i,t-1} - c_{i,t}, \end{aligned}$$

where

$$c_{i,t} = \begin{cases} 0 & \text{if no intercept or trend} \\ \tilde{\varphi}_{i,t} & \text{with intercept, no trend} \\ \tilde{\varphi}_{i,1} - ((t-1)/T)\tilde{\varphi}_{i,t} & \text{with intercept and trend.} \end{cases}$$

[21] See e.g. Busetti et al. (2006).
[22] See Eviews 5 (2004, p.521).

The autoregressive coefficient ϕ is then estimated by

$$\Delta\varphi^*_{i,t} = \phi\varphi^*_{i,t-1} + \nu_{i,t}.$$

Breitung (2000) shows that ϕ is asymptotically normal distributed.

By means of these panel convergence tests, as also done in previous studies as Beck and Weber (2005) and Busetti et al. (2006), we can confirm the results obtained by univariate unit root tests shown in Table 1.1: As shown by the panel ADF tests in Table 1.5, for the subgroup consisting of Austria, Germany, Spain, the Netherlands and Portugal, the null hypothesis of a *joint* process of absolute convergence cannot be rejected for the period prior to the introduction of the euro. Our strategy to identify

Tab. 1.5: National Annual Inflation Rate Differentials (to EMU average): Panel ADF and Breitung Unit Root Tests

Subsample: 1990:1 - 1997:12						
	M-ADF				Breitung	
Group	Fisher-χ^2	p-val*	Choi-Z	p-val*	Br. t-stat	p-val*
EU10	43.58	.0017	-3.660	.0001	.1393	.5554
NCG1: EU10-PRT	37.59	.0044	-3.309	.0005	.2779	.6095
NCG2: NCG1-AUT	31.77	.0107	-2.943	.0016	.5563	.7110
NCG3: NCG2-ESP	26.02	.0257	-2.547	.0054	.7489	.7730
NCG4: NCG3-DEU	20.67	.0554	-2.145	.0159	.8968	.8151
NCG5: NCG4-NLD	15.56	.1128	-1.715	.0431	1.0566	.8547
NCG6: NCG5-FIN	11.17	.1918	-1.308	.0953	-.4835	.3144
EUCG1={AUT,DEU,ESP,NLD,PRT}	28.02	.0018	-3.460	.0003	-.953	.1703

* Probability values assuming asymptotic Chi-Square distribution.

this subgroup was the following: Due to the definition of the null hypothesis in the panel context (where under the null *all* series in the panel possess a unit root, common or individual), we dropped stepwise from the group of EMU members and analyzed the countries for which the null of a unit root (and therefore the hypothesis of non-convergence) could be rejected at standard significance level by means of the ADF unit root (with no intercept) test results of Table 1.1. This stepwise procedure allowed us to identify the subgroup of *non-convergent* countries, and residually, also the subgroup of *convergent* countries. Hereby we followed the multivariate version of the ADF tests, primarily for the sake of comparability between Tables 1.3 and 1.5. For comparison we show also the resulting statistics from the Breitung panel unit root tests. Nevertheless, since under the null of these panel tests all series have a *common* autoregressive term ϕ, these tests impose more restriction under the null than the multivariate versions of the ADF and Phillips-Perron tests.

In sum these findings confirm the test results of the above mentioned studies concerning the convergence of the national inflation differentials prior to the monetary unification and a somewhat divergence thereafter. Especially we do not find support for a hypothesis of stationary inflation rate differentials *around a zero mean*, since as Busetti et al. (2006, p.21) state, when applying a multivariate stability test on a 11-dimensional vector of all (pairwise) inflation differentials obtain that "the null hypothesis is clearly rejected when testing without an intercept term while it cannot be rejected [...] if an intercept is included. Thus, while inflation rates within the EMU can be considered jointly stationary over the period 1998-2004, they appear to fluctuate around different means, forming two or possibly three convergence clubs."

Keeping in mind the cumulative effects that inflation rates which are persistently above or below average inflation rates can have on the competitiveness of domestic products in the international markets of goods and services, these findings rise serious concerns regarding the adequacy of the Maastricht convergence criteria for future candidate countries prior, and the complete absence of them after their entrance in EMU. As discussed before, persistently above-(below-)average inflation rate levels are likely to affect the relative level of economic activity of the monetary union's member countries through the real interest and exchange rate channel, and might represent a threat for their medium run competitiveness if they are not supported by accordant productivity growth developments.

1.4 Structural Analysis of Inflation Differentials and Business Cycles Fluctuations in the EMU

In this section the causes of the rise in inflation rate differentials among the EMU countries before and after the introduction of the euro are investigated. Hereby we focus on the link between the dynamics of relative price inflation and the relative country-specific level of economic activity to the euro area average.

The methodological approach of this section resembles the one of Honohan and Lane (2003), who investigated the existence of inflation differentials in the EMU using different price indices by means of pooled OLS and GMM estimation methods. Their main empirical findings concerning the main determinants of inflation differentials in EMU can be summarized as follows:

- The coefficient of the lagged price level, a proxy for the price level convergence within EMU, enters significantly and with the correct sign in all specifications.
- The rate of change of the nominal effective exchange rate (a measure for the pass-through) influences significantly the inflation gaps calculated with all used price indices.
- The fiscal surpluses are found to be insignificant in all specifications –with the exception of the inflation gap based on the private consumption deflator– where the fiscal surplus is found to be only marginally significant.
- The effect the output gap is positive and statistically significant for all inflation differentials but the one calculated with the import price index.

This study nevertheless differs from Honohan and Lane (2003) in that while they used a panel approach with fixed effects to find joint effects among the EMU countries, the focus here is to determine the country specific role of the national business cycles positions, import price inflation and real marginal costs developments for the inflation differentials.

1.4.1 Theoretical Foundations

Concerning the empirical study of inflation (and more specifically, of the inflation differentials in the EMU), the majority of previous empirical investigations such as von Hagen and Hofmann (2004) and Hofmann and Remsperger (2005) use the hybrid New Keynesian Phillips Curve as the starting point of their econometric estimations. Indeed, during the last decade, New Keynesian style models have become the standard workhorse of structural macroeconomic analysis in the majority of academic and policy-maker circles. Set up in an intertemporal utility maximizing framework, the type of models discussed in Roberts (1995), Rotemberg and Woodford (1997) and Galí and Gertler (1999) explain inflation as the result of a Calvo (1983) staggered price setting by monopolistic firms which, under the assumption that wages are perfectly flexible, reset their prices in an optimal manner when they obtain the opportunity to do so. Under this theoretical setting, the resulting adjustment equation for aggregate price inflation, known as the New Keynesian Phillips Curve,[23] is expressed as

$$\pi_t = y_t + E_t[\pi_{t+1}]. \tag{1.8}$$

where y_t denotes the output gap and $E_t[\pi_{t+1}]$ denotes the expected inflation at $t+1$ based on the information set available at t.

The New Keynesian Phillips Curve –as discussed for example in Mankiw (2001) Estrella and Fuhrer (2002) and Rudd and Whelan (2005)– has, despite of its solid microfoundations, two main empirical shortcomings: In the first place, it implies a negative relationship between the rate of change of inflation and the output gap, while the opposite holds in the majority of countries. In the second place, as eq.(1.8) explains, inflation is only dependent on the actual output gap and on the future expected inflation, with past inflation being completely irrelevant for its actual level. Aggregate macroeconomic data shows, on the contrary, a high degree of inflation persistence not only in the U.S. but in the majority of industrialized countries. In order to account for the high degree of autocorrelation observable in aggregate inflation data, Galí and Gertler (1999) and Galí, Gertler and López-Salido (2001) have proposed a *hybrid version* New Keynesian Phillips Curve:

$$\pi_t = \upsilon_t + E_t[\pi_{t+1}] + \pi_{t-1}, \tag{1.9}$$

where actual inflation does not depend only on future expected inflation, but also on past inflation and additionally not the output gap y, but $\upsilon = \ln(v/v_o)$, the log deviation of the real marginal costs from their steady state value (the actual variable derived by the theoretical New Keynesian model) is included. Galí and Gertler (1999) justify their modification concerning the past inflation influence through the assumption of "rule of thumb"-led firms which –when unallowed to reset their prices optimally– increase them according to the last inflation rate.

Apart from the empirical caveats concerning the New Keynesian Phillips Curve, its very much essence concerning its perception of reality has been questioned in a a variety of recent papers as Erceg et al. (2000) and Blanchard and Galí (2005). The main argument which has been put on the table is that empirical evidence suggests that not prices, but actually nominal wages should be considered as sticky. The high autocorrelation

[23] See Walsh (2003b) for an extensive discussion of the theoretical derivation of the New Keynesian Phillips Curve.

of inflation, or in other words its significant persistence, is likely to be caused primarily by the sluggishness of the nominal unit labor costs (that is, nominal wages corrected from labor productivity) and not by the sluggishness of the price level *per se*. Based on this notion, Erceg et al. (2000) and Christiano et al. (2005) have developed, again in an intertemporal utility maximizing framework, theoretical models with both staggered wages and prices, where nominal wages, staggered also in a Calvo (1983) manner, are set in a monopolistic manner by the households.[24]

We leave however these critical considerations on the New Keynesian approach aside in the empirical analysis of this section and proceed in a rather a-theoretical way which does not constrain our specification to a specific theoretical approach, but rather include freely different variables which are presumed to explain actual inflation by these and other different schools of economic thought. More specifically, we include besides the expected future inflation and past inflation also the log-deviation of the real marginal costs from their long run mean υ, the growth rate of the nominal unit labor costs π^{ulc}, or in other words, the nominal wage inflation rate corrected by the growth rate of labor productivity and π^m, the import price inflation since, as discussed by Goodhart and Hofmann (2005, p.762), "omitting oil prices, commodity prices or import prices from the empirical Phillips Curve may give rise to a downwards biased estimate of the output gap coefficient, which may explain Mehra's (2004) finding that the significance of the output gap can be restored when supply shocks are included in the empirical model." Indeed, as discussed in ECB (2005, p.63-64), the main contributors to the observed inflation differentials in the euro area have been internal factors such as national unit labor costs and gross operating surpluses, and in relatively more open economies as the Netherlands and Belgium, the import prices. The below average development of the unit labor costs in Germany and France since the introduction of the euro also explain the negative inflation gap of these two countries with respect to the euro area average.

Our general specification can be thus expressed as

$$\pi_t = c + \beta_y y_{t-1} + \beta_\upsilon \upsilon_{t-1} + \kappa_f E_t[\pi_{t+1}] + \sum_{j=1}^{J} \kappa_{b,j}\, \pi_{t-j} + \kappa_m \pi_t^m + \kappa_w \pi_t^{ulc}. \quad (1.10)$$

[24] As discussed in the previous chapter, alternatively to the New Keynesians, other researchers such as Fair (2000), or Chiarella, Flaschel and Franke (2005) have modeled the dynamics of wage and price inflation through two separate Phillips Curves, for both price and nominal wage inflation, the latter with different measures of demand pressure – the labor market on nominal wages and the goods market on prices – and more elaborated expectation schemes.

In the same manner, we estimate the national inflation differentials according to

$$\varphi_t \quad = \quad c + \beta_y \tilde{y}_{t-1} + \beta_v \tilde{v}_{t-1} + \kappa_f E_t[\varphi_{t+1}] + \sum_{j=1}^{J} \kappa_{b,j}\ \varphi_{t-j} + \kappa_m \varphi_t^m + \kappa_w \varphi_t^{ulc} \quad (1.11)$$

where ˜ denotes the deviation of real variables (output gap and real unit labor costs) from the euro area average, and φ denotes the gap of price inflation, import price inflation and the growth nominal unit labor costs with respect to the euro average.

1.4.2 Econometric Analysis

Our main objective is to detect the principal differences in the inflation (and inflation differential) determination between the EMU countries. We perform in the first place individual estimations of these two variables by means of the GMM (Generalized Method of Moments) methodology.[25] This estimation procedure, developed on the work by Hansen (1982), is basically an instrumental variables estimation procedure, which nevertheless does not rely on any assumption concerning the distribution of the estimation residuals but instead, as a minimum distance estimator, seeks to optimize a determined objective function. The GMM estimator of β is a vector $\hat{\beta}^{\mathrm{GMM}}$ which solves the problem[26]

$$\hat{\beta}^{\mathrm{GMM}} \equiv \arg\min_{\beta} \left[\sum_{i=1}^{N} Z_i'(y_i - X_i\beta) \right]' \hat{W} \left[\sum_{i=1}^{N} Z_i'(y_i - X_i\beta) \right]$$

where Z is the matrix of instrumental variables, X the matrix of explanatory variables, y the vector of explained variables and $\hat{W}$ a symmetric, positive semidefinite weighting matrix which particular form is to be chosen. For the estimations discussed below, we used a weighting matrix which allows the GMM estimates to be robust against possible heteroskedasticity, as well as serial correlation (of any order and form), in the error terms. The parameter values were computed through simultaneous updating of the HAC (heteroskedasticity and autocorrelation consistent) weighting matrix and the matrix of parameters, whereas the parameter convergence criterion was set to 0.001.

The use of an instrumental variables estimator as GMM is also adequate since it allows for the accounting for eventual regressor endogeneity in the case that some of

[25] For a comprehensive discussion of the GMM methodology see Hayashi (2000) and Wooldridge (2001).

[26] See Wooldridge (2002, p.190).

the explaining variables are not completely exogenous. Additionally, since among the explaining variables contained in our general specification there are also expected future variables, the use of an instrument set composed solely by lagged variables allows for the approximation of the expected values of those forward-looking variables on the basis of the information available at time t. In order to test for the validity of the overidentifying restrictions we calculate the J-statistics as proposed by Hansen (1982).

We performed our single-equation GMM estimations of the inflation rate and inflation differentials adjustment equations according to eqs.(1.10) and (1.11) for Germany (DEU), France (FRA), Spain (ESP), Italy (ITA) and the Netherlands (NLD) including alternatively different measures of aggregate demand pressure on inflation in the set of explaining variables: The cyclical components of the industrial production indices and the national GDPs at constant 1995 prices calculated by the asymmetric band-pass filter of Christiano and Fitzgerald (2003) and by the Hodrick-Prescott Filter, the utilization rate of capacity and the output gap according to the OECD methodology (shown in Figure 1.5). In the set of instrumental variables the four lags of price inflation were included, the respective measure of aggregate demand, import price inflation and the nominal unit labor costs inflation.

With the exception of France, the output gap series, calculated by the OECD, did not turn out to possess any explaining power for the analyzed economies. The use of the cyclical components of the real GDP computed by the asymmetric Christiano-Fitzgerald methodology delivered results quite similar to the ones obtained with the more standard Hodrick-Prescott filtered GDP series. Therefore we discuss here only the estimated equation for each country obtained with the HP filtered GDP as measure of the aggregate demand. The obtained GMM parameter estimates are reported in Table 1.6.

As it can be observed in Table 1.6, the coefficient of aggregate demand pressure β_y enters significantly in both the inflation rate and the inflation differentials equation of all analyzed countries, with exception of Germany, where it possess significant explanatory power only in the first equation. Respecting the extent of such influence on the national inflation differentials, Table 1.6 shows that this is at its largest in Italy and at its lowest in France.

Concerning the coefficient of the real marginal costs, the first main determinant of aggregate price inflation in the New Keynesian Phillips Curve, in Table 1.6 it is found to

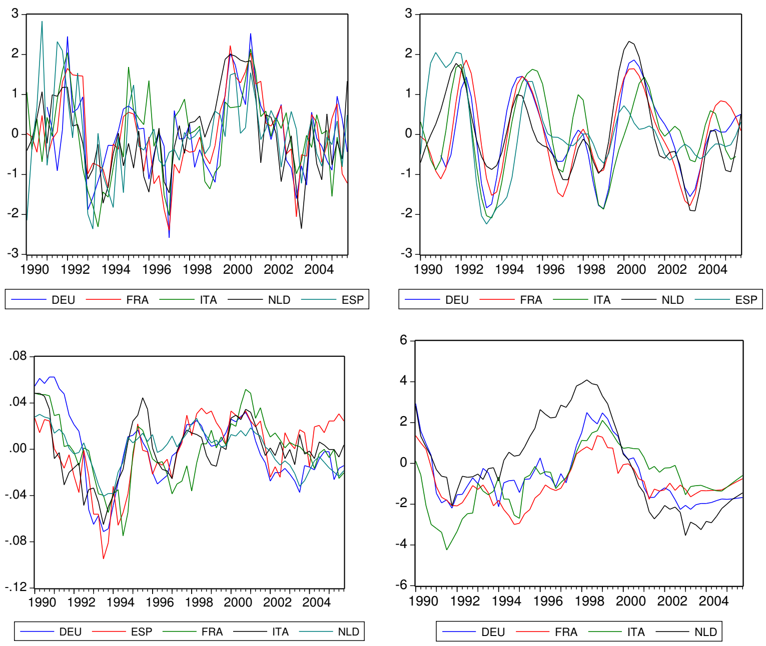


Fig. 1.5: Measures of aggregate demand pressure: GDP at constant 1995 prices (Hodrick Prescott and asymmetric Christiano-Fitzgerald cyclical components), capacity utilization rate of the business sector and output gap (OECD series)

be statistically significant at standard confidence levels only in the inflation adjustment equations of France and Italy, and in the inflation differential equation of France. The second main determinant of inflation according to the New Keynesian approach, the expected future inflation, is found to possess a significant and similar explanatory power for the dynamics of the inflation and the inflation gaps of Italy and the Netherlands.

Lagged price inflation, as well as contemporaneous import price inflation, enter in a significant – and concerning the dimension of their estimated coefficients also in a quite similar – manner in the inflation adjustment equations of all five analyzed countries, and with the exception of Italy, also of all inflation rate differential equations. The sum of the coefficients of lagged inflation, often used as a persistence measure, is found to be the largest in Spain. Finally, respecting the growth rate of the nominal unit labor costs, these seem to account up to a certain degree the difference between the Dutch inflation rate and the euro area average, a result which is consistent with the empirical stylized facts discussed in ECB (2003).

Tab. 1.6: Single-Equation GMM Estimation Results. Aggregate Demand Proxy: GDP at constant 1995 prices (HP Filter Cyclical Components)

Sample: 1990:1 - 2005:12											
	β_y	β_υ	κ_f	$\kappa_{b,j}$	$\kappa_{b,4}$	κ_m	κ_w	const	$\bar{R}^2$	DW	J-stat
π_t^{DEU}	.1176 [.0000]	-	-	.1262 [.0000]	.2292 [.0001]	.0253 [.0000]	-	.0002 [.4718]	.5381	1.737	.1463 .7928
φ_t^{DEU}	.0208 [.8365]	-	-	.2458 [.0001]	-	.0187 [.0001]	-	$-.0019$ [.0000]	.5016	1.672	.1578 .9540
π_t^{FRA}	.0580 [.0234]	.0353 [.0339]	-	-	.3689 [.0000]	.0313 [.0000]	-	.0028 [.0000]	.4832	1.871	.1147 .9576
φ_t^{FRA}	.2878 [.0002]	.0983 [.0000]	-	-	.5159 [.0000]	.0053 [.0000]	-	$-.0020$ [.0000]	.4488	2.079	.1716 .9018
π_t^{ITA}	.1163 [.0008]	.0109 [.0933]	.0892 [.1531]	.2882 [.0000]	.3432 [.0000]	.0065 [.1000]	-	.0020 [.0025]	.7035	1.614	.1322 .9272
φ_t^{ITA}	.0534 [.6602]	-	-	.3365 [.0008]	.1172 [.0787]	.0129 [.0000]	-	-	.1083	1.678	.1855 .8656
π_t^{ESP}	.0652 [.1138]	-	-	.3248 [.0015]	.4749 [.0000]	.0118 [.0789]	-	-	.4721	2.369	.2006 .7551
φ_t^{ESP}	.2198 [.0000]	-	-	-	.9501 [.0000]	.0004 [.8666]	-	$-.0018$ [.0065]	.2640	2.5508	.1379 .9445
π_t^{NLD}	.0546 [.0538]	-	-	-	.3753 [.0000]	.0161 [.0010]	-	.0565 [.0288]	.2945	2.212	.1786 .9644
φ_t^{NLD}	.5734 [.0000]	-	.3908 [.0004]	-	.2278 [.0006]	.0113 [.0000]	-	.0032 [.0000]	.3098	1.803	.1316 .9645

Departing from these single-equation GMM estimation results, we focus now on the effect of the aggregate demand pressure on inflation before and after the introduction of the euro. Hereby we rely on the single-estimation results provided by Table 1.6 and estimate by panel two-stage least squares (TSLS) a reduced form of eq.(1.10), where only lagged price inflation, contemporaneous import price inflation and the proxy for aggregate demand pressure enter as explanatory variables, not including the expected future inflation, which was found to be significant only in Italy and Spain.[27]

Due to the increased sample size which is obtained by a panel estimation procedure, we split our analyzed sample in a pre- and a post-euro subperiod, 1990:1-1997:4 and 1998:1-2005:4, respectively. According to the discussion of the previous section, we would expect an increased influence of the national business cycle position on the aggregate

[27] Hofmann and Remsperger (2005), Goodhart and Hofmann (2005) and Angeloni and Ehrmann (2007), the first and the third concerning the inflation rates and not their differentials, found by fixed-effects panel estimation with euro area country data that expected inflation enters significantly in inflation adjustment equations based on the hybrid New Keynesian Phillips Curve. Nevertheless, we would like to stress again that our estimated coefficients were obtained in a free GMM estimation without the use of constraints such as $\kappa_f + \kappa_{b,1} = 1$, as was done in these mentioned studies.

inflation after the monetary unification due to the disappearance of the country-specific nominal exchange rates. In order to increase the degrees of freedom of the panel estimation and due to the similarity of the estimated coefficients of the past CPI and present import price inflation reported in Table 1.6, we restrict their coefficient in the panel estimation to be the same across countries and allow only β_y to be country-specific.

In both subsamples, the balanced panel contains 155 observations.[28] We present in Table 1.7 the estimation results for two specifications, I and II. In I we used the output gap (measured as the percent deviation of real GDP from the Hodrick-Prescott trend as in the previous section) at $t-1$, while in II the actual output gap value was used.

Tab. 1.7: Panel Two-Stage Least Squares Estimation Results. Aggregate Demand Proxy: GDP at constant 1995 prices (HP Filter Cyclical Components)

	Sample: 1990:1 - 1998:4						Sample: 1998:1 - 2005:4					
	I			II			I			II		
	coeff.	t-stat	p-val	coeff.	t-stat	p-val	coeff.	t-stat	p-val	coeff.	t-stat	p-val
const.	.0044	2.506	.0133	.0043	2.465	.0148	.0072	4.644	.0000	.0075	5.066	.0000
π_{t-1}	.1700	2.768	.0064	.1745	3.166	.0019	-	-	-	-	-	-
π_{t-4}	.5737	10.36	.0000	.5693	11.84	.0000	.5648	12.78	.0000	.5716	12.09	.0000
π_t^m	.0267	3.036	.0028	.0212	2.905	.0042	.0184	5.136	.0000	.0175	5.309	.0000
y_{t-j}^{DEU}	**.6405**	**1.919**	**.0569**	-.8628	-1.294	.1974	.1969	.9232	.3574	.1886	0.674	.5011
y_{t-j}^{ESP}	.1352	0.647	.5182	.3233	1.324	.1875	.0635	.1732	.8627	**.7126**	**1.977**	**.0499**
y_{t-j}^{FRA}	**.5101**	**2.895**	**.0044**	.1923	1.171	.2432	.1861	.6599	.5103	.1848	0.601	.5483
y_{t-j}^{ITA}	.2998	1.322	.1882	.6118	1.601	.1113	**.4377**	**2.755**	**.0066**	**.6641**	**4.565**	**.0000**
y_{t-j}^{NLD}	.2493	1.098	.2740	.1150	0.412	.6804	**.5088**	**2.224**	**.0276**	**.6048**	**2.089**	**.0384**
$\bar{R}^2$		.6063			.6095			.4158			.4218	
DW		2.055			2.130			2.063			2.073	

The estimated coefficients of past CPI inflation and the actual import price inflation are quite stable across the four different estimations reported in Table 1.7. However, a considerable variability concerning the coefficients of the country-specific aggregate demand proxies between the two specifications and also between the two analyzed subsamples can be observed in Table 1.7. Indeed, in specification I, for the first subperiod we have positive, statistically significant and similar coefficients only for Germany and France. For the same subperiod, using not the past but the actual proxy for excessive aggregate demand (specification II), we find insignificant coefficients for all five

[28] The four quarters of 1998 are included in both subsamples due to the fact that, while the euro officially was introduced at the beginning of 1998, it got into circulation among the public in January 1999.

analyzed countries at standard confidence levels.

Concerning the second subperiod, which comprises the monetary unification and the adoption of the euro, we find that the coefficient of aggregate demand turns out to be highly significant in specification I for Italy and the Netherlands, and also for Spain in specification II. Interestingly, the same coefficient for France and Germany loses significance with respect to the first subperiod.

How are these somewhat puzzling results to be interpreted? There are different possible explanations: As a first alternative, the German reunification (and the subsequent exceptional increase in the aggregate demand in Germany) might have influenced to a significant extent not only the German, but also the behavior of the price inflation rates of the other European countries, as Spain, Italy and the Netherlands during the first half of the 1990s. The monetary unification, as well as the slowdown of the German economy in recent years, might have dampened the effect of the German reunification, with the subsequent increase in the influence of the own business cycles observed in our estimations for Spain, Italy and the Netherlands in the second subperiod.

An alternative interpretation could be related with the pro-cyclicality of the fiscal deficits resulting from the present formulation of the Stability and Growth Pact (SGP). The main argument goes as follows: Due to the Stability and Growth Pact (SGP) criteria, the possibilities to conduct a counter-cyclical fiscal policy are restricted to a budgetary deficit limit of 3% of the national GDP, and a level of fiscal debt of 60% of GDP. These values, nevertheless, are not independent from the economic performance of the economy. As it is widely known, the budgetary positions are highly pro-cyclical, with increasing tax revenues (and decreasing social security expenses) in economic upswing phases and widening deficits in recessions. In pronounced recession phases, as for example in Germany since the middle 1990s, governments that are constraint by the SGP criteria, will increase indirect taxes in order to reduce their fiscal deficits, as for example done in Germany in 2007. Higher taxes, nevertheless, are likely to lead to general increases the aggregate price levels, contributing so to a counter-cyclical behavior of national inflation rates.

1.5 Concluding Remarks

In this chapter the reasons for the existence and the dynamic behavior of the national inflation rates in the euro are countries were investigated from both the theoretical and the empirical perspective. Among other things, statistical evidence for a persistent upward or downward bias of national inflation differentials of several EMU Member States was found. Taking into account that in a monetary union such as the EMU the development of the national price levels is central for the homogeneity of the monetary policy impulses as well as for the international competitiveness of the monetary union member countries, the presence of inflation differentials persistently different from zero indeed raises some concerns about the future medium run macroeconomic development of the EMU members.

In order to identify the main determinants for the existence of inflation differentials in Germany, France, Italy, Spain and the Netherlands, single-equation GMM estimations were performed. The resulting parameter estimates shed some interesting insights across the analyzed countries worth to be stressed: First, the effect of the relative business cycle position of the economy is statistically significant for both inflation and inflation differentials adjustment equations in all countries but Germany, where this only holds for the former. Second, the degree of persistence, measured by the coefficients of the lagged values of inflation, is significant and of similar extent in all analyzed countries for both inflation and inflation differentials estimations. Despite the fact that this result is to a significant degree only the reflection of the persistence in the *levels* of the inflation rate, the importance of lagged values, as one of the main explaining variables in the inflation rate differentials, raises some concerns with respect to the probable destabilizing effects that such a persistence might bring with in the medium run for the EMU Member States and also for the EMU as a whole.

These results, nevertheless, are not definitive. The occurrence of extraordinary events such as the German reunification, as well as the simultaneous influence of contrarily acting effects and interplays might have weakened the accuracy of our econometric estimations. With the availability of larger data sets for the EMU Member States after the monetary unification, some of these open questions might be answered in the future.

Appendix A

Univariate and Panel Phillips-Perron Unit Root Tests

Tab. 1.8: National Annual Inflation Rate Differentials (to EMU average): Univariate Phillips-Perron Unit Root Tests

	Subsample: 1990:1 - 1997:12						1998:1 - 2005:12	
	No Intercept		With Intercept				No Intercept	
Country	ϕ	p-val*	ϕ	p-val*	const.	t-stat	ϕ	p-val*
AUT	-.0544	.0544	-.1333	.0705	-.0010	.0557	-.1082	.0913
BEL	-.0164	.3063	-.0545	.4976	-.0005	.2110	-.1502	.0494
DEU	-.0366	.0688	-.0387	.5251	-3.8E-5	.8977	-.0293	.3467
ESP	-.0369	.1016	-.0940	.3445	.0005	.1311	-.0182	.6087
FIN	-.0313	.1115	-.0834	.0361	-.0013	.0082	-.0218	.3387
FRA	-.0082	.3939	-.0323	.8142	-.0004	.3795	-.0372	.3134
ITA	-.0264	.1332	-.0442	.5650	.0004	.4885	-.0793	.1558
LUX	-.0228	.3209	-.1054	.3167	-.0012	.0609	-.3127	.0021
NLD	-.0256	.0778	-.0229	.7787	4.7E-5	.8985	-.0400	.1440
PRT	-.0217	.0499	-.0218	.6375	6.1E-6	.9933	-.0300	.1975

Note: * denotes MacKinnon (1996) one-sided p-values.

Tab. 1.9: National Annual Inflation Rate Differentials (to EMU average): Panel Phillips-Perron and Breitung Unit Root Tests

	Subsample: 1990:1 - 1997:12					
	M-Phillips Perron				Breitung	
Group	Fisher-χ^2	p-val*	Choi-Z	p-val*	Br. t-stat	p-val*
EU10	42.10	.0027	-3.511	.0002	.1393	.5554
NCG1: EU10-PRT	36.58	.0059	-3.191	.0007	.2779	.6095
NCG2: NCG1-AUT	31.15	.0129	-2.853	.0022	.5563	.7110
NCG3: NCG2-ESP	26.30	.0237	-2.540	.0055	.7489	.7730
NCG4: NCG3-DEU	20.74	.0542	-2.116	.0172	.8968	.8151
NCG5: NCG4-NLD	15.32	.1206	-1.646	.0499	1.0566	.8547
NCG6: NCG5-FIN	10.69	.2195	-1.196c	.1158	-.4835	.3144
EUCG1= {AUT,DEU,ESP,NLD,PRT}	26.77	.0028	-3.319	.0005	-.953	.1703

* Probability values assuming asymptotic Chi-Square distribution.

2. Gradual Wage-Price Adjustments and Keynesian Macrodynamics: Theoretical Formulation and Cross-Country Evidence

2.1 Introduction

During the last decade Dynamic Stochastic General Equilibrium (DSGE) models in the line of Erceg et al. (2000), Smets and Wouters (2003) and Christiano et al. (2005) have become the workhorse framework for the study of monetary policy and inflation in the academic literature. Based on solid microfoundations, the representation of the dynamics of the economy by theoretical frameworks of this type is derived from first principles (which result from a rational, forward-looking maximizing behavior by firms and households) and the condition of general equilibrium holding at every moment in time. However, though intellectually appealing at first sight, this approach has nevertheless been questioned from both the theoretical and empirical point of view by a numerous amount of researchers like Mankiw (2001), Estrella and Fuhrer (2002) and Solow (2004), among others, primarily due to its highly unrealistic assumptions concerning the alleged "rationality" in the forward-looking behavior of the economic agents. Indeed, as discussed in Fuhrer and Moore (1995), Mankiw (2001) and more recently in Eller and Gordon (2003), empirical estimations of wage and price Phillips curves based on the New Keynesian approach have, despite their sound microfoundations, only a poor performance in fitting the predictions generated by the underlying theoretical models of this approach with aggregate time series of both the United States and the euro area. As Mankiw (2001) states, "although the new Keynesian Phillips curve has many virtues, it also has one striking vice: It is completely at odds with the facts".

Alternatively, in Chiarella and Flaschel (1996) and Chiarella and Flaschel (2000) a theoretical macroeconomic framework has been proposed where wages and prices react sluggishly to disequilibrium situations in both the goods and labor markets. As it will be discussed in this chapter, despite of the apparent similarity that the gradual wage and price inflation adjustment equations along the lines of Chiarella and Flaschel (2000) share with their recent New Keynesian and DSGE analogues (which, among other things, also include elements of forward and backward looking behavior concerning the inflation dynamics of the economy), their approach is based on the notion of non-clearing goods and labor markets, and therefore of underutilized labor and capital stock. This alternative approach to the modeling of wage and price inflation dynamics thus permits an interesting comparison to New Keynesian work which, knowingly, models the dynamics of wage and price inflation as the result of the reoptimization by the economic agents under a staggered wage and price setting mostly in the line of Rotemberg (1982) and Calvo (1983).

In this chapter the semi-structural baseline Disequilibrium AS-AD model discussed in Chen, Chiarella, Flaschel and Semmler (2006) is described and estimated using aggregate macroeconomic time series not only of the U.S. economy, but also of the Euro Area, the U.K., Germany and France. On this basis, some of the questions to be addressed in this chapter are: To what extent is this semi-structural Keynesian macroeconomic model able to fit the behavior of wages, prices and other macroeconomic variables in the major industrialized economies? Are there significant differences in wage and price inflation (the wage-price spiral) among these economies observable over the past twenty years? Of the main Keynesian transmission channels, which ones are functioning and how strong are they in the analyzed countries? What are the implications of the wage-price spiral for the dynamics of income distribution in those economies?

The remainder of this chapter is organized as follows. In section 2.2 the Keynesian semi-structural macroeconomic framework introduced in Chen, Chiarella, Flaschel and Semmler (2006) is briefly discussed and its main conceptual differences from to the New Keynesian approach are highlighted. In section 2.4 the model is estimated by means of GMM with aggregate time series of the U.S., the Euro Area, the U.K., Germany and France in order to find out sign and size restrictions for its behavioral equations and to study which feedback mechanisms may have primarily influenced these economies in the past twenty years. Section 2.5 focuses on the eigen-value stability analysis of the system. Section 2.6 concludes.

2.2 A Baseline Semi-Structural Macromodel

In this section the baseline Keynesian macromodel introduced in Chen, Chiarella, Flaschel and Semmler (2006) is briefly presented. As it will be discussed in more detail below, this theoretical framework builds on gradual wage and price inflation adjustments as recent New Keynesian macroeconometric models, but assumes in contrast to those models that such adjustments are not the result of the agents' reoptimization to new economic conditions, but instead occur as a reaction to disequilibrium situations in both the goods and the labor markets.

2.2.1 The Goods and Labor Markets

Since the focus of this theoretical framework is indeed the modeling of the wage-price dynamics, the goods and labor markets are modeled in a rather parsimonious manner. Concerning the goods markets dynamics, a dynamic IS-equation is assumed (see also Rudebusch and Svensson (1999) in this regard) where the growth rate of output gap (represented by the growth rate of the capacity utilization rate of firms u) is determined by

$$\hat{u} = -\alpha_u(u - u_o) + \alpha_{uv}(v - v_o) - \alpha_{ur}((i - \hat{p}) - (i_o - \pi_o)), \tag{2.1}$$

Eq.(2.1) has three important characteristics; (i) it reflects the dependence of output changes on aggregate income by assuming a negative, i.e. stable dynamic multiplier relationship in this respect, (ii) it shows the joint dependence of consumption and investment on the real wage – which joint parameter may in the aggregate be positive ($\alpha_{uv} > 0$) or negative ($\alpha_{uv} < 0$), depending on whether consumption or investment is more responsive to real wage changes[1] – and finally (iii) it shows the negative influence of the real rate of interest on the evolution of economic activity.

Concerning the labor market dynamics, a simple empirical relationship is assumed which links output and employment (in hours) according to

$$e_h/\bar{e}_h = (u/u_o)^b.$$

Consequently, the growth rate of employment (in hours) is accordingly given by

$$\hat{e}_h = b\,\hat{u}. \tag{2.2}$$

[1] This simplifying formulation helps to avoid the estimation of separate equations for consumption and investment.

Employment in hours is in fact the relevant measure for the labor input of firms and therefore for the aggregate production function in the economy. Nevertheless, due to the lack of available time series of this variable for the European economies (this series is available only for the U.S.) and for the sake of comparability of the parameter estimates in the next section, it will be assumed here that the dynamics of employment in hours and actual employment are quite similar, so that eq.(2.2) in fact describes the dynamics of actual employment e, so that $\hat{e} = b\,\hat{u}$ holds.

2.2.2 The Wage-Price Dynamics

As stated before, the core of our theoretical framework, which allows for non-clearing labor and goods markets and therefore for under- or over- utilized labor and capital stock, is the modeling of wage-price dynamics, as being specified through two separate Phillips Curves, each one led by its own measure of demand pressure (or capacity bottlenecks), instead of a single one as is usually done in many New Keynesian models as for example by Galí and Gertler (1999) and Galí et al. (2001).

The approach of estimating two separate wage and price Phillips curves is not altogether new: While Barro (1994) observes that Keynesian macroeconomics are (or should be) based on imperfectly flexible wages and prices and thus on the consideration of wage as well as price Phillips Curves equations, Fair (2000) criticizes the low accuracy of reduced-form price equations. In the same study, Fair estimates two separate wage and price equations for the United States, using nevertheless a single demand pressure term, the NAIRU gap. In contrast, by the modeling of wage and price dynamics separately from each other, each one determined by its own measures of demand pressure in the market for labor and for goods, namely $e-e_o$ and $u-u_o$, respectively,[2] the identification problem pointed out by Sims (1987) for the estimation of separate wage and price equations with the same explanatory variables is circumvented.[3] By these means, the dynamics of the real wages in the economy can be analyzed and converse effects which might result from different developments on labor and goods markets can be identified.

The structural form of the wage-price dynamics in this theoretical framework is given

[2] hereby e denotes the rate of employment in the labor market (e_o being the NAIRU-level of this rate) and u the rate of capacity utilization of the capital stock –knowingly closely linked with the output gap– (u_o being its normal level).

[3] See Erceg et al. (2000) and Sbordone (2004) for other alternative approaches.

by:

$$\hat{w} = \beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o) + \kappa_{wp}\hat{p} + (1-\kappa_{wp})\pi_c + \kappa_{wz}\hat{z}, \quad (2.3)$$

$$\hat{p} = \beta_{pu}(u - u_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\hat{w} - \hat{z}) + (1-\kappa_{pw})\pi_c. \quad (2.4)$$

where $\hat{w} = \dot{w}/w$ and $\hat{p} = \dot{p}/p$ denote the growth rates of nominal wages and prices, respectively, that is, the wage and price inflation rates. The demand pressure terms $e - e_o$ and $u - u_o$ in the wage and price Phillips Curves are augmented by three additional terms: the log of the wage share v or real unit labor costs (the error correction term discussed in Blanchard and Katz (1999, p.71)), a weighted average of corresponding expected cost-pressure terms, assumed to be model-consistent, with forward looking, cross-over wage and price inflation rates $\hat{w}$ and $\hat{p}$, respectively, and a backward looking measure of the prevailing inertial inflation in the economy (the "inflationary climate", so to say) symbolized by π_c, and labor productivity growth $\hat{z}$ (which is expected to influence wages in a positive and prices in a negative manner, due to the associated easing in production cost pressure). Concerning the latter variable we assume for simplicity that it is always equal to the growth rate of trend productivity, namely $\hat{z} = g_z$ =const.[4]

Concerning the inertial inflation term, this may be formed adaptively following the actual rate of inflation (by use of some linear or exponential weighting scheme), a rolling sample (with bell-shaped weighting schemes), or other possibilities for updating expectations. For simplicity of exposition the use of a conventional adaptive expectations mechanism will be assumed in the theoretical part of this chapter, namely

$$\dot{\pi}_c = \beta_{\pi_c}(\hat{p} - \pi_c). \quad (2.5)$$

Note that here the Chiarella and Flaschel (1996) approach differs again from the standard New Keynesian framework based on the work by Rotemberg (1982) and Calvo (1983). Instead of assuming that the aggregate price (and wage) inflation is determined in a profit maximizing manner solely by the expected future path of nominal marginal costs, or in the hybrid variant discussed in Galí et al. (2001), which includes the effects of lagged inflation, it assumes that instead of last period inflation, the medium run inflationary development in the economy is taken into account by the economic agents.

[4] Even though explicitly formulated, we will assume in the theoretical framework of this chapter $g_z = 0$ for simplicity and leave the modeling of the labor productivity growth for future research.

The microfoundations of the wage Phillips curve are thus of the same type as in Blanchard and Katz (1999), see also Flaschel and Krolzig (2006), which can be reformulated as expressed as in eq.(2.3) and eq.(2.4) with the unemployment gap in the place of the logarithm of the output gap if hybrid expectations formation is in addition embedded into their approach. Concerning the price Phillips curve, a similar procedure can be applied, based on desired markups of firms. Along these lines an economic motivation for the inclusion of – indeed the logarithm of – the real wage (or wage share) with negative sign in the wage PC and with positive sign in the price PC is obtained, without any need for loglinear approximations. Furthermore the employment- and the output gap are incorporated in these two wage- and price-Phillips Curves equations, respectively, in the place of a single measure (the log of the output gap). This wage-price module is thus consistent with standard models of unemployment based on efficiency wages, matching and competitive wage determination, and can be considered as a valid alternative to the – at least empirically questionable – New Keynesian formulation of wage-price dynamics.

Note additionally, that model-consistent expectations with respect to short-run wage and price inflation are assumed, incorporated into the Phillips curves in a cross-over manner, with perfectly foreseen price- in the wage- and wage inflation in the price-inflation adjustment equations. It should be stressed that forward-looking behavior is indeed incorporated here, without the need for an application of the jump variable technique of the rational expectations school in general and of the New Keynesian approach in particular.[5]

Slightly different versions of the two Phillips curves given by eq.(2.3) and eq.(2.4) have been estimated for the U.S. economy in various ways in Flaschel and Krolzig (2006), Flaschel, Kauermann and Semmler (2007), Chen and Flaschel (2006) and Chen, Chiarella, Flaschel and Semmler (2006), and have been found to represent a significant improvement over the conventional single reduced-form Phillips curve. A particular finding of these studies is that wage flexibility is larger than price flexibility with respect to their demand pressure measures in the labor and goods markets,[6] respectively, and that workers are more short-sighted than firms with respect to their cost pressure terms.

[5] For a detailed comparison with the New Keynesian alternative to this model type see Chiarella et al. (2005).

[6] for lack of better terms we associate the degree of wage and price flexibility with the size of the parameters β_{we} and β_{pu}, though of course the extent of these flexibilities will also depend on the size of the fluctuations of the excess demand expression in the market for labor and for goods.

The corresponding across-markets or *reduced-form Phillips Curve* equations resulting from eqs.(2.1) and (2.2) are given by (with $\kappa = 1/(1-\kappa_{wp}\kappa_{pw})$):

$$\begin{aligned} \hat{w} &= \kappa\left[\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o) + \kappa_{wp}(\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o))\right. \\ &\quad \left. +(\kappa_{wz} - \kappa_{wp}\kappa_{pw})g_z\right] + \pi_c, \qquad (2.6) \\ \hat{p} &= \kappa\left[\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o))\right. \\ &\quad \left. +\kappa_{pw}(\kappa_{wz}-1)g_z\right] + \pi_c, \qquad (2.7) \end{aligned}$$

with pass-through terms behind the $\kappa_{wp}, \kappa_{pw}-$parameters, representing a considerable generalization of the conventional view of a single-market price PC with only one measure of demand pressure, namely the one in the labor market.

Note that for this current version of the wage-price spiral, the inflationary climate variable π_c does not matter for the evolution of the labor share $v = w/(pz)$, which law of motion is given by :

$$\begin{aligned} \hat{v} &= \hat{w} - \hat{p} - \hat{z} \\ &= \kappa\left[(1-\kappa_{pw})(\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o)) - (1-\kappa_{wp})(\beta_{pu}(u-u_o)\right. \\ &\quad \left. +\beta_{pv}\ln(v/v_o)) + (\kappa_{wz}-1)(1-\kappa_{pw})g_z\right]. \qquad (2.8) \end{aligned}$$

Eq.(2.8) shows the ambiguity of the stabilizing property of the real wage channel discussed by Rose (1967) which arises – despite the incorporation of specific measures of demand and cost pressure on both the labor and the goods markets – if the dynamics of the employment rate are linked to the behavior of output and if inflationary cross-over expectations are incorporated in both Phillips curves. Indeed, as illustrated in Figure 2.1, a real wage increase can act, taken by itself, in a stabilizing or destabilizing manner, depending on whether the output dynamics depend positively or negatively on the real wage (i.e. if consumption reacts more strongly than investment or vice versa) *and* on whether price flexibility is larger than nominal wage flexibility with respect to its own demand pressure measure.

These four different scenarios can be jointly summarized as in Table 2.1. As Table 2.1 clearly shows, the combination of these four possibilities sets up four different scenarios where the dynamics of the real wage (in their interaction with the goods and labor markets) might turn out to be *per se* convergent or divergent. As it can be observed in Figure 2.1, there exist two cases where the Rose (1967) real wage channel operates in a stabilizing manner: In the first case, aggregate goods demand (approximated in

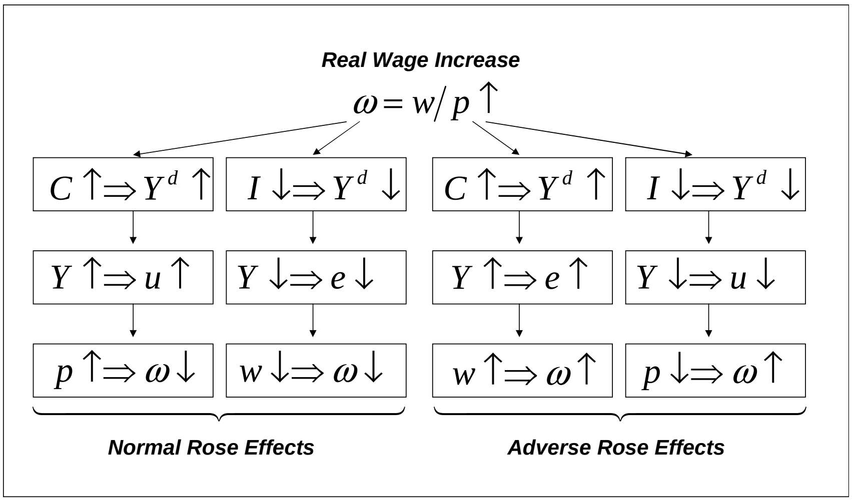


Fig. 2.1: Normal (Convergent) and Adverse (Divergent) Rose Effects: The Real Wage Channel of Keynesian Macrodynamics

this framework by the output gap) depends negatively on the real wage, which can be denoted in a closed economy as the profit-led case[7] – and the dynamics of the real wage are led primarily by the nominal wage dynamics and therefore by the developments in the labor market. In the second case, aggregate demand depends positively on the real wage, and the price inflation dynamics (and therefore the goods markets) determine primarily the behavior of the real wages.[8]

One of the goals of this chapter will thus be the categorization within this setup of the real wage dynamics in the U.S. and the euro area.

[7] In an open economy other macroeconomic channels, such as the real exchange rate channel, would also be influenced by the real wage and in turn influence aggregate demand dynamics, so that the designation "profit led" would not be appropriate anymore. Nevertheless, since we restrict our theoretical analysis to closed economies (or relatively closed as in our econometric analysis of the United States and the euro area), we will adhere to the designation used in Table 2.1.

[8] Note here that the cost - pressure parameters also play a role and may influence the critical stability condition of the real wage channel, see Flaschel and Krolzig (2006) for details.

Tab. 2.1: Four Baseline Real Wage Adjustment Scenarios

	wage-led goods demand	profit-led goods demand
labor market-led real wage adjustment	adverse (divergent)	normal (convergent)
goods market-led real wage adjustment	normal (convergent)	adverse (divergent)

2.2.3 Monetary Policy

Concerning monetary policy, the nominal interest rate is endogenized by using a simple Taylor rule as is customary in the literature, see e.g. Svensson (1999). Indeed, as Romer (2000, p.154-55) states, "Even in Germany, where there were money targets beginning in 1975 and where those targets paid a major role in the official policy discussions, policy from the 1970s through the 1990s was better described by an interest rate rule aimed at macroeconomic policy objectives than by money targeting."[9] The target rate of the monetary authorities and the law of motion resulting from an interest rate smoothing behavior by the central bank are defined as

$$\begin{aligned} i_{\mathrm{T}} &= i_o + \phi_\pi(\hat{p} - \pi_o) + \phi_y(u - u_o) \\ \dot{i} &= \alpha_i(i_{\mathrm{T}} - i). \end{aligned}$$

The target rate of the central bank i_{T} is thus assumed here to depend on the steady state real rate of interest $i_o - \pi_o$ augmented by actual inflation back to a nominal rate, and as usual also on the inflation and on the output gap.[10] With respect to this target there are interest rate smoothing dynamics with strength α_i. Inserting i_{T} and rearranging terms we obtain from this expression the following dynamic law for the nominal interest rate

$$\dot{i} = -\alpha_i(i - i_o) + \gamma_{ip}(\hat{p} - \pi_o) + \gamma_{iu}(u - u_o) \tag{2.9}$$

where we have: $\gamma_{ip} = \alpha_i\phi_\pi$, i.e., $\phi_\pi = \gamma_{ip}/\alpha_i$ and $\gamma_{iu} = \alpha_i\phi_y$.

Furthermore, the actual (perfectly foreseen) rate of inflation $\hat{p}$ is used to measure the inflation gap with respect to the inflation target π_o of the central bank. Note finally

[9] See also Clarida and Gertler (1997).

[10] All of the employed gaps are measured relative to the steady state of the model, in order to allow for an interest rate policy that is consistent with it.

that a new kind of gap, namely the labor share gap, could have included into the above Taylor rule since in this model aggregate demand depends on income distribution (and therefore on the labor share), so that the state of income distribution matters to the dynamics of the model and thus should also play a role in the decisions of the central bank. However this has not been done here.

Taken together the model of this section consists of the following five laws of motion (with the derived reduced-form expressions as far as the wage-price spiral is concerned):[11]

The Model

$$\hat{v} \overset{LaborShare}{=} \kappa[(1-\kappa_{pw})(\beta_{we}(e-e_o)-\beta_{wv}\ln(v/v_o)) \\ -(1-\kappa_{wp})(\beta_{pu}(u-u_o)+\beta_{pv}\ln(v/v_o))+\delta g_z], \tag{2.10}$$

$$\text{with } \delta=(\kappa_{wz}-1)(1-\kappa_{pw})$$

$$\hat{u} \overset{Dyn.IS}{=} -\alpha_u(u-u_o)+\alpha_{uv}(v-v_o)-\alpha_{ur}(i-\hat{p}-(i_o-\pi_o)), \tag{2.11}$$

$$\dot{i} \overset{T.Rule}{=} -\alpha_i(i-i_o)+\gamma_{ip}(\hat{p}-\pi_o)+\gamma_{iu}(u-u_o), \tag{2.12}$$

$$\dot{\pi}_c \overset{I.Climate}{=} \beta_{\pi_c}(\hat{p}-\pi_c) \tag{2.13}$$

$$\hat{e} \overset{O.Law}{=} b\,\hat{u}, \tag{2.14}$$

Note that the law of motion given by eq.(2.10) for the labor share: $\hat{v}=\hat{w}-\hat{p}-\hat{z}$ makes use of the same explanatory variables as the New Keynesian approach but contains inflation rates in the place of their time rates of change and features no accompanying sign reversal concerning the influence of output and wage gaps, as is the case in the 4D baseline New Keynesian models as discussed e.g. in Walsh (2003b). Together with the IS goods market dynamics (2.11), the Taylor Rule (2.12), the law of motion (2.13) that describes the updating of the inflationary climate expression and finally Okun's Law (2.14) as link between the goods and the labor markets, eq.(2.10) represents a simple theoretical framework which nevertheless features the main transmission channels operating in modern economies. Note that the model can be reduced to a 4D system if the actual level of employment is recovered from eq.(2.14)by making use of the original formulation of Okun's Law (see the equation preceding eq.(2.2)), the resulting

[11] As the model is formulated we have no real anchor for the steady state rate of interest (via investment behavior and the rate of profit it implies in the steady state) and thus have to assume that it is the monetary authority that enforces a certain steady state value for the nominal rate of interest.

functional relationship is inserted in the remaining equations of the system. We can thus prescind from eq.(2.14) (and the influence of e as an endogenous variable) in the stability analysis to be discussed below.

In order to get an autonomous nonlinear system of differential equations in the state variables labor share v, output gap u, the nominal rate of interest i, and the inflationary climate expression π_c, we have to make use of eq. (2.7) (the reduced-form price Phillips Curve equation). This then has to be inserted into the remaining laws of motion in various places.

With respect to the empirically motivated restructuring of the original theoretical framework, the model is as pragmatic as the approach employed by Rudebusch and Svensson (1999). By and large it represents a working alternative to the New Keynesian approach, in particular when the current critique of the latter approach is taken into account. It overcomes the weaknesses and the logical inconsistencies of the old Neoclassical synthesis, see Asada, Chen, Chiarella and Flaschel (2006), and it does so in a minimal way from a mature, but still traditionally oriented Keynesian perspective (and is thus not really "New"). It preserves the problematic stability features of the real rate of interest channel, where the stabilizing Keynes effect or the interest rate policy of the central bank is interacting with the destabilizing, expectations driven Mundell effect. It preserves the real wage effect of the old Neoclassical synthesis, where – due to an unambiguously negative dependence of aggregate demand on the real wage – it was the case that price flexibility was destabilizing, while wage flexibility was not. This real wage channel, summarized in the Figure 2.1, is not normally discussed in the New Keynesian literature due to the specific form of wage-price and IS dynamics there considered.

2.3 4D Feedback-Guided Stability Analysis

In this section the local stability properties of the interior steady state of the dynamical system given by eqs.(2.10)-(2.13) (with eq.(2.7) inserted wherever needed) are analyzed through partial considerations from the feedback chains that characterize this empirically oriented baseline model of Keynesian macrodynamics. The Jacobian of the 4D dynamic system, calculated at its interior steady state, is

$$J = \begin{pmatrix} - & \pm & 0 & 0 \\ \pm & + & - & + \\ \pm & + & - & + \\ \pm & + & 0 & 0 \end{pmatrix}.$$

Since the model is an extension of the standard AS-AD growth model, we know from the literature that the real rate of interest, first analyzed by formal methods in Tobin (1975) (see also Groth (1992)) typically affects, in a negative manner, the dynamics of the economic activity (J_{23}). Additionally, there is the activity stimulating (partial) effect of increases in the rate of inflation (as part of the real rate of interest channel) that may lead to accelerating inflation under appropriate conditions (J_{24}). This transmission mechanism is known as the Mundell effect. The stronger the Mundell Effect, the faster the inflationary climate adjusts to the present level of price inflation. This is due to the positive influence of this climate variable both on price as well as on wage inflation and from there on rates of employment of both capital and labor. Concerning the Keynes effect, due to the use of a Taylor rule in the place of the conventional LM curve, it is here implemented in a more direct way towards the stabilization of the economy (coupling nominal interest rates directly with the rate of price inflation) and it works the stronger the larger the choice of the parameters γ_{ip}, γ_{iu}.

As it is formulated, the theoretical model also features further potentially (at least partially) destabilizing feedback mechanisms due to the Mundell- and Rose-effects in the goods-market dynamics and the converse Blanchard-Katz error correction terms in the reduced form price Phillips curve. There is first of all J_{12}, see eq.(2.10), the still undetermined influence of the output gap (the rate of capacity utilization) on the labor share, which depends on the signs and values of the parameter estimates of the two structural Phillips curves, and therefore on the cross-over expectations formation of the economic agents. In the second place, see eq.(2.11), we have J_{21}, the ambiguous influence of the labor share on (the dynamics of) the rate of capacity utilization. This should be a negative relationship if investment is more responsive than consumption to real wage increases and a positive relationship in the opposite case. Concerning also the effects of the labor share on capacity utilization, we have aggregate price inflation determined by the reduced form price Phillips curve given by eq.(2.7). Thus there is an additional, though ambiguous channel through which the labor share affects the dynamics of the output gap on the one hand and the inflationary climate of the economy

(J_{41}) through eq.(2.13) on the other hand. Mundell-type, Rose-type and Blanchard-Katz error-correction feedback channels therefore make the dynamics indeterminate on the theoretical level.

The feedback channels just discussed will be the focus of interest in the following stability analysis of the D(isequilibrium)AS-AD dynamics. Reduced-form expressions have been employed in the above system of differential equations whenever possible. Thereby a dynamical system in four state variables was obtained that is in a natural or intrinsic way nonlinear (due to its reliance on growth rate formulations). We can see furthermore that there are many items that reappear in various equations, or are similar to each other, implying that stability analysis can exploit a variety of linear dependencies in the calculation of the conditions for local asymptotic stability. A rigorous proof of the local asymptotic stability for the original model version and its loss by way of Hopf bifurcations can be found in Asada, Chen, Chiarella and Flaschel (2006).

In order to focus on the interrelation between wage-price and output gap dynamics, we make use of the following proposition.

Proposition 1:

Assume that the parameter β_{π^c} is not only close to zero but in fact equal to zero. This decouples the dynamics of π^c from the rest of the system and the system becomes 3D. Assume furthermore that the partial derivative of the second law of motion J_{22} depends negatively on v, and that $(1-\kappa_p)\beta_{we} > (1-\kappa_w)\beta_u$ holds. Then: The interior steady state of the implied 3D dynamical system

$$\begin{aligned}\hat{v} &= \kappa[(1-\kappa_{pw})(\beta_{we}(e(u)-e_o)-\beta_{wv}\ln(v/v_o)) \\ &\quad -(1-\kappa_{wp})(\beta_{pu}(u-u_o)+\beta_{pv}\ln(v/v_o))], \quad (2.15)\\ \hat{u} &= -\alpha_u(u-u_o)-\alpha_{uv}(v-v_o)-\alpha_{ur}((i-\hat{p})-(i_o-\pi_o)), \quad (2.16)\\ \dot{i} &= -\alpha_i(i-i_o)+\gamma_{ip}(\hat{p}-\pi_o)+\gamma_{iu}(u-u_o), \quad (2.17)\end{aligned}$$

is locally asymptotically stable.

Sketch of proof: In the considered situation we have for the Jacobian of the reduced dynamics at the steady state:

$$J = \begin{pmatrix} - & + & 0 \\ - & - & - \\ 0 & + & - \end{pmatrix}.$$

According to the Routh-Hurwitz stability conditions for the characteristic polynomial of the considered 3D dynamical system, asymptotic local stability of a steady state is fulfilled when:

$$a_i > 0, \quad i = 1, 2, 3 \quad \text{and} \quad a_1 a_2 - a_3 > 0,$$

where: $a_1 = -\text{trace}(J)$, $a_2 = \sum_{k=1}^{3} J_k$ with

$$J_1 = \begin{vmatrix} J_{22} & J_{23} \\ J_{32} & J_{33} \end{vmatrix}, J_2 = \begin{vmatrix} J_{11} & J_{13} \\ J_{31} & J_{33} \end{vmatrix}, J_3 = \begin{vmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{vmatrix},$$

and: $a_3 = -\det(J)$. The determinant of this Jacobian is obviously negative if the parameter γ_i is chosen sufficiently small. The sum of the minors of order 2: a_2 is unambiguously positive. The validity of the full set of Routh-Hurwitz conditions then easily follows, since trace $J = -a_1$ is obviously negative. ∎

Proposition 2:

Assume now that the parameter β_{π_c} is positive, but its specific value is chosen sufficiently small, Assume furthermore that α_i is sufficiently small, and that $\gamma_{ip} > 1$. Then: The interior steady state of the resulting 4D dynamical system (where the state variable π^c is now included)

$$\begin{aligned}
\hat{v} &= \kappa[(1-\kappa_{pw})(\beta_{we}(e(u)-e_o) - \beta_{wv}\ln(v/v_o)) \\
&\quad -(1-\kappa_{wp})(\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o))], && (2.18)\\
\hat{u} &= -\alpha_u(u-u_o) - \alpha_{uv}(v-v_o) - \alpha_{ur}(i - \hat{p} - (i_o - \pi_o)), && (2.19)\\
\dot{i} &= -\alpha_i(i-i_o) + \gamma_{ip}(\hat{p} - \pi_o) + \gamma_{iu}(u-u_o), && (2.20)\\
\dot{\pi}^c &= \beta_{\pi^c}(\hat{p} - \pi^c) && (2.21)
\end{aligned}$$

is locally asymptotically stable.

Sketch of proof: Under the mentioned stated assumptions, the Jacobian of the 4D system is equal to:

$$J = \begin{pmatrix} - & + & 0 & 0 \\ - & - & - & + \\ 0 & + & - & + \\ 0 & + & 0 & - \end{pmatrix}.$$

We can clearly see that J_{34} describes the reaction of the nominal interest rate with respect to inflation. According to the Taylor (1993) principle, as long as $\gamma_{ip} > 1$, monetary policy stabilizes the economy. Together with sufficiently small β_{π^c} and α_i, the incorporation of the inflationary climate as a state variable in the dynamical system does not disturb the local stability properties of the system. ■

Summing up, we can state that a weak Mundell effect; the neglect of Blanchard-Katz error correction terms; a negative dependence of aggregate demand on real wages, coupled with larger nominal wage- than price level flexibility; and a Taylor rule that stresses inflation targeting are here (for example) the basic ingredients that allow for the proof of local asymptotic stability of the interior steady state of the dynamics (2.10) – (2.13).

In order to investigate in more detail the stability properties concerning variations in the parameter values, in the next section the theoretical model discussed here will be estimated with aggregate data of major industrialized economies in order to obtain empirical parameter values. These in turn will serve as baseline parameters in the eigen-value analysis below.

2.4 Econometric Analysis

In this section the estimation results of the theoretical model of the previous section obtained with aggregate time series data of the U.S., the euro area, the U.K., Germany and France are reported. The objective of these estimations is twofold: On the one hand they are supposed to demonstrate the consistency of theoretical model discussed in the previous section with aggregate empirical data and; on the other hand, to highlight the main similarities and differences of the determinants of wage and price inflation dynamics in these economies.

2.4.1 Model Estimation

As discussed in the previous section, the law of motion for the real wage rate given by eq.(2.10) represents a reduced form expression of the two structural equations for $\hat{w}_t$ and $\hat{p}_t$. Noting again that the inflation climate variable is defined in the estimated model as a linearly declining function of the past twelve price inflation rates, the dynamics of the system (2.3) – (2.9) can be then reformulated as:

$$\begin{aligned}
\hat{w}_t &= \beta_{we}(e_{t-1} - e_o) - \beta_{wv}\ln(v_{t-1}/v_o) + \kappa_{wp}\hat{p}_t + (1-\kappa_{wp})\pi_t^{12} + \kappa_{wz}\hat{z}_t \\
\hat{p}_t &= \beta_{pu}(u_{t-1} - u_o) + \beta_{pv}\ln(v_{t-1}/v_o) + \kappa_{pw}(\hat{w}_t - \hat{z}_t) + (1-\kappa_{pw})\pi_t^{12} \\
\ln u_t &= \ln u_{t-1} + \alpha_u(u_{t-1} - u_o) - \alpha_{ui}(i_{t-1} - \hat{p}_t) + \alpha_{uv}(v_t - v_o) \\
\hat{e}_t &= \alpha_{eu-1}\hat{u}_{t-1} + \alpha_{eu-2}\hat{u}_{t-2} + \alpha_{eu-3}\hat{u}_{t-3} \\
i_t &= \phi_i i_{t-1} + (1-\phi_i)\phi_\pi \hat{p}_t + (1-\phi_i)\phi_y(u_{t-1} - u_o) + \epsilon_{it},
\end{aligned}$$

with sample means denoted by a subscript o (with the exception of e_o, which is supposed to represent the (eventually time-varying) NAIRU-equivalent employment rate). We estimate this model with time series of the U.S., the Euro Area, the UK, Germany and France. The corresponding time series stem from the Federal Reserve Bank of St. Louis data set (see http:/www.stls.frb.org/fred) for the U.S. and the OECD database for the European countries and the Euro Area as a whole (where also estimates for the U.S. NAIRU are available). The data is quarterly, seasonally adjusted and concerns the period from 1980:1 to 2004:4. The logarithms of wages and prices are denoted by $\ln(w_t)$ and $\ln(p_t)$, respectively. Their first differences (backwardly dated), i.e. the current rate of wage and price inflation, are denoted $\hat{w}_t$ and $\hat{p}_t$.

Tab. 2.2: Data Description

Variable	Description of the original series
e	Employment Rate
u	Capacity Utilization: Manufacturing, Percent of Capacity
w	Nonfarm Business Sector: Compensation Per Hour, 1992=100
p	Gross Domestic Product: Implicit Price Deflator, 1996=100
z	Output Per Hour of All Persons, 1992=100
v	Real Compensation Per Output Unit, 1992=100
i	Short Term Interest Rate

As stated above, in eq. (2.22) $e - e_o$ represents the deviation of the employment rate from its NAIRU consistent level, and not the deviation of the former from its sample mean, as it is the case with the other variables. This differentiation is particularly important for the estimation of the European countries, since while the U.S. unemployment rate has fluctuated, roughly speaking, around a constant level (what would suggest a somewhat constant or at least a not all too varying NAIRU) over the last two decades, the European employment (unemployment) rate has displayed a persistent downwards (upwards) trend over the same time period.

This particular European phenomenon has been explained by Layard, Nickell and Jackman (1991) and Ljungqvist and Sargent (1998) by an over-proportional increase in the number of long-term unemployed (i.e. workers with an unemployment duration over 12 months) with respect to short term unemployed (workers with an unemployment duration of less than 12 months) and the phenomenon of hysteresis especially in the first group. One main explanation for the persistence in long-term unemployment is that human capital, and therefore the productivity of the unemployed, tend to diminish over time, which makes the long-term unemployed less "hirable" for firms, see Pissarides (1992) and Blanchard and Summers (1991). Because the long-term unemployed become less relevant, and primarily the short-term unemployed are taken into account in the determination of nominal wages, the potential downward pressure on wages resulting from the unemployment of the former diminishes, with the result of a higher level of the NAIRU.[12] When long-term unemployment is high, the aggregate unemployment rate of an economy thus, "becomes a poor indicator of effective labor supply, and the macroeconomic adjustment mechanisms – such as downward pressure on wages and inflation when unemployment is high – will then not operate effectively."[13] Indeed, Llaudes (2005) for example, by using a modified wage Phillips curve which incorporates the different influences of long-and short-term unemployed in the wage determination, finds empirical evidence of the fact that for some OECD countries the long-term unemployed have only a negligible influence on the wage determination.

Since time series data for long-term unemployment in the euro area is not available as is the case for the other analyzed countries, we have tried to approximate it in a rather simple way: First we ran the HP-filter on the euro area unemployment rate with a high smoothing factor ($\lambda = 640000$). The resulting smoothed series are then normalized so that the 1970:1 value equals zero, implicitly assuming that in 1970:1 the number of long-term unemployed was not too different from zero, since before the oil shocks in the 1970s unemployment (and also long-term unemployment) was extremely low on the European continent. This smoothed series can be interpreted as a proxy for the actual development of long-term unemployment. The difference between this series and the aggregate unemployment rate, denoted u^{st}, can then be interpreted as a proxy for the

[12] See Blanchard and Wolfers (2000).
[13] OECD (2002, p.189).

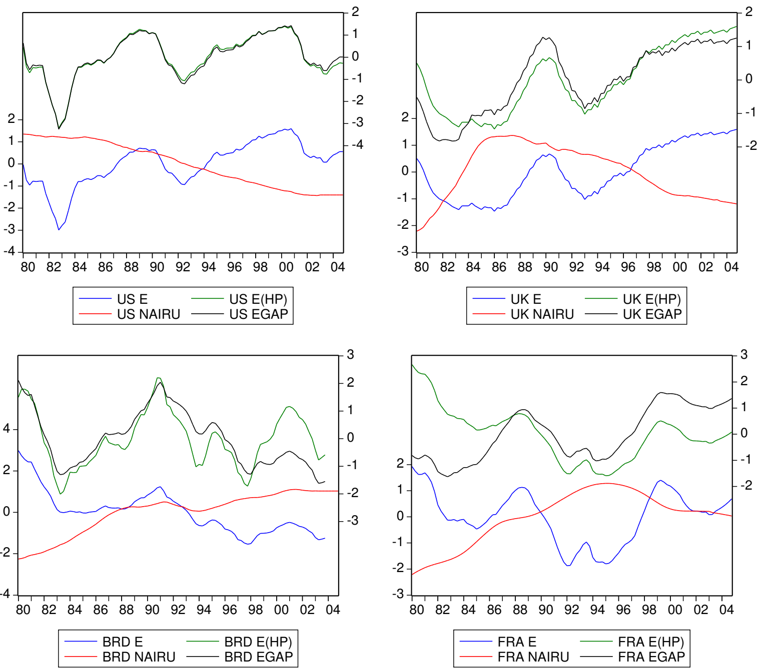


Fig. 2.2: Employment Rate and NAIRU (left axis) and Employment Rate Deviation from NAIRU-consistent Level (HP Methodology and OECD Data) (right axis) (normalized data)

short term unemployment rate, which is the relevant variable in the wage bargaining process. With this series the alternative employment rate measure $e = 1 - u^{st}$ for the euro area is calculated. In Figure (2.2) the equivalent time series for the U.S., the U.K., Germany and France calculated according to this procedure are contrasted with the actual employment gap,[14] showing that indeed this procedure, though quite simple and *ad-hoc*, can nevertheless deliver an acceptable proxy for the short-term unemployed in the euro area.[15]

In order to test for stationarity, Phillips-Perron unit root tests were carried out for each series in order to account, not only for residual autocorrelation as is done by the standard ADF Tests, but also for possible residual heteroskedasticity when testing for

[14] defined as the deviation of the employment rate from the time-varying NAIRU-employment rate calculated by the OECD.

[15] Note nevertheless that, by the construction of the Hodrick-Prescott filter, the calculated course of the proxy for the long-term unemployed (the smoothed series) depends on the whole sample period.

Tab. 2.3: Phillips-Perron Unit Root Test Results

Sample: 1980:1 - 2004:4

Country	Variable	Lag Length	Determ.	Adj. Test Stat.	Prob.*
	$\hat{p}_t$	1	-.	-2.106	0.034
U.S.	$\hat{w}_t$	1	-	-2.589	0.010
	d(e_t)	-	-	-4.909	0.000
	d(u_t)	1	-	-7.122	0.000
	i	1	-	-1.856	0.061
	dln(p)	1	-	-2.362	0.018
Euro area	dln(w)	1	-	-2.197	0.027
	d(e)	1	-	-3.152	0.001
	d(u)	1	-	-8.089	0.000
	i	1	-	-1.481	0.129
	$\hat{p}_t$	1	-	-5.289	0.000
U.K.	$\hat{w}_t$	1	-	-3.139	0.002
	d(e_t)	1	-	-8.576	0.000
	d(u_t)	1	-	-23.695	0.000
	i	1	-	-1.697	0.085
	$\hat{p}_t$	1	-	-3.788	0.000
Germany	$\hat{w}_t$	1	-	-4.386	0.000
	d(e_t)	1	-	-3.657	0.000
	d(u_t)	1	-	-7.969	0.000
	i	1	-	-1.405	0.148
	$\hat{p}_t$	1	-	-2.316	0.021
France	$\hat{w}_t$	1	-	-2.376	0.018
	d(e_t)	1	-	-2.977	0.003
	d(u_t)	1	-	-8.494	0.000
	i	1	-	-1.550	0.113

*McKinnon (1996) one-sided p-values.

stationarity. The Phillips-Perron test specifications and results are shown in Table 2.3. As it can be observed there, the applied unit root tests confirm the stationarity of all series with the exception of the short term nominal interest rate i in all countries. Nevertheless, although the Phillips-Perron test on these series cannot reject the null of a unit root, there is no reason to expect both time series to be unit root processes. Indeed, it is reasonable to expect these rates to be constrained to certain limited ranges. Due to the general low power of the unit root tests, these results can be interpreted as providing only a hint of the possibility that the nominal interest rates exhibit a strong autocorrelation.

The discrete time version of the structural model formulated above was estimated by means of instrumental variables system GMM (Generalized Method of Moments).[16]

[16] As stated in Wooldridge (2001, p.92), a GMM estimation possesses several advantages in compari-

The use of an instrumental variables estimator such as GMM is indeed adequate since it allows for eventual regressor endogeneity to be accounted in the case that some of the explaining variables are not completely exogenous. Additionally, since among the explaining variables contained in our general specification there are also expected future variables, the use of an instrument set composed solely by lagged variables allows for the approximation of expected values of those forward-looking variables on the basis of the information available at time t. In order to test for the validity of the overidentifying restrictions (since we have more instrumental variables as coefficients to be estimated) we calculate the J-statistics as proposed by Hansen (1982).

The weighting matrix in the GMM objective function was chosen to allow the resulting GMM estimates to be robust against possible heteroskedasticity and serial correlation of an unknown form in the error terms. Concerning the instrumental variables used in our estimations, since at time t only past values are contained in the information sets of the economic agents, for all five equations, besides the strictly exogenous variables, the last four lagged values of the employment rate, the labor share (detrended by the Hodrick-Prescott Filter) and the growth rate of labor productivity were incorporated. In order to test for the validity of the overidentifying restrictions, the $J-$statistics for both system estimations were calculated. We present and discuss the structural parameter estimates for the analyzed economies (t-statistics in brackets), as well as the $J-$statistics (p-values in brackets) in the next subsections.

Before discussing the estimation results for each country individually, it should be pointed out at a general level, that the GMM parameter estimates shown in the following tables deliver an empirical support for the theoretical Keynesian disequilibrium model specified in the previous section. This confirms for the Euro Area, UK, Germany and France some of the empirical findings of Flaschel and Krolzig (2006) and Flaschel et al. (2007) for the U.S. economy. Especially, the specification of cross-over inflation expectation terms, with the wage inflation entering in the price Phillips curve and the price inflation entering in the wage Phillips Curve, as well as the inclusion of lagged price inflation (as a proxy for the inflationary climate term) in both equations seems

son to more traditional estimation methods such as OLS and 2SLS. This is especially true in time series models, where heteroskedasticity in the residuals is a common feature: "The optimal GMM estimator is asymptotically no less efficient than two-stage least squares under homoskedasticity, and GMM is generally better under heteroskedasticity." This and the additional robustness property of GMM estimates, of not relying on a specific assumption with respect to the distribution of the residuals, make the GMM methodology appropriate and advantageous for our estimation.

to be supported by the data. Nevertheless, the role of this term in the wage and price inflation determination in the two analyzed economies seems to be somewhat heterogeneous: While for example in the estimated wage Phillips curves for the U.S. and the U.K. the influence of the perfectly foreseen actual price inflation κ_{wp} is around 0.4 and in the Euro area, Germany and France it is around 0.8; in the estimated price Phillips curves the corresponding parameter κ_{pw} is around 0.10 for all economies with the exception of the U.K., where this parameter is around 0.35. The lagged price inflation thus seems to have a predominant role in the price determination by the firms, while actual price inflation apparently influences to a higher extent the dynamics of wage inflation.

Also in line with Flaschel and Krolzig (2006) and Flaschel et al. (2007) the empirical evidence from the analyzed countries suggests that wage flexibility is larger than price flexibility (towards their demand pressure terms in the labor and goods markets, respectively) by and large, in all economies. Concerning the (log of the) wage share, namely the Blanchard-Katz error correction terms, we find by and large statistically significant and numerically similar coefficients in both wage and price adjustment equations with a similar influence on the price inflation dynamics in all analyzed economies and a larger effect of this variable on the wage dynamics in the European countries, confirming (from a qualitative perspective) the empirical findings of Blanchard and Katz (1999).

Next the estimations of the individual countries are discussed in detail.

Estimation Results: U.S. Economy

As stated before, the theoretical model specification discussed in the previous section is confirmed by parameter estimates shown in Table 2.4 for the U.S. economy. As expected, we find a large responsiveness of wage inflation towards the labor market gap, which is higher than the responsiveness of price inflation towards the goods markets gap. Concerning the (log of the) wage share, statistically significant coefficients (with the expected negative sign in the wage inflation- and the positive sign in the price inflation equations) were estimated. This result contradicts the findings of Blanchard and Katz (1999), which found these coefficients to be significant only in Europe. Concerning the effect of the wage share in the dynamic IS equation represented by the coefficient α_{uv}, a negative and statistically significant influence was found which supports the standard

Tab. 2.4: GMM Parameter Estimates: U.S.

Estimation Sample: 1980 : 1 – 2004 : 4							
Kernel: Bartlett, Bandwidth: Andrews (2.59)							
$\hat{w}$	β_{we}	β_{wv}	κ_{wp}	κ_{wz}	const.	$\bar{R}^2$	DW
	0.948	-0.234	0.350	0.278	0.016	0.354	1.871
	[12.055]	[5.824]	[3.152]	[8.809]	[11.457]		
$\hat{p}$	β_{pu}	β_{pv}	κ_{pw}	const.		$\bar{R}^2$	DW
	0.293	0.116	0.046	-		0.763	1.263
	[13.277]	[5.107]	[3.167]				
$\hat{u}_t$	α_u	α_{ui}	α_{uv}	const.		$\bar{R}^2$	DW
	-0.077	-0.040	-0.176	0.002		0.902	1.521
	[9.028]	[4.256]	[8.163]	[3.511]			
$\hat{e}$	α_{eu-1}	α_{eu-2}	α_{eu-3}	α_{eu-4}		$\bar{R}^2$	DW
	0.202	0.114	0.040	-		0.387	1.638
	[22.780]	[8.204]	[3.884]				
i	ϕ_i	ϕ_{ip}	ϕ_{iu}			$\bar{R}^2$	DW
	0.831	2.173	0.423			0.929	1.916
	[71.464]	[36.152]	[5.113]				
Determinant Residual Covariance:			7.95E-21				
J-Statistic [p-val]:			0.373 [0.975]				

notion that real wage increases lead to a de-acceleration of the economy due to its effects on aggregate investment and on net exports. With respect to the labor market dynamics, the sum of the estimated lagged coefficients of $\hat{u}$ is quite close to 0.3, what also confirms Okun's (1970) notion about the relationship between goods and labor markets. This result is consistent across all estimated economies with the exception of Germany.

Estimation Results: Euro Area

Concerning the parameter estimates for the Euro Area (shown in Table 2.5), the main finding is the quite significant and numerically high coefficient of the (log of the) wage share in the wage inflation equation, what corroborates (also from the qualitative perspective) the findings of Blanchard and Katz (1999). But also the numerically large (and statistically significant) coefficient of the wage share in the goods markets dy-

Tab. 2.5: GMM Parameter Estimates: Euro Area

Estimation Sample: 1980 : 1 − 2004 : 4 Kernel: Bartlett, Bandwidth: Andrews(3.20)							
$\hat{w}$	β_{we}	β_{wv}	κ_{wp}	κ_{wz}	const.	$\bar{R}^2$	DW
	0.346	-0.383	0.886	0.223	0.005	0.692	1.606
	[4.724]	[8.613]	[7.579]	[9.587]	[8.027]		
$\hat{p}$	β_{pu}	β_{pv}	κ_{pw}	const.		$\bar{R}^2$	DW
	0.291	0.089	0.075	-		0.887	1.389
	[9.320]	[3.551]	[4.229]				
$\hat{u}_t$	α_u	α_{ui}	α_{uv}	const.		$\bar{R}^2$	DW
	-0.104	-0.061	-0.238	-0.068		0.926	2.012
	[10.997]	[-6.968]	[-14.889]	[14.622]			
$\hat{e}$	α_{eu-1}	α_{eu-2}	α_{eu-3}	α_{eu-4}		$\bar{R}^2$	DW
	0.128	0.115	0.057	0.159		0.645	1.501
	[28.448]	[19.691]	[7.972]	[14.994]			
i	ϕ_i	ϕ_{ip}	ϕ_{iu}			$\bar{R}^2$	DW
	0.936	1.539	1.782			0.981	1.385
	[105.06]	[15.977]	[6.056]				
Determinant Residual Covariance:			2.18E-22				
J-Statistic [p-val]:			0.316 [0.996]				

namics equation suggest that the link between the wage share and the dynamics of output might be stronger in the euro area than in the U.S.. In addition, the estimated parameter β_{we} (which measures the wage flexibility with respect to labor market developments) is found to be significantly higher in the United States than in the euro area if the proxy variable for the euro area short term unemployed (which as stated before is the relevant group in the wage bargaining process) is used instead of the aggregate unemployment rate.

Estimation Results: U.K.

Concerning the model estimation with U.K. time series shown in Table 2.6, it corroborates the overall formulation of the theoretical model and the related sign restrictions on the variables of the system, delivering by and large similar structural coefficients to those of the U.S. and the euro area. The main differences between the U.K. and the

Tab. 2.6: GMM Parameter Estimates: U.K.

Estimation Sample: 1980 : 1 − 2004 : 4							
Kernel: Bartlett, Bandwidth: Andrews: 2.62							
$\hat{w}$	β_{we}	β_{wv}	κ_{wp}	κ_{wz}	const.	$\bar{R}^2$	DW
	0.345	-0.212	0.289	0.360	0.010	0.589	1.183
	[15.84]	[16.678]	[21.971]	[21.784]	[20.998]		
$\hat{p}$	β_{pu}	β_{pv}	κ_{pw}	const.		$\bar{R}^2$	DW
	0.357	0.219	0.383	-		0.353	2.338
	[4.647]	[7.081]	[16.262]				
$\hat{u}_t$	α_u	α_{ui}	α_{uv}	const.		$\bar{R}^2$	DW
	-0.361	-0.015	-0.095	-		0.426	1.995
	[23.217]	[4.089]	[12.046]				
$\hat{e}$	α_{eu-1}	α_{eu-2}	α_{eu-3}	α_{eu-4}		$\bar{R}^2$	DW
	0.124	0.057	0.122			0.266	1.396
	[33.624]	[9.420]	[26.413]				
i	ϕ_i	ϕ_{ip}	ϕ_{iu}			$\bar{R}^2$	DW
	0.949	0.249	1.181			0.934	1.805
	[221.371]	[4.460]	[6.703]				
Determinant Residual Covariance:			1.91E-21				
J-Statistic [p-val]:			0.241 [0.961]				

euro area are the significantly lower values of κ_{wp}, α_{uu} and α_{uv}, as well as the larger value of κ_{pw} compared with the two previous cases. Besides of these differences, an interesting finding in the U.K. estimation is the remarkable similarity in all coefficients in the wage and price inflation equations, what follows from the fact that these two macro-variables have exhibited in the U.K. a quite similar dynamic behavior in the last twenty years.

Estimation Results: Germany

With respect to the Germany estimation, Table 2.7 shows three main findings which highlight the differences in the dynamics of wage and price inflation in the German economy with respect to the U.S. and the U.K. In the first place, we have at first glance a counterintuitive finding that wage flexibility towards the labor market gap is indeed of a comparable dimension to that in the U.S.; This, however, becomes understandable

Tab. 2.7: GMM Parameter Estimates: Germany

Estimation Sample: 1981 : 2 – 2003 : 4							
Kernel: Bartlett, Bandwidth: Andrews (2.06)							
$\hat{w}$	β_{we}	β_{wv}	κ_{wp}	κ_{wz}	const.	$\bar{R}^2$	DW
	0.809	-0.887	1.149	0.190	0.001	0.371	2.035
	[22.012]	[45.026]	[50.048]	[12.076]	[2.543]		
$\hat{p}$	β_{pu}	β_{pv}	κ_{pw}	const.		$\bar{R}^2$	DW
	0.086	0.199	0.124	0.005		0.427	2.166
	[30.861]	[27.069]	[47.469]	[48.653]			
$\hat{u}_t$	α_u	α_{ui}	α_{uv}	const.		$\bar{R}^2$	DW
	-0.157	-0.044	-0.784	0.002		0.893	1.804
	[57.542]	[7.691]	[75.529]	[7.369]			
$\hat{e}$	α_{eu-1}	α_{eu-2}	α_{eu-3}	α_{eu-4}		$\bar{R}^2$	DW
	0.042	0.031	0.051	-		0.341	0.976
	[31.334]	[25.827]	[32.280]				
i	ϕ_i	ϕ_{ip}	ϕ_{iu}	const.		$\bar{R}^2$	DW
	0.926	0.631	1.195	0.002		0.966	1.309
	[438.31]	[10.827]	[35.775]	[26.713]			
Determinant Residual Covariance:			1.03E-20				
J-Statistic [p-val]:			0.476 [0.754]				

when one recalls that it is indeed the deviation of the actual employment rate to its NAIRU-consistent- and not to its long-run average level the variable included in the wage adjustment equation. In the second place, we find a quite high numerical value of β_{wv}, the effect of income distribution on wage inflation, compared to those in the other economies, showing the significant influence of trade unions in the German wage setting. And lastly, the relatively low value of β_{pu} should also be highlighted, which is indeed the lowest among all analyzed countries.

Concerning the dynamics of the capacity utilization rate, particularly interesting is the high numerical value of α_{uv}, which is the reaction coefficient of $\hat{u}$ with respect to the wage share for the German economy. This value, though, should be interpreted not as coming about from the importance of income distribution for the goods markets dynamics, but rather from the clear export-orientation of the German economy. Under this interpretation, a higher wage share (or, in a more neoclassical language, higher real unit labor costs) leads to a slowdown of the economic activity not due to the predominant decrease of investment over consumption, but rather due to the loss of competitiveness in the international goods markets. And finally, concerning Germany's employment rate dynamics, there are the low values of α_{eu} for several estimated lags, which clearly show the decoupling of the labor and the goods markets in the German economy.

Estimation Results: France

The estimated French parameter values (shown in Table 2.8), are also quite in line with the parameter values obtained from the other economies, corroborating again the empirical validity of the model specification discussed in the previous section. Particularly

Tab. 2.8: GMM Parameter Estimates: France

Estimation Sample: 1980 : 1 − 2004 : 4							
Kernel: Bartlett, Bandwidth: Andrews (4.87)							
$\hat{w}$	β_{we}	β_{wv}	κ_{wp}	κ_{wz}	const.	$\bar{R}^2$	DW
	0.354	0.109	0.745	0.025	0.027	0.767	1.434
	[16.701]	[5.627]	[23.770]	[1.628]	[27.857]		
$\hat{p}$	β_{pu}	β_{pv}	κ_{pw}	const.		$\bar{R}^2$	DW
	0.403	0.158	0.070	-		0.888	1.172
	[31.699]	[12.668]	[7.028]				
$\hat{u}_t$	α_u	α_{ui}	α_{uv}	const.		$\bar{R}^2$	DW
	-0.113	-0.026	-0.047	0.001		0.906	1.609
	[17.295]	[9.983]	[25.074]	[7.605]			
$\hat{e}$	α_{eu-1}	α_{eu-2}	α_{eu-3}	α_{eu-4}		$\bar{R}^2$	DW
	0.209	0.188	0.106	-		0.436	0.689
	[31.442]	[25.941]	[12.588]				
i	ϕ_i	ϕ_{ip}	ϕ_{iu}			$\bar{R}^2$	DW
	0.935	1.236	1.649			0.958	1.716
	[214.86]	[20.367]	[7.697]				
Determinant Residual Covariance:			2.00E-21				
J-Statistic [p-val]:			0.217 [0.975]				

we find highly significant coefficients of the cross-over inflation expectations terms in both wage and price inflation adjustment equations. Again, the coefficient κ_{wp} is found to be higher than κ_{pw}, as it was the case in all analyzed countries with the U.K. as the sole exception.

The main particularity in Table 2.8 is, however, that the estimation with French aggregate data delivers the Blanchard-Katz error correction terms coefficients with the lowest numerical values (though statistically significant) of all economies, and that the corresponding coefficient of the wage share in the goods markets equation is also the lowest estimated. Income distribution, though, seems to play a lesser role for both the dynamics of wage and price inflation in a direct manner as well as in an indirect manner through its effect on the dynamics of the capacity utilization rate.

2.5 Eigen-Value Stability Analysis

After having obtained empirical numerical values for the parameters of the theoretical model, in this section the effect of parameter value variations –and especially of wage- and price flexibility– for the stability of the economic system is further investigated.[17] For this, following Chen, Chiarella, Flaschel and Semmler (2006), the focus is set on the effect of parameter variations for the maximum value of the real parts of the eigenvalues of the model using exemplarily the estimated parameters of the U.S. economy.[18]

These maximum eigen-value diagrams concerning variations in the structural parameters of the wage-price module are depicted in Figure 2.3. They clearly show in a graphical manner what was indeed proven in the local stability analysis of section 2.3, namely the relevance of the cross-over inflation expectations terms κ_{pw} and κ_{wp} in both wage and price Phillips Curves, of the degree of price flexibility to goods markets disequilibria β_{pu} as well as of the adjustment speed of the inflationary climate variable β_{π^c} for the stability of the system.

Indeed, in Figure 2.3 we can clearly observe that higher values of these parameters lead ceteris paribus to a loss of local stability of the steady state of the system. This leads to the conclusion that a somehow sluggish adjustment of the system variables is indeed needed to ensure local stability if the dynamics of the system are not driven

[17] The calculations underlying the plots in this section were performed using the SND package described in Chiarella, Flaschel, Khomin and Zhu (2002).

[18] An analogous analysis was also performed using the estimated parameters of the other countries which led to similar conclusions. These graphs are available upon request.

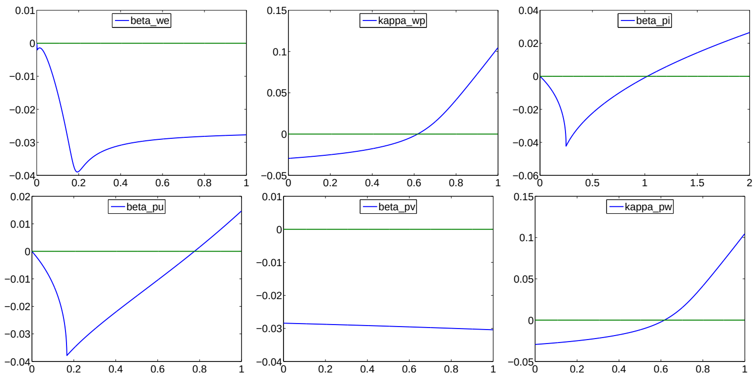


Fig. 2.3: Eigen-Value-based Stability Analysis: Wage-Price Dynamics

by the rational expectations assumption, where possible unstable paths are simply not possible by definition.[19]

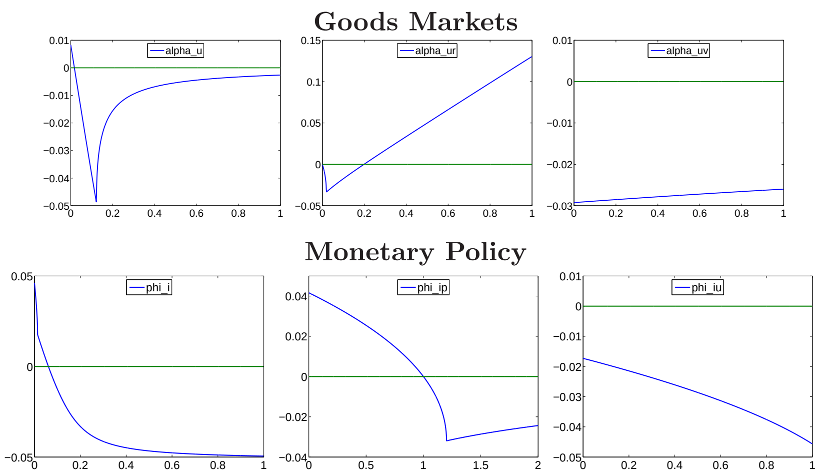


Fig. 2.4: Eigen-Value Stability Analysis: Goods Markets Dynamics and Monetary Policy

Concerning the parameters determining the goods markets dynamics, the second panel in the first row of figure 2.4 shows the destabilizing influence of Mundell-Effect, which would increase for higher values of the goods markets real interest rate sensitivity parameter α_{ur}. As expected, the monetary policy parameters, shown in the second row of figure 2.4, confirm two standard notions in the monetary policy literature (see e.g.

[19] See Flaschel, Groh, Proaño and Semmler (2008, ch.1) for an extensive discussion of this issue.

Woodford (2003)): First, that a too large interest rate smoothing term might reduce the effectiveness of monetary policy and, second, that the validity of the Taylor principle, i.e. of a sufficiently active interest rate policy (what implies $\phi_\pi = \gamma_{ip}/(1 - \phi_i) > 1$) is central for the stability of the economy.

2.6 Concluding Remarks

In this chapter a significant extension and modification of the traditional approach to AS-AD growth dynamics developed by Chen, Chiarella, Flaschel and Semmler (2006) was discussed and estimated with aggregate time series of the main industrialized countries.

The various estimations of the structural model equations for the different economies, besides confirming the theoretical sign restrictions of the dynamical system, delivered some interesting insights into the similarities and differences of both economies with respect to the analyzed macroeconomic variables. In the first place a remarkable similarity in nearly all of the estimated coefficients in the structural equations was found. For the euro area this is indeed a rather surprising result if we keep in mind that the euro area became a factual currency union with a unique and centrally determined monetary policy only eight years ago, on January 1999, so that for a long interval of the estimated sample the estimated coefficients reflect only the theoretical values of an artificial economy. Nonetheless, the euro area and all other analyzed economies seem to share more common characteristics than is commonly believed, specially concerning the wage inflation reaction to labor market developments, once a proxy for the rate of short term unemployed rather than the aggregate unemployment rate is taken into account.

Taken together, these results deliver a different perspective on the dynamics of wage and price inflation. While the alternative New Keynesian approach is based on the assumption that primarily future expected values are relevant for the respective wage and price determination, the estimation results of this chapter deliver empirical support for an alternative specification of the wage-price inflation dynamics. Indeed, the cross over expectation formation (where current price (wage) inflation influences the current wage (price) inflation rate) as well as the inflationary climate cannot be rejected as significant explanatory variables in the wage and price Phillips Curves. In sum, the system estimates for all analyzed countries discussed in the previous section provide empirical evidence that supports the theoretical sign restrictions in all economies. They, moreover, provide more clear answers with respect to the role of income distribution in the considered disequilibrium AS-AD or DAS-AD dynamics. In particular, they also confirm the orthodox point of view that economic activity is likely to depend negatively on real unit wage costs. We have also a stabilizing effect of real wages on the dynamics of income distribution in the U.S. and the euro area, in the sense that the growth rate of the real wages depends – through Blanchard-Katz error correction terms – negatively on its own level.

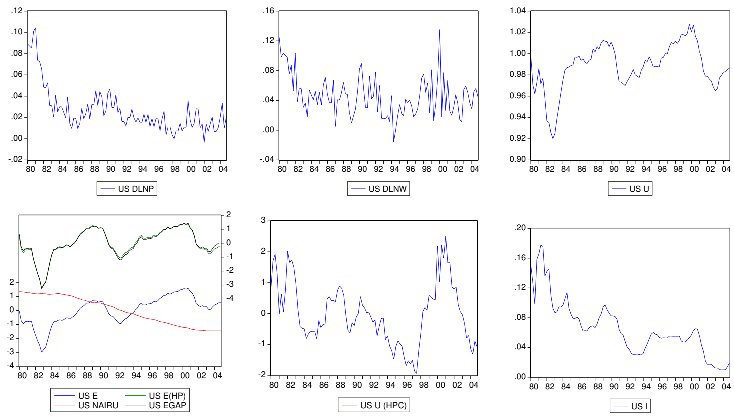
More empirical work is indeed needed in order to check for the model's parameter stability and so to account Lucas's (1976) Critique. However, given the empirical cross-country evidence discussed in this chapter, this framework (which may be called a disequilibrium approach to business cycle modeling of mature Keynesian type) seems to provide an interesting alternative to the DSGE framework for the study of monetary policy and inflation dynamics.

Appendix A

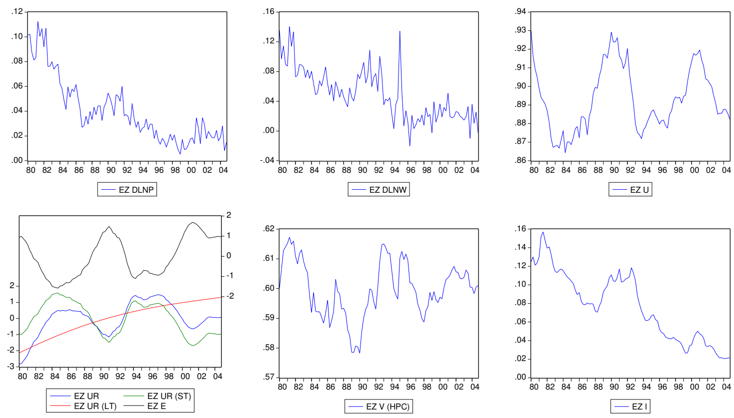
The Time Series Data

As previously stated, the time series data used in the econometric estimations of this chapter stem from the FRED database of the Federal Reserve Bank of St. Louis for the U.S. and the OECD database for the euro area and the individual European countries. DLNP and DLNW denote price and nominal wage inflation rates, respectively, **u** the capacity utilization rate (or output gap, when the former to available), **e** the deviation of the actual employment rate from its NAIRU-equivalent, **v** the HP cyclical component of the wage share and **i** the short term nominal interest rate.

Time Series: U.S. Economy

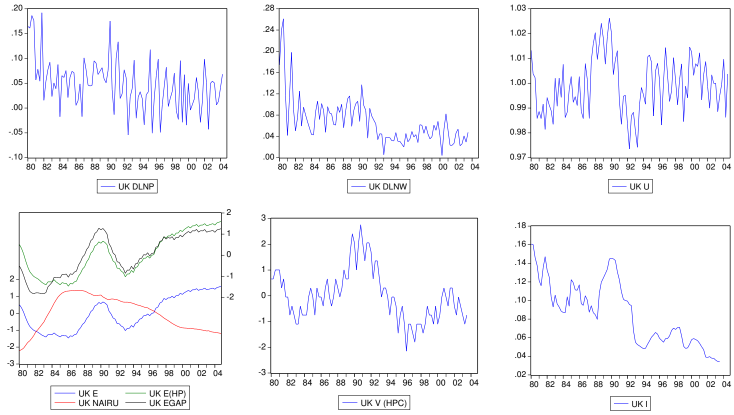


Time Series: Euro Area

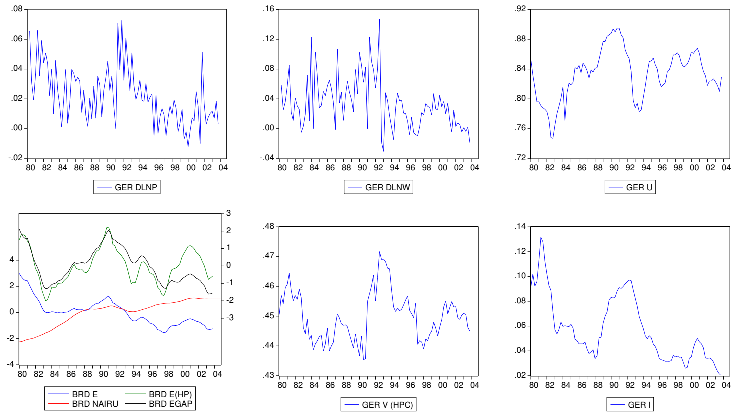


Note: In the first panel in the second row UR stands for the unemployment rate, LT for long-term, ST for short term (calculated through the procedure discussed in this chapter) and E the resulting deviation of the employment rate from its NAIRU-equivalent.

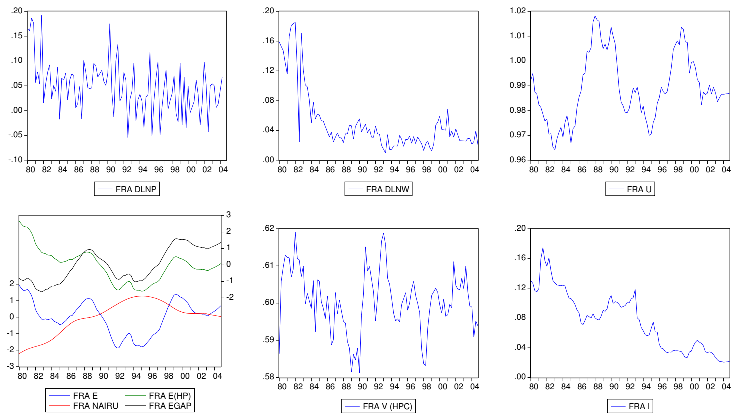
Time Series: U.K.



Time Series: Germany



Time Series: France



3. Gradual Wage-Price Adjustments, Labor Market Frictions and Monetary Policy Rules

3.1 Introduction

In contrast to the assumption of Walrasian labor markets commonly used in mainstream macroeconometric models, in the real world the existence of structural imperfections such as search and trading costs hinder the frictionless functioning of the labor markets, leading generally to outcomes of Non-Walrasian type, with involuntary unemployment and unfilled vacancies in "equilibrium". Additionally, the existence of such frictions also affects the dynamics of the real side of the economy by delaying the responses of output and employment to exogenous and endogenous shocks, increasing therefore the persistence of such effects. Concerning wage and price inflation, the presence of labor market rigidities is also likely to sluggish their response to output developments through their effect on real unit labor costs (or, from another perspective, on the labor share), one of the main determinants of price inflation. Due to these different factors, the incorporation of labor market frictions in a macroeconomic framework is likely to explain to a significant extent the high degree of persistence observed in many aggregate macroeconomic indicators such as price inflation in the majority of industrialized countries, and especially in the major countries of the European Monetary Union (EMU).

Somewhat surprisingly, though, in most of the macroeconomic models developed in the last decade – including the increasingly popular DSGE (Dynamic Stochastic General Equilibrium) models in the line of Erceg et al. (2000) and Christiano et al. (2005) – the existence of labor market frictions and their role in the dynamics of employment, output and inflation remained besides the research agenda due to the almost exclusive focus of the majority of models of New Keynesian type on the existence and theoretical modeling of nominal rigidities. Nevertheless, as discussed for example in Chari, Kehoe and McGrattan (2000), a central problem of intertemporal optimizing macroeconomic models featuring only nominal rigidities is that the dynamic responses generated by them do not feature the degree of persistence observed in real data.

The empirical shortcomings of these DSGE models have led recently to the incorporation within that framework of not only nominal, but also real rigidities in form of labor market frictions in a wage bargaining setting, as done recently in Walsh (2003a), Trigari (2004) and Gertler and Trigari (2006), among others. Nevertheless, the adequacy of such types of models, concerning the rational expectations assumption and the modeling strategy, still remains questioned by a large number of researchers such as Mankiw (2001), Eller and Gordon (2003) and Solow (2004), precisely due to its exclusive focussing on intertemporal, "rational" and forward-looking modeling of economic agents. Solow (2004) goes one step further and rises serious doubts about the implications for economic policy advisement based on such models, primarily due to their low ability to fit real data. While elegant in their theoretical microfoundations, these types of macroeconomic models are nevertheless still far too restrictive to describe and analyze a variety of macroeconomic interactions within an economy. The microfoundations of the wage and price setting, completely oriented to the intertemporal maximization of utility and profits, disregard short run factors and dynamics which might take place even if they are not consistent with the solution of an intertemporal maximization problem. Aggregate demand pressures, as well as the state of the markets, especially of the labor markets, are not considered in models of the New Keynesian sort as the ones developed in Galí and Gertler (1999), Erceg et al. (2000) and Christiano et al. (2005).

Due to these arguments –especially due to our focus on the role of frictions in the labor markets for the dynamics of the economy as a whole– our theoretical analysis will be based on disequilibrium rather than equilibrium situations, following the theoretical modeling approach by Chiarella and Flaschel (2000), Chiarella et al. (2005) and Chen, Chiarella, Flaschel and Semmler (2006). As discussed in a previous chapter of this dissertation, this theoretical approach, which relies on the interdependent but nevertheless separate gradual adjustments of wages and prices, allows, in contrast to standard DSGE models, for disequilibrium situations in both goods and labor markets, and might therefore be more appropriate for a realistic theoretical analysis of the role of labor market frictions for the dynamics of output, inflation and income distribution.

The remainder of this chapter can be summarized as follows. In section 3.2 the recent literature on staggered wage and price and employment dynamics is briefly overviewed, with special focus on the DSGE approach. In section 3.3 an alternative Keynesian (Disequilibrium) AS-AD model in the line of Chen, Chiarella, Flaschel and Semmler (2006) is developed, where frictions in the labor markets are additionally introduced by means of a search and matching labor market module. As it will be discussed there, this alternative modelling approach features a similar or even better ability to emulate the dynamic behavior of aggregate macroeconomic data, generating for example a higher degree of inflation persistence without the use of the highly questionable Calvo (1983) price setting mechanism often used in the DSGE framework. After identifying the local stability conditions of the resulting 4D dynamical system, in section 3.4 the dynamic adjustment paths of the variables of the theoretical model to monetary and aggregate demand shocks are analyzed on the basis of previously estimated parameters. Thereafter, in section 3.5, the design of monetary policy within our theoretical framework is discussed through the analysis of the dynamic adjustment and degrees of persistence of the model variables under alternative monetary policy rules. Section 3.6 draws some conclusions and further research directions from this study.

3.2 Overview of the Literature

As stated before, labor markets are confronted to a larger extent than other types of markets with a variety of frictions such as the asymmetric or incomplete information about the state of the market, geographical and skill mismatches, as well as searching and trading costs.[1] Indeed, as pointed out by Pissarides (2000, p.3), unlike other markets, trading in labor markets is likely to be "uncoordinated, time-consuming, and costly for both firms and workers". It is also likely to depend on the actual market conditions, that is, on the relative size of unemployed workers and vacancies.

In the last decade, nevertheless, labor markets of Walrasian type, where workers and employers do not face any type of frictions or trading costs, have been assumed in the majority of macroeconomic models discussed in the mainstream literature. Indeed, in models of New Keynesian type such as Blanchard and Kiyotaki (1987), Goodfriend and King (1997) and Rotemberg and Woodford (1997), research focused primarily

[1] In the EMU, for example, despite of the absence of legal barriers concerning the labor mobility among the full Member States, language and cultural differences still represent important barriers which might explain the low degree of labor mobility in EMU.

on the modelling of nominal rigidities. Specifically, with rational, forward looking, intertemporal utility maximizing households and profit maximizing firms, the only source of frictions assumed in that framework are the existence of a staggered price setting mechanism á la Calvo (1983), whereafter only a fraction of firms can reset their goods prices to the monopolistically optimal level in every period.[2] The notion of the existence of Non-Walrasian labor market equilibrium situations, where households and firms might not be able to find adequate counterparts in the labor markets,[3] remained to a large extent unconsidered in those models: Because firms and households always (and without time or monetary costs) find a proper workers and employment position, respectively, and the resulting real wage in the labor markets always fulfills simultaneously the intertemporal consumption/leisure preferences of households and the profit maximization condition by the firms, no involuntary unemployment exists.

In early New Keynesian models featuring only price rigidities as e.g. Roberts (1995), the assumption of frictionless, Walrasian labor markets delivered also wide-reaching implications for the conduction of monetary policy. According to the baseline New Keynesian Phillips Curve (NKPC), inflation is simple a function of the actual output gap and future expected inflation. This implies for the monetary authorities, so the conclusion of such models, that there exists no trade-off between inflation and output stabilization, in contrast to the experience of the majority of central bankers around the world.[4]

Contrarily to the above mentioned New Keynesian models, the more recently elaborated DSGE models in the line of Erceg et al. (2000), Smets and Wouters (2003) and Christiano et al. (2005), feature besides price- also nominal wage rigidities.[5] Now, while with the inclusion of nominal wage rigidities the absence of a trade-off between output,

[2] See Mankiw (2001), Estrella and Fuhrer (2002) and Rudd and Whelan (2005) for some critical assessments concerning the theoretical and empirical implications of the New Keynesian approach.

[3] and therefore where involuntary unemployment and unoccupied job positions might exist in equilibrium.

[4] The absence of an output-inflation stabilization trade-off still exists in the more elaborated versions of the New Keynesian framework, for example under the hybrid NKPC developed by Galí and Gertler (1999) and Galí et al. (2001) (where actual inflation additionally depends on lagged inflation due to the assumption of price indexation), also due to its basic assumption of perfect nominal wage flexibility, as shown in Woodford (2003).

[5] These mentioned studies feature additionally various types of real rigidities such as habit formation in consumption, investment and adjustment costs and variable capacity utilization, but still do not incorporate labor market frictions.

employment and inflation stabilization (referred by Blanchard and Galí (2005) as the "divine trinity") disappears and the dynamics of inflation predicted by the underlying theoretical model become, in a more realistic way, more persistent, the wage and price development is still solely determined by abstract stochastic processes. Indeed, in these models, wage stickiness is introduced by assuming, in analogy to the standard modeling of optimal price setting by firms, that households – offering differentiated types of labor – possess enough indeed monopolistic power to unilaterally set (!) the level of nominal wages which allows them to maximize their intertemporal utility function. Nevertheless, just like firms in the baseline New Keynesian framework, only a constant fraction of households obtains in every period the opportunity to reset their wages optimally in a Calvo (1983) manner.[6] Now, while this scheme of staggered wage contracts facilitates an easy and elegant incorporation of nominal rigidities in the DSGE framework, its closeness to reality is highly questionable. This criticism applies also to the standard New Keynesian Phillips Curve, which is also derived from the assumption of staggered price contracts à la Calvo (1983)). Indeed, in most industrialized countries, and especially in the members countries of EMU, most of the wages are set through a bargaining process between firms and trade unions. Even in more decentralized labor markets as in the U.S., the assumption of households setting wages in a monopolistic manner is highly questionable, due to the rather low degree of differentiation of the labor supply by the majority of the population economically active.[7]

In recent times, the theoretical research on the role of labor market frictions for the dynamics not only of output but also of real marginal costs and of wage and price inflation has experienced a revival, after nearly two decades where it was almost completely left aside from the academic literature on monetary economics. In a series of research papers, Walsh (2003a), Trigari (2004), Christoffel, Kuester and Linzert (2006) and Gertler and Trigari (2006), among others, have started to investigate the role that labor market frictions play in the dynamics of the real economy by integrating some elements of the job search theory popularized by Mortensen and Pissarides (1994) and Pissarides (2000) (a standard approach used in labor economics to model labor market frictions) into DSGE frameworks with nominal wage and price rigidities.[8] The rea-

[6] see e.g. Erceg et al. (2000) and Christiano et al. (2005)

[7] In the next section we will discuss the alternative (D)AS-AD approach to wage and price inflation dynamics by Chiarella and Flaschel (2000) and Chiarella et al. (2005).

[8] In the search and matching framework, the search for adequate business partners in the labor market (firms and employers) is assumed to be costly and time consuming. Vacancies and unemployed

soning for this new modelling strategy is the following: When labor markets do not function in a frictionless manner but are confronted to real rigidities, they are not able to accommodate aggregate demand and supply shocks immediately. Its delayed reaction to such shocks, thus, weakens the link between output and employment, making their reactions less strong and more persistent.

In order to introduce nominal rigidities in her model, Trigari (2004) assumes that, while nominal wages are re-set through a bargaining process between firms and workers in every period, firms can re-optimize their prices in a Calvo (1983) manner with additional price indexation.[9] Gertler and Trigari (2006) follow the same strategy, though in a more elaborated framework, by gathering nominal wage staggering with a multi-period wage bargaining resulting from the use of the job search theory. Alternatively, following Hall (2005), in Christoffel et al. (2006) and Christoffel and Linzert (2006) nominal rigidity is introduced by specifying a "wage norm or social consensus" after which "the actual wage level is given by a weighted average of past wage level and the equilibrium wage level".[10] The basic result of these studies is that while the incorporation of labor market frictions into DSGE models implies qualitatively similar responses of output, employment and inflation to aggregate demand shocks and monetary policy shocks as in DSGE models with Walrasian labor markets, from the quantitative point of view, this modification decreases the responsiveness of output and inflation and increases their degree of persistence.

Nevertheless, despite its actual popularity in the mainstream literature, the adequacy of this type of theoretical modeling approach has been strongly questioned by a large number of researchers such as Mankiw (2001), Eller and Gordon (2003) and Solow (2004), precisely due to its exclusive focussing on intertemporal, "rational" and forward-looking modeling of economic agents. Solow (2004) goes one step further and rises serious doubts about the implications for economic policy advisement based on such models, primarily due to their low ability to fit real data. Indeed, these types of

workers are assumed furthermore to be brought together by a matching function which depends on the state of the market. The use of aggregate search and matching functions in the line of Pissarides (2000) has become standard in labor economics for the analysis of the labor markets at an aggregate level, due to the high diversity in the nature of the frictions affecting labor markets. See Petrongolo and Pissarides (2001) for a survey article on the aggregate matching functions.

[9] As discussed before, this Galí et al. (2001) specification leads to a hybrid type of New Keynesian Phillips Curve, where actual inflation depends on future expected and past inflation.

[10] Christoffel and Linzert (2006, p.16).

macroeconomic models are still far too restrictive to describe and analyze a variety of macroeconomic interactions within an economy. The microfoundations of the wage and price setting, completely oriented to the intertemporal maximization of utility and profits, disregard short run factors and dynamics which might take place even if they are not consistent with the solution of an intertemporal maximization problem. Aggregate demand pressures, as well as the state of the markets, especially of the labor markets, are not considered in models of the New Keynesian sort as the ones developed in Galí and Gertler (1999), Erceg et al. (2000) and Christiano et al. (2005).

Due to these arguments, our theoretical analysis will be based on disequilibrium rather than equilibrium situations, following the theoretical modeling approach by Chiarella and Flaschel (2000), Chiarella et al. (2005) and Chen, Chiarella, Flaschel and Semmler (2006). This theoretical approach, which relies on the interdependent but nevertheless separate gradual adjustments of wages and prices, allows, in contrast to standard DSGE models, for disequilibrium situations in both goods and labor markets. It might therefore be more appropriate for a realistic theoretical analysis of the role of labor market frictions for the dynamics of output, inflation and income distribution. Additionally, as it will be discussed in the next section, due to the special specification of the inflation expectations, with perfectly foreseen actual wage inflation entering in the price inflation adjustment equation and vice versa, both goods and labor markets influence in a direct manner both wage and price inflation behavior in the economy.

3.3 The Model

In the next section an alternative approach to the DSGE framework developed by Chiarella and Flaschel (2000) and Chiarella et al. (2005) is modified and extended. Nevertheless, in contrast to Chen, Chiarella, Flaschel and Semmler (2006) (where the dynamics of the goods and the labor markets were linked in by a dynamic version of Okun's (1970) law) the dynamics in the labor markets will be modeled through a search and matching module in the line of Pissarides (2000).

3.3.1 The Labor Markets

In a quite standard manner, a single input factor technology is assumed, by which output is simply produced according to

$$Y_t = z_t N_t^{\alpha}, \tag{3.1}$$

where N_t denotes the actual (realized) level of employment and z_t represents the average labor productivity in the economy.

In the same manner, full employment output Y_t^f is simply a function of the actual level of labor supply in the economy $L_t = \bar{L}$ (assumed for simplicity to be constant)

$$Y_t^f = z_t L^{\alpha}. \tag{3.2}$$

Firms, confronted with an aggregate demand level Y^{D}, determine their labor demand according to eq.(3.1), that is

$$L_t^{\mathrm{D}} = (Y_t^{\mathrm{D}}/z_t)^{1/\alpha}. \tag{3.3}$$

Due to the existence of labor market frictions, the actual level of employment N_t is not necessarily consistent with the labor demand by firms L_t^{D}, so that $L_t^{\mathrm{D}} = N_t$ does not hold in the normal case.

Hall (2005) and Shimer (2005) find that the rise in unemployment during economic slowdowns is caused not by a higher rate of job destruction (at least in the U.S. employed workers do not get fired more frequently than in economic booms), but by a lower rate of job creation. Following these studies, it is assumed here that a certain number of jobs are destroyed at an exogenous rate ρ in each period.[11] The actual number of employed workers at t is thus determined by the level of remaining jobs from the previous period and by the "matches" occurred at the beginning of the actual period. At t, the number of employees is given by

$$N_t = (1-\rho)N_{t-1} + m(U_t, V_t) \tag{3.4}$$

[11] This assumption is also met by Gertler and Trigari (2006), Christoffel and Linzert (2006) and Christoffel et al. (2006). Trigari (2004) and Campolmi and Faia (2006), in contrast, assume that the job separation rate depends partly on the position of the economy within the business cycle, making the separation rate of employment partly endogenous.

where $m(U_t, V_t)$ is a matching function of a standard Cobb-Douglas type, expressed as

$$m(U_t, V_t) = \mu U_t^{\nu} V_t^{1-\nu}, \quad \mu \in (0,1) \tag{3.5}$$

with μ representing the matching technology level, $U_t = L_t - (1-\rho)N_{t-1}$ the number of unemployed and $V_t = L_t^{\mathrm{D}} - (1-\rho)N_{t-1}$ the number of vacancies at the beginning of period t (which can be negative if the firms decide to lower their demand of labor).

By defining $u_t = U_t/L_t$ and $v_t = V_t/L_t$ as the unemployment and vacancy rates, respectively, and normalizing the total labor supply to $L_t = \bar{L} = 1$, we can reformulate eq.(3.4) in terms of the employment rate $e_t = N_t/\bar{L} = N_t$ as

$$e_t = (1-\rho)e_{t-1} + m(u_t, v_t). \tag{3.6}$$

This specification, though quite simple, allows us to incorporate in our theoretical framework the dependency of employment on the actual labor market situation. By defining the degree of actual labor market tightness as

$$\Theta_t = v_t/u_t,$$

we can reexpress the matching function described by eq.(3.5) as

$$m(\Theta_t, v_t) = \mu \Theta_t^{-\nu} v_t,$$

with $m'(\Theta_t) = -\nu\mu\Theta_t^{-\nu-1} v_t < 0$. The level of employment, determined by the matching function, decreases if the ratio of labor demand (the vacancy rate) to unemployment rate increases. Making use of the fact that

$$L_t^{\mathrm{D}}/L = \left(Y_t^{\mathrm{D}}/Y_t^f\right)^{1/\alpha},$$

we can rewrite eq.(3.6) as

$$e_t = (1-\rho)e_{t-1} + \mu[1-(1-\rho)e_{t-1}]^{\nu}\left[\left(Y_t^{\mathrm{D}}/Y_t^f\right)^{1/\alpha} - (1-\rho)e_{t-1}\right]^{1-\nu} \tag{3.7}$$

or, after reordering, as

$$e_t - e_{t-1} = \mu\left[1-(1-\rho)e_{t-1}\right]^{\nu}\left[\left(Y_t^{\mathrm{D}}/Y_t^f\right)^{1/\alpha} - (1-\rho)e_{t-1}\right]^{1-\nu} - \rho e_{t-1}, \tag{3.8}$$

which represents the law of motion of employment in discrete time. Defining generally the time lag length as h, for $h \longrightarrow 0$, we obtain an approximate formulation of eq.(3.8) in continuous time, expressed as

$$\dot{e} = \mu \left[1 - (1-\rho)e\right]^{\nu} \left[\left(Y^{\mathrm{D}}/Y^{f}\right)^{1/\alpha} - (1-\rho)e\right]^{1-\nu} - \rho e. \tag{3.9}$$

As this labor market module is formulated, the state of the market (the labor market tightness) influences in a direct way the capability of firms to serve aggregate demand: Indeed, due to the existence of labor market frictions, firms usually do not obtain their desired level of labor demand L_t^{D}, but N_t instead. Note that the more rigid the labor markets are, the greater will be the discrepancy between L_t^{D} and N_t, and therefore, through the wage dynamics to be discussed below, the more sluggishly the nominal unit labor costs will react to exogenous and endogenous shocks.

As eq.(3.9) shows, the rate of change of the employment rate depends on the *level* of aggregate demand $L^{\mathrm{D}}/L_t = \left(Y_t^{\mathrm{D}}/Y_t^{f}\right)^{1/\alpha}$, and not on the rate of change of aggregate output.[12] By partial differentiation, we can confirm the adequacy of the qualitative response of the employment dynamics to the aggregate demand Y^{D} and to the level of the employment rate:

$$\begin{aligned} \frac{\partial \dot{e}}{\partial Y^{\mathrm{D}}} &= (1-\nu)\mu\nu u^{\nu} v^{-\nu} \alpha^{-1} \left(Y_t^{\mathrm{D}}/Y_t^{f}\right)^{1/\alpha - 1} > 0 \\ \frac{\partial \dot{e}}{\partial e} &= \nu\mu\, u^{\nu-1}(-1+\rho)v^{1-\nu} + (1-\nu)\mu u^{\nu} v^{-\nu}(-1+\rho) - \rho < 0 \end{aligned}$$

Note that our formulation of the employment rate dynamics differs significantly from traditional search and matching labor market models, because here the vacancies are determined basically by the goods aggregate demand pendant on the labor market (since $L^{\mathrm{D}} = (Y^{\mathrm{D}}/z)^{1/\alpha}$) and not, as usual, through a forward-looking decision process including Bellman equations and in there the cost-benefit considerations of both workers and firms. However, as discussed later on in this paper, the formulation of the employment rate dynamics delivers quite reasonable dynamics when simulated.

[12] which would be the case if $Y_t^{\mathrm{D}} = Y_t$, as formulated for example in Franke, Flaschel and Proaño (2006) with the modeling of a dynamic Okun's law.

3.3.2 The Goods Markets

The dynamics of the goods markets in this theoretical model are still of a Keynesian type, with aggregate demand driving the level of employment and output, in this order. Indeed, due to the incorporation of labor market rigidities in our theoretical framework, the level of production in the economy is not only determined by the aggregate demand, as in standard Keynesian models, but is also influenced in a direct manner by the degree of inflexibility of the labor markets. Accordingly, we differentiate between the full-employment production level $Y_t^f = z_t \bar{L}^\alpha$ and the potential output level

$$Y_t^p = z_t \phi \bar{L}^\alpha \tag{3.10}$$

where ϕ represents a time-invariant term comprising structural labor market factors to be defined below.

We assume that excess aggregate demand (the log deviation of aggregate demand from the full employment output level) is simply determined by

$$y_t^d = \ln\left(\frac{Y_t^{\mathrm{D}}}{Y_t^f}\right) = \alpha_y y_{t-1} - \alpha_{yr}(i_{t-1} - \hat{p}_t - (i_o - \pi_o)) - \alpha_{yv}(v_{t-1} - v_o) \tag{3.11}$$

where y_{t-1} represents the output gap (to be defined below) in the previous period, i_o denotes the steady state nominal interest rate, π_o the target inflation rate of the central bank (assumed for simplicity to be equal to the actual steady state inflation rate) and $v_t - v_o$ being the deviation of the actual labor share v_t from its steady state level v_o. According to eq.(3.11), aggregate demand is assumed to depend (i) positively (with $0 < \alpha_y < 1$) on aggregate income, (ii) negatively on the labor share (in principle this dependence could be positive, depending on whether consumption is more responsive to real wage changes than investment),[13] and (iii) negatively on the real interest rate.

Making use of eq.(3.7) we can express the actual output gap y (defined as the log deviation of the actual, realized output level from potential output) as

$$\begin{aligned} y_t &= \ln(Y_t/Y_t^p) = \ln\left(\frac{z_t N_t^\alpha}{z_t \phi L^\alpha}\right) = \alpha \ln(e_t/\phi), \\ y_t &= \alpha \ln\left(\frac{(1-\rho)e_{t-1} + \mu[1-(1-\rho)e_{t-1}]^\nu \left[\exp\left(y_t^d\right)^{1/\alpha} - (1-\rho)e_{t-1}\right]^{1-\nu}}{\phi}\right) \qquad (3.12) \\ &= f_y(e_t), \quad f'(e_t) > 0, \quad f''(e_t) < 0 \end{aligned}$$

[13] See Franke et al. (2006) for an extensive discussion of the ambiguity of the Rose real wage channel.

Note that for $e_t = \phi = e_0$, with e_o being the steady state employment rate, $y_t = 0$ holds.

As this module is formulated, aggregate goods demand determines the level of employment desired by firms, and through the search and matching function expressed by eq.(3.5), the actual level of employment (the employment rate). This, in turn, determines the level of production through the assumed production function, which, despite of being influenced through the existence of labor market frictions, is still demand driven and thus Keynesian in nature.

Furthermore, the growth rate of the output gap results by definition, namely

$$\hat{y}_t = y_t - y_{t-1}$$

contrarily to the dynamic IS-equation used in Asada, Chen, Chiarella and Flaschel (2006), for example.

3.3.3 The Wage-Price Dynamics

As stated before, recent DSGE models in the line of Erceg et al. (2000) and Christiano et al. (2005) incorporate both staggered wage and price setting. In contrast to this framework, the dynamics of wage and price inflation are driven only by the rational, forward-looking, profit and utility maximizing behavior of firms and households,[14] in the Keynesian disequilibrium approach by Chiarella and Flaschel (2000) and Chiarella et al. (2005), the dynamics of wages and prices depend on the demand pressure of the relevant market, namely of the labor and the goods markets, respectively. In this theoretical framework, the measure of demand pressure in the labor markets is the deviation of the actual employment rate from the NAIRU equivalent e_o. In the goods markets, conversely, it is the output gap which measures the pressure of aggregate demand on prices.[15]

[14] Note furthermore that the influence of both goods and labor market conditions on the behavior of wages and prices, present in the real world, is not considered explicitly in those types of models.

[15] This separate specification of the wage and price dynamics also allows to circumvent the identification problem pointed out by Sims (1987) for simultaneous estimations of wage and price equations with the same explanatory variables.

The structural form of the wage-price dynamics in our framework is given by:

$$\hat{w} = \beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o) + \kappa_{wp}\hat{p} + (1-\kappa_{wp})\pi_c + \kappa_{wz}\hat{z}, \tag{3.13}$$

$$\hat{p} = \beta_{pu}(y - y_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\hat{w} - \hat{z}) + (1-\kappa_{pw})\pi_c. \tag{3.14}$$

The demand pressure terms $e - e_o$ and $u - u_o$ in the wage and price Phillips Curves are augmented by three additional terms: the log of the wage share v (the error correction term discussed in Blanchard and Katz (1999, p.71)), a weighted average of corresponding expected cost-pressure terms – assumed to be model-consistent with forward looking, cross-over wage and price inflation rates $\hat{w}$ and $\hat{p}$, respectively – and a backward looking measure of the perceived inertial inflation in the economy (the "inflationary climate", so to say) symbolized by π_c, and labor productivity growth $\hat{z}$.[16] Concerning the latter term for simplicity it is assumed that it always equals the growth rate of trend productivity, namely $\hat{z} = g_z$ =const.[17] Note that here our approach differs again from the standard New Keynesian approach based on the work by Taylor (1980) and Calvo (1983). Instead of assuming that the aggregate price (and wage) inflation is determined in a profit maximizing manner solely by the expected future path of nominal marginal costs, or in the hybrid variant discussed in Galí et al. (2001), also by lagged inflation, in the (D)AS-AD framework it is assumed that not only the last period inflation, but also the inflationary climate where the economy is embedded is taken into account.

The microfoundations of the wage Phillips curve are of the same type as in Blanchard and Katz (1999), where the dynamics of nominal wages are determined by a wage bargaining process between the trade unions and firms. Blanchard and Katz assume, as in standard wage setting models, that the expected real wage by the trade unions is simply determined by a weighted average of the reservation real wage $\omega_t^{\min}$ and the currency labor productivity z, augmented additionally by the state of the labor market, represented by the unemployment rate u_t, that is

$$\omega^e = \theta\omega_t^{\min} + (1-\theta)z_t - \beta_{wu}u_t \tag{3.15}$$

The reservation real wage, in turn, is assumed to be determined by a simple rule of the

[16] which is expected to influence wages in a positive and prices in a negative manner, due to the associated easing in production cost pressure

[17] Even though explicitly formulated, we will assume $g_z = 0$ in the theoretical part of this chapter for simplicity and leave the modeling of the labor productivity growth for future research.

form

$$\omega_t^{\min} = a + \lambda\omega_{t-1} + (1-\lambda)z_t. \tag{3.16}$$

By inserting eq.(3.16) into (3.15), after some arrangements, see e.g. Flaschel and Krolzig (2006), we obtain

$$\Delta w_t = -\beta_{wu} u_t - (1-\theta\lambda)\ln(v_{t-1}/v_o) + \hat{p}_t^e + (1-\theta\lambda)\hat{z}_t + \theta a. \tag{3.17}$$

Eq.(3.17) is nearly equivalent to eq.(3.13) (with the unemployment gap in the place of the logarithm of the output gap), if hybrid expectations formation is additionally incorporated and additionally a zero growth rate of labor productivity is assumed.

Concerning the price Phillips curve, a similar procedure may be applied based on desired markups of firms, as discussed for example in Flaschel and Krolzig (2006). Along these lines, an economic motivation for the inclusion of – indeed the logarithm of – the real wage (or wage share) with negative sign into the wage PC and with positive sign into the price PC is obtained, without any need for loglinear approximations. The employment gap and the output gap are thus included in these two Philips Curves, respectively, in the place of a single measure (the log of the output gap), as done for example in Woodford (2003). The wage-price module is thus consistent with standard models of unemployment based on efficiency wages, matching and competitive wage determination, and can be considered as an interesting alternative to the – at least empirically questionable – New Keynesian form of wage-price dynamics.[18]

Note that we assume model-consistent expectations with respect to short-run wage and price inflation, nevertheless incorporated in the above Phillips Curves in a cross-over manner, with perfectly foreseen price inflation in the wage Phillips Curve and wage inflation in the price Phillips curve. We stress that our model indeed features a

[18] For comparison, in more elaborated New Keynesian models as e.g. in Woodford (2003, p.225), the joint evolution of wages and prices is described by the following two loglinear equations

$$\hat{w}_t \overset{WPC}{=} \beta E_t[\hat{w}_{t+1}] + \beta_{wy} y_t - \beta_{w\omega} \ln \omega_t,$$
$$\hat{p}_t \overset{PPC}{=} \beta E_t[\hat{p}_{t+1}] + \beta_{py} y_t + \beta_{p\omega} \ln \omega_t,$$

where y_t represents the output gap, usually calculated as the deviation of the growth rate of output from its long-term trend, and ω represents the deviation of the real wage from its "natural" level. As it can easily be observed the expected next period wage inflation does not influence in a direct manner the price inflation and viceversa, as in eqs.(3.13) and (3.14).

forward-looking behavior here, without the need for an application of the jump variable technique of the rational expectations school in general and the New Keynesian approach in particular as will be shown in the next section.[19]

The corresponding across-markets or reduced-form Phillips curves are given by (with $\kappa = 1/(1 - \kappa_{wp}\kappa_{pw})$):

$$\begin{aligned}\hat{w} &= \kappa\,[\beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o) + \kappa_{wp}(\beta_{py}(y - y_o) + \beta_{pv}\ln(v/v_o)) \\ &\quad +(\kappa_{wz} - \kappa_{wp}\kappa_{pw})g_z] + \pi_c, \qquad (3.18)\\ \hat{p} &= \kappa\,[\beta_{py}(y - y_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o)) \\ &\quad +\kappa_{pw}(\kappa_{wz} - 1)g_z] + \pi_c, \qquad (3.19)\end{aligned}$$

which both represent a considerable generalization of the conventional view of a single-market price PC with only one measure of demand pressure, namely the one in the labor market.

Note that for this version of the wage-price spiral, the inflationary climate variable does not matter for the evolution of the labor share $v = w/(pz)$, whose law of motion is given by

$$\begin{aligned}\hat{v} &= \hat{w} - \hat{p} - \hat{z} \\ &= \kappa\,[(1 - \kappa_{pw})f_w(e, v) - (1 - \kappa_{wp})f_u(u, v) + (\kappa_{wz} - 1)(1 - \kappa_{pw})g_z]\,. \qquad (3.20)\end{aligned}$$

with

$$\begin{aligned}f_w(e, v) &= \beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o) \quad \text{and} \\ f_p(u, v) &= \beta_{pu}(u - u_o) + \beta_{uv}\ln(v/v_o)\end{aligned}$$

Eq.(3.20) shows the ambiguity of the stability property of the real wage channel discussed by Rose (1967) which arises if the dynamics of the employment rate and of the output gap are linked (despite the incorporation of specific measures of demand and cost pressure on both the labor and the goods markets), and if inflationary cross-over expectations are incorporated in both Phillips curves. Indeed, as discussed in Franke et al. (2006), a real wage increase can act itself in a stabilizing or destabilizing manner, depending on whether the dynamics of the capacity utilization rate depend positively or

[19] For a detailed comparison of our modelling approach to the New Keynesian alternative see Chiarella et al. (2005).

negatively on the real wage (i.e. if consumption reacts more strongly than investment or vice versa) *and* whether price flexibility is larger than nominal wage flexibility with respect to its own demand pressure measure.

Concerning the evolution of the overall inflationary expectations among the economic agents in the model economy, we follow Franke et al. (2006) and assume that the dynamic behavior of the inflationary climate is described by[20]

$$\dot{\pi}_c = \beta_{\pi_c}[\kappa_{\pi_c}(\hat{p} - \pi_c) + (1 - \kappa_{\pi_c})(\pi_o - \pi_c)], \tag{3.21}$$

where β_{π_c} is an adjustment speed parameter and κ_{π_c} a weight parameter between 0 and 1, and π_o is to be thought of as the target rate of inflation of the central bank, which is assumed to be known by the public. The degree of their confidence *vis-à-vis* the trend-chasing adaptive expectations component is measured by $(1 - \kappa_{\pi_c})$, which can also be referred to as the central bank's credibility.

3.3.4 Monetary Policy

As standard in the actual theoretical literature, the dynamics of the nominal short term interest rate are modeled through a law of motion of a Taylor rule type. Indeed, as Romer (2000, p.154-55) states, "Even in Germany, where there were money targets beginning in 1975 and where those targets payed a major role in the official policy discussions, policy from the 1970s through the 1990s was better described by an interest rate rule aimed at macroeconomic policy objectives than by money targeting."[21]

The target rate of the monetary authorities and the law of motion resulting from an interest rate smoothing behavior by the central bank are given as

$$i_{\mathrm{T}} = i_o + \phi_{\hat{p}}(\hat{p} - \pi_o) + \phi_y(y - y_o) \tag{3.22}$$

$$\dot{i} = \alpha_i(i_{\mathrm{T}} - i). \tag{3.23}$$

The target rate of the central bank i_{T} is here assumed to depend on the steady state real rate of interest $i_o - \pi_o$ augmented by actual inflation back to a nominal rate, and

[20] Even though the introduction of an inflationary climate term is not essential for the dynamics of the model, we introduce it now to facilitate the incorporation of open economy effects, as it will be done in the next chapter of this dissertation. There, the inflationary climate term refers to the CPI inflation, and therefore comprises the effects of imported goods prices on the dynamics of domestic inflation.

[21] See also Clarida and Gertler (1997).

as usual on the inflation- and on the output gap.[22] By inserting i_{T} into eq.(3.23) and rearranging terms we obtain from this expression the following dynamic law for the nominal interest rate

$$\dot{i} = -\alpha_i(i - i_o) + \gamma_{ip}(\hat{p} - \pi_o) + \gamma_{iy}(y - y_o) \tag{3.24}$$

where we have $\gamma_{ip} = \alpha_i\phi_{\hat{p}}$, i.e., $\phi_{\hat{p}} = \gamma_{ip}/\alpha_i$ and $\gamma_{iy} = \alpha_i\phi_y$. The actual (perfectly foreseen) rate of inflation $\hat{p}$ is used to measure the inflation gap with respect to the inflation target π_o of the central bank.

3.3.5 The 4D Dynamical System

Taken together, our theoretical model consists of the four laws of motion, which together form the following autonomous 4D dynamical system

$$\begin{aligned}
\dot{e} &= \mu\,(1-(1-\rho)e)^{\nu}\left(\exp(y^d)^{1/\alpha} - (1-\rho)e\right)^{1-\nu} - \rho e && (3.25)\\
\dot{i} &= -\alpha_i(i - i_o) + \gamma_{ip}(\hat{p} - \pi_o) + \gamma_{iy}y && (3.26)\\
\hat{v} &= \kappa\,[(1-\kappa_{pw})f_w(e,v) - (1-\kappa_{wp})f_u(u,v) + (\kappa_{wz}-1)(1-\kappa_{pw})g_z] && (3.27)\\
\dot{\pi}^c &= \beta_{\pi_c}[\kappa_{\pi_c}(\hat{p} - \pi_c) + (1-\kappa_{\pi_c})(\pi_o - \pi_c)] && (3.28)
\end{aligned}$$

with

$$\begin{aligned}
y^d &= \alpha_y y - \alpha_{yr}(i - \hat{p} + (i_o - \pi_o)) - \alpha_{yv}(v - v_o)\\
y &= f_y(e)
\end{aligned}$$

and $\hat{p}$, according to eq.(3.19), to be inserted in several places.

Steady State Solution

The unique steady state of the 4D dynamical system can be determined in a sequential manner as follows. The goods markets are in equilibrium when $i = i_o = 0$, $\hat{p} = \pi_o$ and $y^d = y = 0$. Inserting these values in the dynamic law of the employment rate delivers

$$\begin{aligned}
\dot{e} &= \mu\,[1-(1-\rho)e]^{\nu}\,[1-(1-\rho)e]^{1-\nu} - \rho e\\
&= \mu(1-(1-\rho)e) - \rho e
\end{aligned}$$

[22] All of the employed gaps are measured relative to the steady state of the model, in order to allow for an interest rate policy that is consistent with it.

since $\exp(0)^{1/\alpha} = 1$. For $\dot{e} = 0$, we obtain

$$e_o = \frac{\mu}{(1-\rho)\mu + \rho}. \tag{3.29}$$

If $e = e_o$, the labor markets are in equilibrium and do not exert any pressures on the dynamics of wages and prices.

As it can be easily observed, the steady state rate of employment is determined solely by structural factors concerning the labor markets, namely the labor separation rate ρ and the matching technology μ, with

$$\begin{aligned}
\frac{\partial e_o}{\partial \rho} &= -\mu[(1-\rho)\mu+\rho]^{-2}(1-\mu) < 0 \\
\frac{\partial e_o}{\partial \mu} &= [(1-\rho)\mu+\rho]^{-1} - \mu(1-\rho)[(1-\rho)\mu+\rho]^{-2} \\
&= \frac{(1-\rho)\mu+\rho-(1-\rho)\mu)}{[(1-\rho)\mu+\rho]^2} = \frac{\rho}{[(1-\rho)\mu+\rho]^2} > 0
\end{aligned}$$

Note that these factors not only influence the *level* of the steady state employment rate, but also the dynamic response of the labor markets to exogenous shocks, as illustrated in Figure 3.1.

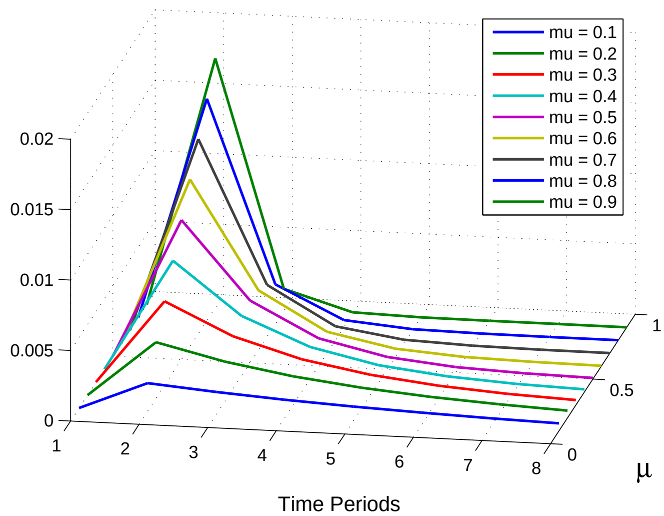


Fig. 3.1: Employment rate response to an exogenous 1% labor demand shock in $t = 2$ for different values of the matching technology μ

As shown there, the larger the value of the matching technology parameter μ, the larger is the response of the employment rate to an exogenous labor demand shock, and the faster is the return of the employment rate to its steady state level (which in turn also depends on the value of μ). Ceteris paribus, a low matching technology leads thus to a low response of the actual employment to labor demand shocks that is *also* more persistent, a result which is in line with other studies featuring aggregate matching functions in the labor markets, see e.g. Amable and Ernst (2006).

Concerning the dynamics of wages and prices at the steady state, it should be clear that in equilibrium none of them is confronted with any demand pressures neither from the labor nor from the goods markets.

The Jacobian of the 4D dynamic system (which comprises the first partial derivatives of the dynamical endogenous variables), calculated at the interior steady state described above, is characterized by the following sign structure:

$$J = \begin{pmatrix} \partial\dot{e}/\partial e & \partial\dot{e}/\partial i & \partial\dot{e}/\partial v & \partial\dot{e}/\partial\pi_c \\ \partial\dot{i}/\partial e & \partial\dot{i}/\partial i & \partial\dot{i}/\partial v & \partial\dot{i}/\partial\pi_c \\ \partial\dot{v}/\partial e & \partial\dot{v}/\partial i & \partial\dot{v}/\partial v & \partial\dot{v}/\partial\pi_c \\ \partial\dot{\pi}_c/\partial e & \partial\dot{\pi}_c/\partial i & \partial\dot{\pi}_c/\partial v & \partial\dot{\pi}_c/\partial\pi_c \end{pmatrix} = \begin{pmatrix} ? & - & ? & + \\ + & - & ? & + \\ ? & 0 & - & 0 \\ + & 0 & ? & - \end{pmatrix}.$$

This representation of the interaction between the different variables within the economy by means of partial derivatives allows us to examine in more detail the different channels through which the different variables act in a stabilizing or destabilizing manner.

Due to the formulation of our model and the role that labor market frictions play in it, the labor markets affect the output determination in a twofold manner: In the first place, through the restrictions they impose concerning the level of output the firms can actually produce; and in the second place, due to the effect they have on the reduced form of the price Phillips curve described by eq.(3.19). The qualitative direction of this influence, nevertheless, is unambiguously positive. In contrast, as the dynamics of the labor markets and more specifically of the employment rate are formulated, the effect of the employment rate on its own rate of change ($\partial\dot{e}/\partial e$) is indeed undetermined: On the one hand, a high level of macroeconomic activity (high employment rate) influences $\dot{e}$ positively; but on the other hand, due to the specification of the matching process of labor, the level of the employment rate itself affects the tightness of the labor market, decreasing therefore the rate at which workers and vacancies are matched.[23]

The rate of change of the employment rate is also influenced (through the aggregate goods and labor demand) by the nominal (and real) interest rate, as well as by the wage share (the real wage), of which the influence is assumed here to be negative (due its cost effect on the firms' profits and investment). However, it could also be positive if alternatively the income effect on consumption turns out to be predominant.[24] Concerning the real interest rate, note that, through our formulation of the reduced form Phillips curve equation to be inserted in eq.(3.25), price inflation is determined not only by the goods, but also by the labor market situations and the weighting coefficients of both wage and price Phillips curves equations concerning the cross-over expectations mechanism.

As this model is formulated, it also features additional potential (at least partially) destabilizing feedback mechanisms concerning the influence of the wage share on aggregate demand, employment and output (in this order), due to the presence of the Mundell-effect in the dynamics of the goods-market and the opposing Blanchard-Katz error correction terms in the reduced form price Phillips curve given by eq.(3.19). As formulated there, the (log of the) labor share (the Blanchard-Katz error correction terms), affects aggregate price inflation and the inflationary expectations in an ambiguous manner, through its opposing influence on the structural wage and price Phillips curve equations given by eq.(3.13) and (3.14). Note that since the net effect of the Blanchard-Katz terms on aggregate price inflation depends on the values of κ_{wp} and κ_{pw}, the cross-over expectation formation by the economic agents determines to a greater extent the direction of the labor share's influence on output.

Concerning the dynamics of the labor share ($\partial \dot{v}/\partial e < 0$), the joint, net effect of the goods and labor market dynamics depends on the signs and values of the parameter estimates of the two structural Phillips curves and therefore, again, on the cross-over expectations formation of the economic agents. On the contrary, the influence of the (log of the) wage share on its rate of growth is unambiguously negative, according to eq.(3.20).

As it can be observed in the last column of the Jacobian of the 4D dynamical system, our

[23] In the next section we will show that the relative size of these effects is central for the stability of the system.

[24] See Chiarella et al. (2005), as well as Proaño, Flaschel, Ernst and Semmler (2006) and Franke et al. (2006) for a detailed discussion of the Rose real wage channel.

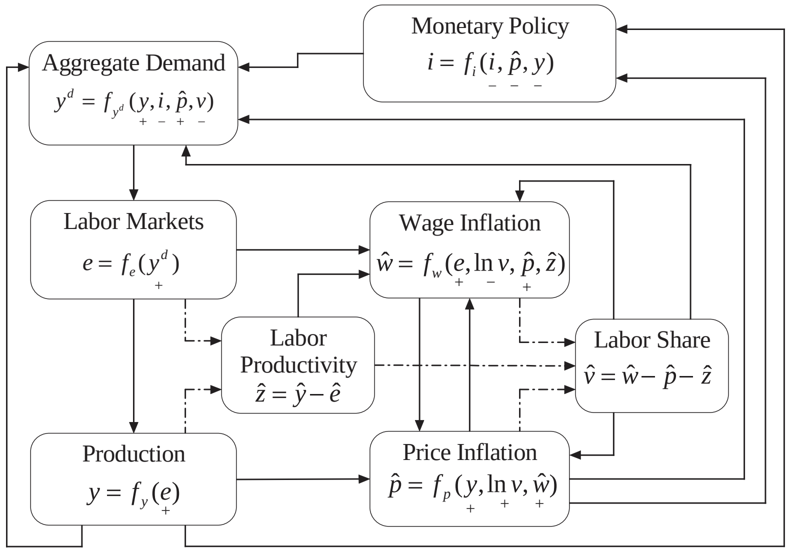


Fig. 3.2: The structure of the model

model also incorporates the Mundell inflationary expectations channel, which affects positively the dynamics of all other dynamic variables of the system through its positive influence on price and wage inflation, and from there on the employment rate and the output gap. This unambiguous property of the Mundell expectations channel (discussed extensively in Chiarella et al. (2005)) is more destabilizing the higher β_π is. These and the remaining feedback channels and interactions of our theoretical D(isequilibrium)AS-AD model are illustrated in Figure 3.2.

Reduced 3D-Feedback Guided Stability Analysis

Having explicitly defined the unique steady state of the economy, we now turn to the analysis of the local asymptotic stability properties of the interior steady state of the 4D dynamical system given by eqs.(3.25)-(3.28) (with eqs.(3.11), (3.12) and (3.19) inserted wherever needed) through partial considerations from the feedback chains that characterize this empirically oriented baseline model of Keynesian dynamics.

Reduced-form expressions in the above system of differential equations have been employed whenever possible. We have thereby obtained a dynamical system in four state variables that is in a natural or intrinsic way nonlinear (due to its reliance on growth rate formulations). Note that there are many items that reappear in various equations, or are similar to each other, implying that stability analysis can exploit a variety of linear dependencies in the calculation of the conditions for local asymptotic stability.

In order to focus more specifically on the role of the labor market friction for the stability of the economy, we decouple the dynamics of the inflation expectations and their influence on the rest of the system by setting $\beta_{\pi_c} = 0$, reducing so our dynamical system by one dimension. Note that in this case the inflationary expectations become static, with the growth rate of labor productivity g_ℓ entering in both wage and price Phillips curve equations with a weight coefficient equal to one.

According to the Routh-Hurwitz stability conditions for a 3D dynamical system, asymptotic local stability of a steady state is fulfilled when

$$a_i > 0, \quad i = 1,2,3 \quad \text{and} \quad a_1 a_2 - a_3 > 0,$$

where $a_1 = -\text{trace}(J)$, $a_2 = \sum_{k=1}^{3} J_k$ with

$$J_1 = \begin{vmatrix} J_{22} & J_{23} \\ J_{32} & J_{33} \end{vmatrix}, J_2 = \begin{vmatrix} J_{11} & J_{13} \\ J_{31} & J_{33} \end{vmatrix}, J_3 = \begin{vmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{vmatrix}.$$

and $a_3 = -\det(J)$. Our reduced 3D dynamical system is stable around its interior steady state, if following propositions are fulfilled:

Proposition 1:

Assume the validity of the inequality

$$|\mu(1+\rho)+\rho| > (1-\nu)\mu \left(\frac{\alpha\alpha_y}{e_o} + \frac{\alpha_{yr}\kappa\left(\frac{\alpha\beta_{py}}{e_o} + \beta_{we}\kappa_{pw}\right)}{\alpha} \right),$$

that assures the unambiguous stability of the employment rate dynamics at least with respect to its own influence. Then: The trace of the implied 3D dynamical system (assuming g_z=0 for simplicity)

$$\begin{aligned}
\dot{e} &= \mu\left(1-(1-\rho)e\right)^{\nu}\left(\exp(y^d)^{1/\alpha}-(1-\rho)e\right)^{1-\nu} - \rho e, \\
\dot{i} &= -\alpha_i(i-i_o) + \gamma_{ip}(\hat{p}-\pi_o) + \gamma_{iy} f_y(e) \\
\hat{v} &= \kappa\left[(1-\kappa_{pw})(\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o))\right. \\
&\quad \left. -(1-\kappa_{wp})(\beta_{pu} f_y(e) + \beta_{pv}\ln(v/v_o))\right]
\end{aligned}$$

around its interior steady state is unambiguously negative. ■

Sketch of Proof:

Evaluated at the unique steady state, the 3D Jacobian of the system is given by

$$\begin{pmatrix} -\rho+\mu(\rho-1)+(1-\nu)\mu\left(\frac{\alpha\alpha_y}{e_o}+\frac{\alpha_{yr}\kappa\left(\frac{\alpha\beta_{py}}{e_o}+\beta_{we}\kappa_{pw}\right)}{\alpha}\right) & -\frac{\alpha_{yr}(1-\nu)\mu}{\alpha} & \frac{(1-\nu)\left(-\alpha_{yv}+\alpha_{yr}\kappa\left(\frac{\beta_{pv}-\beta_{wv}\kappa_{pw}}{v}\right)\right)\mu}{\alpha} \\ \frac{\alpha\gamma_{iy}}{e_o}+\gamma_{ip}\kappa\left(\frac{\alpha\beta_{py}}{e_o}+\beta_{we}\kappa_{pw}\right) & -\alpha_i & \gamma_{ip}\kappa\left(\frac{\beta_{pv}-\beta_{wv}\kappa_{pw}}{v}\right) \\ \kappa(1-\kappa_{pw})\left(\beta_{we}-\frac{\alpha\beta_{py}(1-\kappa_{wp})}{e_o}\right) & 0 & \kappa(1-\kappa_{pw})\left(\frac{-\beta_{wv}-\beta_{pv}(1-\kappa_{wp})}{v_o}\right) \end{pmatrix}.$$

Under Proposition 1, which assures a stable dynamic behavior of the employment rate with respect to its own dynamics, the sign structure of the Jacobian is

$$\begin{pmatrix} - & - & \pm \\ + & - & \pm \\ \pm & 0 & - \end{pmatrix},$$

and $\mathrm{tr}(J) < 0$ unambiguously holds. ■

Proposition 2:

Assume that $|\alpha_{yv}| > \alpha_{yr}\kappa\left(\frac{\beta_{pv}-\beta_{wv}\kappa_{pw}}{v_o}\right)$, and additionally, that $\beta_{we} \gtreqless \beta_{py}$ hold. Under these conditions, $a_2 > 0$, the second Routh-Hurwitz local stability condition for a 3D dynamical system,

$$a_2 \quad = \quad J_1 + J_2 + J_3 = \begin{vmatrix} J_{22} & J_{23} \\ J_{32} & J_{33} \end{vmatrix} + \begin{vmatrix} J_{11} & J_{13} \\ J_{31} & J_{33} \end{vmatrix} + \begin{vmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{vmatrix},$$

is always fulfilled.

Sketch of Proof:

Under the validity of Proposition 1, but without the need of further assumptions, J_1 and J_3 in are unambiguously positive. If Proposition 2 additionally holds,[25] then

[25] What would be consistent with the parameter values estimated by Franke et al. (2006) and Proaño, Flaschel, Ernst and Semmler (2006).

$$J_2 = \left[\mu(1-\rho)+\rho-(1-\nu)\mu\left(\frac{\alpha\alpha_y}{e_o}+\frac{\alpha_{yr}\kappa\left(\frac{\alpha\beta_{py}}{e_o}+\beta_{we}\kappa_{pw}\right)}{\alpha}\right)\right]\cdot$$
$$\left(\frac{\beta_{wv}+\beta_{pv}(1-\kappa_{wp})}{v_o}\right)-\frac{(1-\nu)\mu}{\alpha}\left(-\alpha_{yv}+\alpha_{yr}\kappa\left(\frac{\beta_{pv}-\beta_{wv}\kappa_{pw}}{v_o}\right)\right)\cdot$$
$$\left(\beta_{we}-\frac{\alpha\beta_{py}(1-\kappa_{wp})}{e_o}\right)>0,$$

and the sum of the minors of order 2, a_2, is positive. ■

Under the validity of Propositions 1 and 2, the full set of Routh-Hurwitz conditions are always fulfilled, since $\det J = -a_3$ is unambiguously negative. In this case, the interior steady state reduced 3D dynamical system is locally stable.

3.3.6 Model Calibration and Stochastic Simulation

After having identified the stability conditions of the dynamical system, we analyze now the effects of labor market frictions for the dynamics of the system after different types of shocks by means of computer simulations. To do so, we use a discrete time version of the 4D continuous time system discussed in the previous section,[26] using nevertheless alternative labor market specifications to the search framework described in section 3.3 in order to evaluate the dynamic properties of the model. On the one hand, we analyze a scenario where the labor markets function frictionless, so that $L_t^{\mathrm{D}} = N_t$ and $Y_t^{\mathrm{D}} = Y_t$ always hold – and the dynamic law of motion of the employment rate based on the aggregate matching function is replaced simply by the production technology equation –. On the other hand, we model the link between the goods and labor markets by means of a dynamic version of Okun's Law, as done in Asada, Chen, Chiarella and Flaschel (2006), Proaño, Flaschel, Ernst and Semmler (2006) and Franke et al. (2006), where the growth rate of the employment rate is determined by

$$\hat{e}_t = \alpha_{ey1}\hat{y}_{t-1} + \alpha_{ey2}\hat{y}_{t-2} + \alpha_{ey3}\hat{y}_{t-3}. \tag{3.30}$$

The parameter values used in the different specifications are shown in Table 3.1.

[26] The simulations were computed with MATLAB. The source code is available upon request.

Tab. 3.1: Baseline calibration parameters

Goods Markets	α_{yy}	α_{yi}	α_{yv}		
	0.7	0.05	0.1		
Wage Phillips Curve	β_{we}	β_{we}	κ_{wp}	$1-\kappa_{wp}$	
	0.510	0.230	0.420	0.580	
Price Phillips Curve	β_{we}	β_{we}	κ_{wp}	$1-\kappa_{wp}$	
	0.210	0.270	0.550	0.450	
Monetary Policy Rule	α_i	$\phi_{\hat{p}}$	ϕ_y		
	0.7	1.5	0.5		
Labor Markets	α	μ	ρ	ν	g_z
	0.70	0.6	0.1	0.2	0.0

Labor Markets In the baseline scenario I set the matching technology factor $\mu = 0.6$ (Christoffel and Linzert (2006) choose $\mu = 0.4$). For the job separation rate ρ (exogenous in our model), a value of 0.1 was chosen, which is consistent with the empirical findings (on quarterly frequency) by Hall (1995), Hall (2005), Shimer (2005). For the choice of the Cobb-Douglas parameter of the the search and matching function ν, I set a lower value ($\nu = 0.2$) than Walsh (2005), who sets this parameter equal to 0.4.[27] Note that in the scenarios featuring the labor search function the steady state employment rate is not one, as in the other two scenarios, but is instead determined by the structural labor markets parameters according to eq.(3.29).

Goods Markets For the choice of the parameters α_{yy}, α_{yi} and α_{yv}, we rely on the system GMM parameter estimates of Proaño, Flaschel, Ernst and Semmler (2006) and Franke et al. (2006), which are consistent with other studies as Goodhart and Hofmann (2005) who also perform system GMM estimations of Phillips curve and IS equations, using nevertheless also expected values of future variables.

Wage-Price Dynamics Concerning the parameters in the wage and price Phillips curve equations (assumed to be equal across all labor market specifications), we use the empirical parameter estimates obtained for the U.S. economy by Proaño, Flaschel, Ernst and Semmler (2006) and Franke et al. (2006) using system GMM estimation techniques. These estimated parameter values, even though obtained by means of the GMM methodology, are consistent with related studies on wage and price inflation dynamics as Chen and Flaschel (2006) and Flaschel and Krolzig (2006).

[27] Setting a value of $\nu = 0.4$ does not change the qualitative reactions of the model, but delivers too low responses compared with the scenario featuring Okuns' Law.

Monetary Policy Following Taylor (1999) and all the related literature on monetary policy rules, we set the responsiveness of the short term interest rate to the inflation gap equal to 1.5, and to the output gap, 0.5, and we set the interest rate smoothing parameter value equal to 0.7 as in Walsh (2005) in order to take into account the high degree of inertia observable in nominal interest rate time series data.[28]

In order to evaluate the empirical plausibility of the present theoretical framework under this parameter calibration the model was simulated over 1000 quarters, assuming that in each quarter the economy is hit by an aggregate demand, a labor productivity and a monetary policy shock. For the first two shocks a first order autoregressive process with an autoregressive parameter of $\rho_y = \rho_z = 0.7$ was assumed, as usually done in the literature, see e.g. Smets and Wouters (2003).

Based on the estimations by Juillard, Karam, Laxton and Pesenti (2006), we set the standard deviations of output, labor productivity and the nominal interest rate equal to $\sigma_z = 0.0089$, $\sigma_z = 0.0039$ and $\sigma_z = 0.0039$, respectively.[29]

Tab. 3.2: Actual (1980:1 – 2005:4) and Simulated Standard Deviations (in percent)

	Output	Employment Rate	Price Inflation	Wage Inflation
U.S.	2.2	1.5	0.525	0.675
euro area	1.7	1.4	0.650	0.850
Model	1.9	2.4	0.600	0.610

Given the rather parsimonious formulation of the present model and the fact that in this simulation only three types of shocks (compared with the eight of Juillard et al. (2006)) are assumed to hit the economy in each period, the performance of the model concerning second moments seems to be quite acceptable, even though precisely the volatility of the employment rate seems somewhat high when compared with actual data.

[28] As discussed in Rudebusch and Wu (2003) and Franke et al. (2006), there are also some empirical and theoretical arguments supporting the modelling of monetary policy impulses as autoregressive processes due, for example, the uncertainty of the monetary authorities at time t concerning the actual state of the economy. We choose nevertheless to model the interest rate inertia by means of a smoothing parameter in the Taylor rule, in order to remain consistent with the theoretical framework of the previous section.

[29] We assumed though normally distributed shocks, while Juillard et al. (2006) assume that these are inverse gamma distributed.

3.4 Dynamic Adjustments under Different Labor Market Schemes

In the following the dynamic properties of our model by simulating the responses of the economy to two different types of exogenous shocks: a monetary policy shock and an aggregate demand shock are analyzed. The underlying time unit is a quarter, but to ease the interpretation of the simulation results the data is annualized.

Figure 3.3 shows the dynamic response of the artificial economy to a one percent increase in the nominal interest rate. As it can observed, the model delivers quite reasonable qualitative responses, which are also in line with the predicted reactions of other macroeconomic models with labor frictions, such as Walsh (2003a) and Walsh (2005). This is despite the fact that the present approach does not rely on intertemporal utility and profit maximizing behavior by households and firms assumed there, nor on the highly questionable Calvo (1983) staggered wage and price setting behavior.

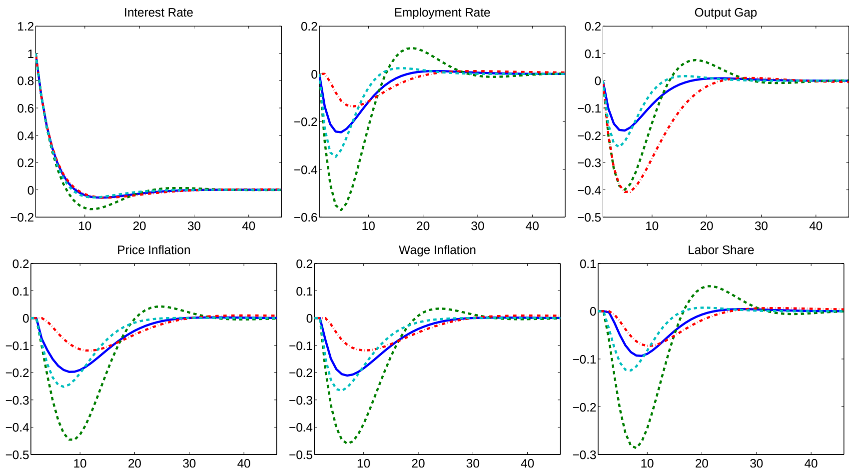


Fig. 3.3: Impulse-response functions to a one-percent monetary shock for different employment rate dynamic adjustment mechanisms (annualized inflation rates, in quarters, percent values): The solid line represents the baseline calibration with labor market frictions and a matching technology factor of $\mu = .6$. The dashed line represents the scenario with $\mu = .1$, that is, with a lower degree of labor market rigidity. The dotted line shows the case where the labor markets function frictionless, and the dashed-dotted line represents the specification with a dynamic Okun's law.

As expected, after an increase in the nominal interest rate, both output and employment decrease, leading also to a fall in wage and price inflation. The reaction of the wage share, on the contrary, is much more complex. This is because it depends strongly not only on the relative sizes of the output and employment growth but also on the weighting parameters in the wage and price Phillips curve equations. However, we observe a uniform negative response of the labor share in all labor market scenarios. The perfectly flexible labor markets scenario, as expected, showed the largest response. Concerning specifically the role of labor market frictions for the dynamic response of the economy to shocks, as the impulse response functions in Figure 3.3 show, the more rigid the labor markets are the weaker is the responsiveness of employment (and output) to exogenous shocks. This, in turn, affects the reaction of price and wage inflation to exogenous developments and therefore also the reaction of the wage share dynamics, as discussed in the previous section.

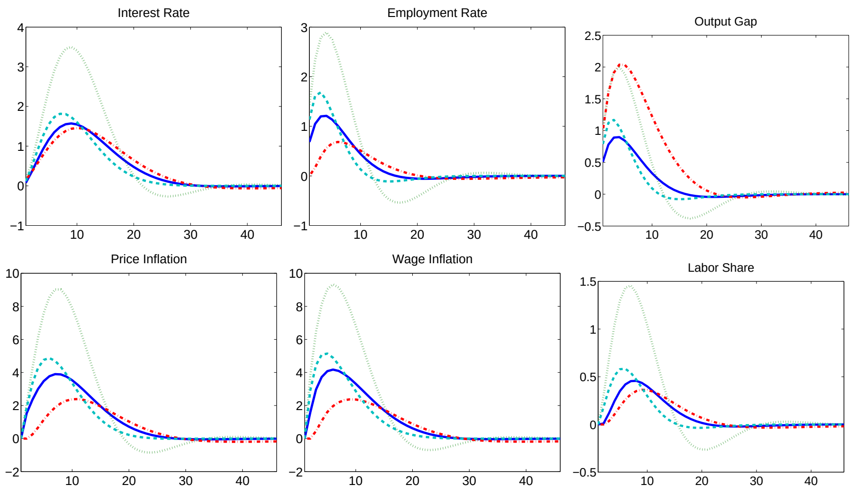


Fig. 3.4: Impulse-response functions to a one-percent aggregate demand shock for different employment rate dynamic adjustment mechanisms

The second scenario studied is the response of the economy to an aggregate demand shock, say, due to an expansionary fiscal policy impulse (shown in Figure 3.4). Again, the aggregate variables of our model deliver quite reasonable dynamic responses, with employment and output increasing in response to the higher aggregate demand, and price and wage inflation, as well as the nominal interest rate, following the former variables (the response of the nominal interest rate is due to the Taylor rule specification, obviously). Note again that the degree of labor market rigidity plays a key role in the extent as well as in the persistence of the impulse responses generated by the model, and that the procyclical reaction of the labor share is by no means trivial but rather the result of the formulation of the cross-over expectations in both wage and price Phillips

Curves.

Finally, we simulate again the reaction of the economy to a monetary policy shock for the case of higher credibility of the price stability commitment (represented by a lower value of κ_{π_c} in the inflation climate adjustment mechanism) by monetary authorities.

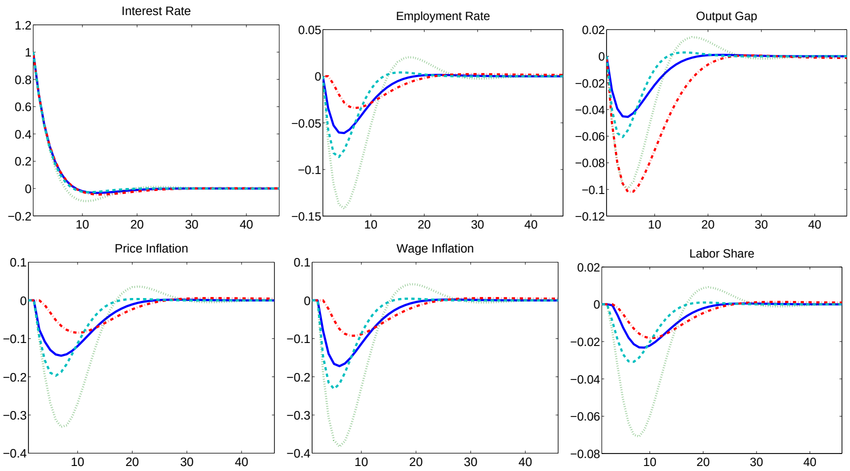


Fig. 3.5: Impulse-response functions to a one-percent monetary shock with higher credibility.

By comparing the dynamic responses of the economy depicted in Figures 3.3 and 3.5, we find that in the higher credibility scenario the duration and extent of such reactions are lower than in the alternative case, where the inflation climate depends on a more significant manner on the past inflation rates than on the actual inflation target of the monetary authorities. This result is quite intuitive, showing that higher inflation inertia leads to an overall slower adjustment of all variables of the economy to exogenous and endogenous shocks.

3.5 Output Stabilization and Monetary Policy Rules

After the analysis of the dynamic properties of the model under different labor market-schemes and degrees of search efficiency we focus now on the role of monetary policy and more specifically on the monetary policy targets for the dynamics of the economy.

In order to investigate the dynamic response of the model economy to a monetary policy shock under different monetary policy rules, the reaction of the model under different rules is simulated, whereas as the benchmark rule we use Taylor's (1993) specification

(Rule I), according to which

$$\text{Rule I:} \qquad \phi_{\hat{p}} = 1.5, \qquad \phi_y = 0.5.$$

The alternative monetary policy rules as well as the corresponding target weights values are shown in table 3.3.

Tab. 3.3: Alternative Monetary Policy Rules: Weighting Parameters

Rule / Weights	II. Strict Inflation Targeting	III. Flexible Inflation Targeting with Employment Target	IV. Flexible Inflation Targeting with Wage Inflation Target	V. Flexible Inflation Targeting with Wage Share Target
$\phi_{\hat{p}}$	2	1	1	1
ϕ_y	0	0.5	0.5	0.5
ϕ_e	0	0.5	0	0
$\phi_{\hat{w}}$	0	0	0.5	0
ϕ_v	0	0	0	0.5

The (absolute) cumulated dynamic responses of the model sketched in figure 3.6 deliver three important insights on the importance of the choice of the targets and the relative weighting values in objective function of the monetary authorities:

In the first place, they highlight the multi-dimensionality of monetary policy conduction that comes to light once the baseline New Keynesian model with (solely) price stickiness is abandoned and nominal wage as well as labor market rigidities are incorporated.

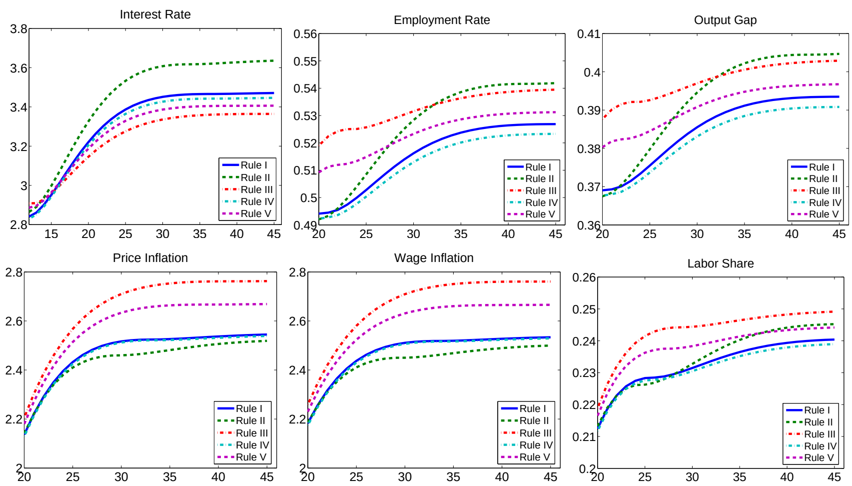


Fig. 3.6: Cumulated impulse-response functions under alternative monetary policy rules.

As figure 3.6 and table 3.4 clearly show, monetary policy rules that achieve an efficient stabilization of price inflation are not necessarily as effective concerning other variables. Indeed, it can be observed, Taylor's (1993) original specification (I) and the flexible inflation targeting with nominal wage growth target (IV) outperform the other three rules: strict inflation targeting (II), flexible inflation targeting with an employment target (III) and flexible inflation targeting with employment and with wage share target (V), concerning the overall extent of the dynamic responses of the economy.

In the second place, the dynamic responses under rules I and IV (Taylor's (1993) specification and flexible inflation targeting with a nominal wage inflation target) have an almost identical performance concerning the cumulated reaction of the economy. According to our model, a pure flexible inflation targeting rule with a weight $\phi_{\hat{p}} = 1.5$ is nearly equivalent to a flexible inflation targeting with weights $\phi_{\hat{p}} = 1$ and $\phi_{\hat{w}} = 0.5$ (both with $\phi_y = 0.5$).[30]

[30] Galí (2008), in a New Keynesian DSGE model with staggered wages and prices, arrives to a similar result.

Tab. 3.4: Cumulated Responses at Different Horizons

	8 Quarters	16 Quarters	24 Quarters	32 Quarters
Monetary Policy Rule		**Output**		
I	0.3191	0.3700	0.3855	0.3926
II	0.3215	0.3704	0.3945	0.4039
III	0.3246	0.3915	0.3970	0.4017
IV	0.3183	0.3686	0.3831	0.3899
V	0.3229	0.3923	0.3908	0.3959
		Employment Rate		
I	0.4273	0.4954	0.5162	0.5257
II	0.4305	0.4960	0.5283	0.5408
III	0.4346	0.5242	0.5315	0.5379
IV	0.4261	0.4936	0.5129	0.5220
V	0.4323	0.5119	0.5233	0.5301
		Price Inflation		
I	0.4095	0.5728	0.6291	0.6331
II	0.3255	0.5718	0.6149	0.6243
III	0.3265	0.5966	0.6775	0.6900
IV	0.3227	0.5709	0.6280	0.6318
V	0.3256	0.5874	0.6584	0.6667
		Wage Inflation		
I	0.3552	0.5790	0.6277	0.6309
II	0.3577	0.5772	0.6125	0.6205
III	0.3590	0.6047	0.6773	0.6895
IV	0.3545	0.5770	0.6266	0.6300
V	0.3579	0.5947	0.6577	0.6661

Lastly, our dynamic simulations show that the strict inflation targeting rule (II), while this rule is the most effective in shortening the adjustment duration of the economy, it is not the most effective when it comes to the reduction in the response variability of all macroeconomic variables besides price inflation. Indeed, as shown in figure 3.6, due to the overshooting that takes place when only price inflation is targeted, the adjustment process of the economy after a monetary policy shock is much more volatile than in the alternative cases, a result which is in line with the theoretical considerations of Woodford (2003, ch.4).

In a related paper – though within a DSGE framework – Faia (2006) performs similar experiments which are all in all in line with our findings. There is though one important difference between her conclusions and ours: Since in her framework the evolution of the real marginal costs depend solely on unemployment, targeting the output gap is sub-optimal towards targeting the unemployment gap, since the latter is the variable which comprises the source of the inefficiency in the economy. In our framework, however, the choice of the optimal strategy is not that straightforward, because the dynamics of the labor share (the real marginal costs) are not only driven by the unemployment gap but also by the disequilibrium in the goods markets due to our cross-over specification in the wage-price dynamics. In fact, a strategy which targets both output and employment gaps as rule III seems to be less efficient than a Taylor rule with standard coefficients as rule I, as shown in figure 3.6.

3.6 Concluding Remarks

Despite of the high degree of technological process in the industrialized countries, their labor markets are and probably will also be in the future confronted with a variety of real imperfection which will hinder the complete clearing of the market in equilibrium. This chapter studied the role of structural labor market frictions in the dynamics of the economy by incorporating in a theoretical framework in the line of Chen, Chiarella, Flaschel and Semmler (2006) a labor market module containing basic search-and-matching elements. As the present model was formulated, the degree of labor market rigidity affected not only the dynamics of the employment rate, but also of the output gap (and consequently also wage and price inflation) through the restrictions it imposed on the ability of firms to find adequate workers and serve aggregate demand.

This straightforward modification of the baseline (D)AS-AD framework delivered some interesting results concerning the dynamic responses of the economy to various exogenous shocks. On the one hand, we found that the degree of rigidity in the labor markets has an important effect on the dynamics of output and inflation: The more rigid the labor markets are, the smaller is the response of employment, output and inflation to exogenous shocks. On the other hand, though still concerning this first result, we found that the dynamic response of the labor share, which in turn influences the aggregate demand as well as price inflation, depends dramatically on the *relative* responses of production and employment to shocks, and therefore on how and through which channels shocks are transmitted within the economy. Since nowadays the predominant view (represented also by the DSGE approach) is that the real marginal costs (the labor share) are the main force driving price inflation, this approach delivers an interesting alternative to the DSGE modeling approach, which considers the real marginal costs as being determined primarily by intertemporal profit maximization under imperfect competition.

Concerning the role of monetary policy, the dynamic simulations performed here showed that a flexible inflation targeting rule in the line of Taylor (1993), where price inflation as well as output are targeted, and/or a flexible inflation targeting rule with an additional wage inflation target have a better performance than flexible inflation targeting rules where employment or the wage share besides the output gap are targeted, or strict inflation targeting where the inflation gap is the only target variable of concern.

On more real world-related grounds, if one takes into account the significant differences in the characteristics of the labor markets across the EMU countries, the findings of this chapter might deliver some interesting insights on the recent inflation developments in those economies, with countries as Germany or Austria with persistently low inflation rates compared to other countries such as Spain and Ireland, as discussed for example in the previous chapter, as well as in Honohan and Lane (2003), Fritsche et al. (2005) and Angeloni and Ehrmann (2007). In the next chapter the implications of labor market rigidity for as well as the effectiveness of alternative monetary policy rules in a monetary union with heterogenous national labor market characteristics such as the EMU are analyzed.

4. Optimal Monetary Policy in Currency Unions with Asymmetric National Labor Markets

4.1 Introduction

It is widely accepted that the creation of a monetary union implies a significant loss of their macroeconomic flexibility for the participating economies. With such a step, the member countries do not only lose their ability to conduct an independent monetary rate policy; Additionally, due to the replacement of the country-specific for a union-wide nominal exchange rate, their capability to correct internal and external imbalances through real exchange rate adjustments in a fast and efficient manner is also significantly diminished.

Given the radical regime change that the joining in a monetary union represents, the adequacy of a one-size-fits-all monetary policy not only for the currency area as a whole but also for the individual economies depends to a major extent on their macroeconomic homogeneity. In the case of the initial EMU Member States, it is nowadays widely accepted that despite of the remarkable success concerning the convergence and synchronization process initiated at the latest with the signing of the Maastricht Treaty 1992, at the time of the introduction of the euro, these economies could still not be considered as optimal candidates for a joint monetary union in terms of the Optimum Currency Areas (OCA) Theory. Indeed, despite the similar sectoral patterns of production, relative role of the national governments and financial structure (some of the OCA optimality criteria), the significant differences in the wage bargaining and price setting mechanisms and the related wage and price inflation developments, the degree of openness of the economy, the functioning and strength of the different monetary policy transmission channels, as well as the low labor mobility existing among the EMU countries (pointed out by Bertola (2000) and Braunerhjelm et al. (2000)) led to a large number of observers to doubt on the long-term viability of the European monetary unification project.

While in contrast to the one-country-one-currency case the maintenance of price stability might indeed be "the best contribution that monetary policy can give to reduce the general level of uncertainty and promote an efficient allocation of resources,"[1] in a monetary union featuring different national inflation rates and output gap developments the definition of price stability and its stabilization role become much more complex: Indeed, with different inflation rates and output developments within the common currency area, what should be their relative importance for the decision making of the Monetary Union's Central Bank (MUCB)? Should the MUCB react solely to average developments or instead explicitly take into account (and incorporate) national developments (in its intertemporal loss function)?

The main aim of this chapter is to investigate this issue and, in more general terms, to conceptualize the design of optimal monetary policy in a common currency area with asymmetric national labor markets. For this, a simple two-country semi-structural macroeconomic model featuring labor market frictions based in the model of the previous chapter is set up which, despite the disequilibrium foundations of the wage-price dynamics, shares nonetheless many similarities with the more mainstream New Keynesian models as the ones developed by Erceg et al. (2000) and Christiano et al. (2005).

This study is organized as follows. In section 4.2 the relevance of national developments for the conduction of monetary policy in a monetary union with asymmetric national labor markets such as the EMU is briefly discussed. In section 4.3 the (Disequilibrium)AS-AD model with labor market frictions developed in the last chapter is extended to a two-country framework where the economies possess different degrees of labor market rigidity and therefore different adjustment speeds to exogenous shocks. Section 4.4 focuses on the design of optimal monetary policy under a strict forecast targeting of average price inflation (under the consideration of the average of certain macroeconomic variables of the member economies) and under an alternative formulation where the individual country-specific developments of the member economies are explicitly formulated into the intertemporal loss function of the MUCB. Section 4.5 draws some concluding remarks.

[1] Issing, Gaspar, Angeloni and Tristani (2001, p.67).

4.2 Preliminary Considerations

As stated before, the design and conduction of monetary policy in currency unions with asymmetric member economies is of a much higher complexity than in the one-country-one-currency case. The objectives trade-off which monetary policy is confronted with in a common currency area were already pointed out by Mundell's (1961, p.659) in the following manner: "In a currency area comprising different countries with national currencies the pace of employment in deficit countries is set by the willingness of surplus countries to inflate. But in a currency area comprising many regions and a single currency, the pace of inflation is set by the willingness of central authorities to allow unemployment in deficit regions."

The extent to which the member economies of a monetary union are indeed affected by asymmetric, country-specific shocks (and therefore the extent up to which their business cycles are correlated – and in a more updated sense the degree of synchronization – with each other) is a key feature for the effectiveness and adequateness of monetary policy in a monetary union. Indeed, as already recognized by Mundell (1961), if factor (and specifically labor) mobility is not sufficiently large between the monetary union participant countries, the existence of asymmetric (country- or region-specific) shocks is likely to complicate to a significant degree the conduction of monetary policy by the central authorities.

Even leaving aside the influence of asymmetric shocks, the complexity of monetary policy design in a monetary union starts at the mere conception of the union-wide target variables: Indeed, when an aggregate indicator such as the Monetary Union Index of Consumer Prices (MUICP) of the ECB is used, national developments matter solely to the extent of the relative size of the respective economies within the monetary union. However, can this proceeding be considered optimal? In order to answer this question, it is helpful to think of a monetary union consisting of two economies which, though heterogenous in their macroeconomic characteristics, are nevertheless of the same economic size. In this case, should the price inflation developments of both economies enter with the same weight in the aggregate loss function of the MUCB, or should this rather consider explicitly the structural differences between the two member economies in its decision making? The central point which should be analyzed is the adequacy of one-size-fits all monetary policy at the individual country level and the possible violation of the Taylor (1993) principle – which demands a sufficiently aggressive monetary policy reaction to inflation developments – at the member country level. Indeed, even if member economies are confronted with similar exogenous shocks and the qualitative *direction* of the monetary policy responses determined by the MUCB is correct for all monetary union members, individual macroeconomic characteristics such as the specific strength and functioning of the monetary policy transmission channels, the degrees of exchange rate pass-through, the wage and price flexibility as well as the rigidity of the national labor markets might distort and diminish the efficiency and adequacy of monetary policy at the country-level.

These considerations are by no means trivial. Concerning the transmission mechanisms of monetary policy in the euro area countries, Mojon and Peersman (2003) show through the estimation of identified VAR models for the single member economies that while their overall reaction to monetary shocks exhibits qualitatively similar patterns, there is still a high uncertainty concerning the actual dimension of the effects. These authors also point out the lack of consistency among different studies concerning the ranking of the potency of monetary policy across countries, highlighting that, for example, "Barran, Coudert and Mojon (1997) find the largest impact in Germany and the weakest in Italy, while Peersman and Smets (1999) find the opposite".[2]

Looking into the interest rate channel of monetary policy and more specifically into the relationship between money market and bank interest rates, Sorensen and Werner (2006) find a significant heterogeneity in the extent of pass-through of market interest rates to bank interest rates in the euro area. In that study, both long-run multiplier as well as the speed of the adjustment coefficients are found to be significantly different between the euro area countries, corroborating the previous findings by Baele, Ferrando, Hördahl, Krylova and Monnet (2004).

However, as stated by Berben, Locarno, Morgan and Vallés (2005), most asymmetries in the transmission of monetary policy shocks are to be found in the working of labor and goods markets. This is not surprising given the importance of the labor markets not only in the determination of the actual production level of the economy but also

[2] Mojon and Peersman (2003, p.66). In the same volume, Angeloni, Kashyap, Mojon and Terlizzese (2003, p.390) discuss also the lack of hard and consistent *quantitative* evidence on the monetary policy transmission in the euro area, highlighting as the sole reliable stylized fact that in the euro area countries aggregate investment plays a relative greater role than consumption in the transmission of monetary policy in contrast to the U.S., where consumption variations clearly represent the main transmission channel of monetary policy into the real economy.

due to their role in the determination of the marginal costs of firms, and therefore for the dynamics of wage and price inflation. Indeed, as shown in a variety of recent theoretical papers such as Walsh (2003a), Trigari (2004) and Christoffel et al. (2006) (as well as in the model of the previous chapter) the degree of labor market flexibility has a central role for the extent and speed to which the main variables of the economy such as output, employment and inflation react to exogenous shocks.

As previously pointed out, given the fact that the member countries of a monetary union do not dispose of a country-specific nominal exchange rate that would act in part as a macroeconomic absorber to exogenous shocks,[3] the characteristics of their national labor markets are of central importance to the extent and duration of the dynamic responses of the respective economies and by extension for the conduction of monetary policy in the monetary union. In the next sections the implications of asymmetric labor markets for the conduction of monetary policy in a currency union will be discussed within a theoretical framework.

4.3 The Model

In this section a simplified open-economy, two-country version of the Keynesian semi-structural model with labor market frictions developed in the last chapter is introduced. Two small open economies which form a monetary union and therefore are subject to a single common monetary policy by a central monetary authority (the Monetary Union's Central Bank MUCB) are assumed. The two economies **a** and **b** are modeled identically in every aspect, differing from each other only in the degree of flexibility of their respective labor markets, with **a** featuring a more flexible labor market than **b**. This specification will allow us to investigate the working and effectiveness of monetary policy in a monetary union with asymmetric national labor markets.

4.3.1 The Labor Markets

To keep the model as simple as possible, a linear single input factor technology is assumed by which output is produced according to

$$Y_t = z_t N_t, \tag{4.1}$$

[3] Campolmi and Faia (2006), for example, find in a calibrated DSGE that differences in labor market institutions among the euro area countries can be related to the respective inflation rate differentials.

where N_t denotes the actual (realized) level of employment and z represents the average labor enhancing technology level, which is assumed in the following to be constant for notational simplicity.

In the same manner, full employment output Y_t^f, is simply a function of the actual level of labor supply in the economy L_t, expressed as

$$Y_t^f = zL_t \tag{4.2}$$

Firms, confronted with an aggregate demand level Y_t^{D}, determine their labor demand according to eq.(4.1), that is

$$L_t^{\mathrm{D}} = Y_t^{\mathrm{D}}/z \tag{4.3}$$

Nevertheless, due to the existence of labor market frictions, the actual level of employment N_t is not necessarily consistent with the labor demand by firms L_t^{D}, so that $L_t^{\mathrm{D}} = N_t$ does not hold in the normal case. Instead, the actual number of employed workers at t is determined by the level of remaining jobs from the previous period (determined in turn by the exogenous job separation rate ρ) and by the "matches" at the beginning of the actual period. At t, the number of employees is determined by

$$N_t = (1-\rho)N_{t-1} + m(U_t, V_t) \tag{4.4}$$

where $m(U_t, V_t)$ is a linear matching function[4]

$$m(U_t, V_t) = \mu(\nu U_t + (1-\nu)V_t), \quad \mu \in (0,1) \tag{4.5}$$

with μ representing the matching technology level, $U_t = L_t - (1-\rho)N_{t-1}$ the number of unemployed and $V_t = L_t^{\mathrm{D}} - (1-\rho)N_{t-1}$ the number of vacancies at the beginning of period t (which can be negative if the firms decide to lower their demand of labor).

By defining $u_t = U_t/L_t$ and $v_t = V_t/L_t$ as the unemployment and vacancy rates, respectively, and normalizing the total labor supply to $L_t = \bar{L} = 1$, we reformulate eq.(4.4) in terms of the employment rate $e_t = N_t/\bar{L} = N_t$ as

$$e_t = (1-\rho)e_{t-1} + m(u_t, v_t). \tag{4.6}$$

Making use of the fact that

$$L_t^{\mathrm{D}}/\bar{L} = Y_t^{\mathrm{D}}/\bar{Y}^f$$

[4] Despite the known shortcomings of linear matching functions, see e.g. Stevens (2004), such a matching function is used here in order to attain linearity in the employment rate equation, in contrast to the previous chapter, where a more standard Cobb-Douglas function was used.

we can rewrite eq.(4.6) as

$$e_t = (1-\rho)e_{t-1} + \mu\left[\nu(1-(1-\rho)e_{t-1}) + (1-\nu)\left(Y_t^{\mathrm{D}}/\bar{Y}^f - (1-\rho)e_{t-1}\right)\right] \quad (4.7)$$

or, after reordering,

$$e_t - e_{t-1} = \mu\left[\nu\,(1-(1-\rho)e_{t-1}) + (1-\nu)\left(Y_t^{\mathrm{D}}/\bar{Y}^f - (1-\rho)e_{t-1}\right)\right] - \rho e_{t-1}, \quad (4.8)$$

which represents the law of motion of employment in discrete time. Defining generally the time lag length as h, for $h \longrightarrow 0$, we obtain the following approximate formulation of eq.(4.8) in continuous time

$$\dot{e} = \mu\left[\nu\,(1-(1-\rho)e) + (1-\nu)\left(Y^{\mathrm{D}}/Y^f - (1-\rho)e\right)\right] - \rho e. \quad (4.9)$$

As this labor market module is formulated, the state of the market (the labor market tightness) influences in a direct way the capability of firms to serve aggregate demand: Indeed, due to the existence of labor market frictions, firms usually do not obtain their desired level of labor demand L_t^{D}, but N_t instead. Note that the more rigid the labor markets are, the greater will be the discrepancy between L_t^{D} and N_t, and therefore, through the wage dynamics to be discussed below, the more sluggishly the nominal unit labor costs will react to exogenous and endogenous shocks.

As eq.(4.9) shows, the rate of change of the employment rate depends on the *level* of the aggregate demand $L^{\mathrm{D}}/\bar{L} = Y_t^{\mathrm{D}}/\bar{Y}^f$.[5] By partial differentiation, we can confirm the adequacy of the qualitative response of the employment dynamics to the aggregate demand Y^{D} and to the level of the employment rate:

$$\begin{aligned}\frac{\partial \dot{e}}{\partial Y^{\mathrm{D}}} &= \mu(1-\nu)/\bar{Y}^f > 0\\ \frac{\partial \dot{e}}{\partial e} &= \mu(-\nu(1-\rho) - (1-\nu)(1-\rho)) - \rho = -\mu(1-\rho)\rho < 0\end{aligned}$$

Note that our formulation of the employment rate dynamics differs significantly from traditional search and matching labor market models, because here the vacancies are determined basically by the goods aggregate demand pendant on the labor market (since $L^{\mathrm{D}} = Y^{\mathrm{D}}/z$) and not, as usual, through a forward-looking decision process including Bellman equations and in there intertemporal cost-benefit considerations of both workers and firms. However, as discussed later on in this paper, this formulation of the employment rate dynamics will deliver economically reasonable dynamic responses.

[5] and not on the rate of change of aggregate output (which would be the case if $Y^{\mathrm{D}} = Y_t$, as formulated for example in Chen, Chiarella, Flaschel and Semmler (2006) with the modeling of a dynamic Okun's law).

4.3.2 The Goods Markets

The dynamics of the goods markets in this theoretical model are still of a Keynesian type, specifically with aggregate demand driving the level of employment and output. Indeed, due to the incorporation of labor market rigidities in our theoretical framework, the level of production in the economy is not only determined by the aggregate demand, as in standard Keynesian models, but is also influenced in a direct manner by the degree of flexibility of the labor markets. Accordingly, we differentiate between the full-employment production level $Y^f = \bar{L}$ and the potential output level

$$Y^p = \phi \bar{L} \tag{4.10}$$

where ϕ represents a time-invariant term comprising structural labor market factors to be defined below.

We assume that excess aggregate demand $y^{\mathrm{D}} := (Y^{\mathrm{D}} - Y^f)/Y^f$ is determined by

$$y_t^{\mathrm{D}} = \alpha_y(y_{t-1} - y_o) - \alpha_{yr}(i_{t-1} - \hat{p}_t - (i_o - \pi_o)) - \alpha_{yv}(v_{t-1} - v_o) + \alpha_\eta \eta_{t-1} \tag{4.11}$$

where y_{t-1} represents the output gap (to be defined below) in the previous period, i_o denotes the steady state nominal interest rate, π_o the steady state inflation rate, $v_t - v_o$ the deviation of the actual labor share v_t from its steady state level v_o[6] and η the log real exchange rate (defined as $\eta = \ln(p^b/p^a)$).[7]

Making use of eq.(4.7) we can express the actual output gap y (defined in this chapter as the ratio of actual, realized output level to potential output) as

$$\begin{aligned} y_t &= \; = Y_t/Y_t^p = \frac{N_t}{\phi L_t} = e_t/\phi, \\ y_t &= \mu\phi^{-1}\left[\nu(1-(1-\rho)\phi y_{t-1}) + (1-\nu)\left(L^{\mathrm{D}}/\bar{L} - (1-\rho)\phi y_{t-1}\right)\right] \qquad (4.12) \\ &= +(1-\rho)y_{t-1}, \quad f'(y_t) > 0, \quad f''(y_t) < 0 \end{aligned}$$

with $e_t = \phi$ and $y_t = y_o = 1$. In equilibrium thus e_o, the steady state employment rate, equals ϕ.[8]

[6] Note that aggregate demand could depend either positively or negatively on the labor share, depending on whether consumption is more responsive to real wage changes than investment. See Proaño, Flaschel, Ernst and Semmler (2006) and Franke et al. (2006) for an extensive discussion of the ambiguity of the Rose real wage channel.

[7] For simplicity this will be the only open-economy term we will analyze here, leaving the introduction of direct foreign goods demand as a determinant of domestic economic activity for further research.

[8] e_o and therefore ϕ will be further defined below.

As this module is formulated, aggregate goods demand determines the level of employment desired by firms, and through the search and matching function expressed by eq.(4.5), the actual level of employment (the employment rate). This, in turn, determines the level of production through the assumed production function, which, despite of being influenced through the existence of labor market frictions, is still demand driven and thus Keynesian in nature.

4.3.3 The Wage-Price Dynamics

Following the theoretical approach by Chiarella and Flaschel (2000) and Chiarella et al. (2005), the following structural form of the wage-price inflation dynamics is assumed:

$$\hat{w}_t = \beta_{we}(e_{t-1} - e_o) + \kappa_{wp}\hat{p}_t + (1-\kappa_{wp})\pi_t^c + \kappa_{wz}\hat{z}_t, \tag{4.13}$$

$$\hat{p}_t = \beta_{pu}(y_{t-1} - y_o) + \kappa_{pw}(\hat{w}_t - \hat{z}_t) + (1-\kappa_{pw})\pi_t^c. \tag{4.14}$$

The demand pressure terms $e - e_o$ and $u - u_o$ in the wage and price Phillips Curves are augmented by two additional terms: a weighted average of corresponding expected cost-pressure terms, assumed to be model-consistent, with forward looking, cross-over wage and price inflation rates $\hat{w}$ and $\hat{p}$, respectively, and a backward looking measure of the perceived inertial inflation in the economy symbolized by π^c, and labor productivity growth $\hat{z}$. Concerning the latter variable we assume for simplicity that it is always equal to the growth rate of trend productivity, namely $\hat{z} = g_z$ =const.[9]

Concerning the "inflationary climate" term, we assume that the measure that is taken by workers to judge the medium-run evolution of prices in their respective economies is the Consumer Price Index, defined as

$$p_c = p^{\xi}(sp^f)^{1-\xi},$$

the geometric average of domestic and import prices – with p^f as the foreign price level and s as the nominal exchange rate between the two countries (which equals one by definition in a monetary union).

[9] As stated before, even though explicitly formulated, in this chapter it will be assumed for simplicity that $g_z = 0$. The modeling of the labor productivity growth as well as the investigation of the implications of different labor productivity developments for the conduction of monetary policy are left for future research.

Consequently, the CPI inflation $\hat{p}^c$ includes both domestic inflation (with a specific weight ξ) and imported goods price inflation (with weight $1-\xi$), so that

$$\hat{p}_c = \xi\hat{p} + (1-\xi)\hat{p}^f. \tag{4.15}$$

Because of the uncertainty linked with nominal exchange rate movements, we assume for both workers and firms' decision making processes that the perceived CPI inflation π^c is updated in an adaptive manner according to

$$\dot{\pi}_c = \beta_{\pi_c}(\hat{p}_c - \pi_c) = \beta_{\pi_c}\xi(\hat{p} - \pi_c) + \beta_{\pi_c}(1-\xi)(\hat{p}^f - \pi_c) \tag{4.16}$$

or, expressed in discrete time,

$$\pi_t^c = \pi_{t-1}^c + \beta_{\pi_c}(\hat{p}_t^c - \pi_{t-1}^c) = \beta_{\pi_c}\xi(\hat{p}_t - \pi_{t-1}^c) + \beta_{\pi_c}(1-\xi)(\hat{p}_t^f - \pi_{t-1}^c) \tag{4.17}$$

The corresponding across-markets or reduced-form Phillips curves are given by (with $\kappa = 1/(1-\kappa_{wp}\kappa_{pw})$):

$$\hat{w}_t = \kappa\left[\beta_{we}(e_{t-1} - e_o) + \kappa_{wp}(\beta_{py}(y_{t-1} - y_o)) + (\kappa_{wz} - \kappa_{wp}\kappa_{pw})g_z\right] + \pi_t^c, \tag{4.18}$$

$$\hat{p}_t = \kappa\left[\beta_{py}(y_{t-1} - y_o) + \kappa_{pw}(\beta_{we}(e_{t-1} - e_o)) + \kappa_{pw}(\kappa_{wz} - 1)g_z\right] + \pi_t^c, \tag{4.19}$$

which represent a considerable generalization of the conventional view of a single-market price PC with only one measure of demand pressure, namely the one in the labor market.

Note that here the perceived CPI inflation π_c does not matter for the evolution of the labor share $v = w/(pz)$, which law of motion is given by (z, the labor productivity, is assumed to be constant) :

$$\hat{v} = \kappa\left[(1-\kappa_{pw})\beta_{we}(e - e_o) - (1-\kappa_{wp})\beta_{pu}(y - y_o) + (\kappa_{wz} - 1)(1-\kappa_{pw})g_z\right]. \tag{4.20}$$

Eq.(4.20) shows the ambiguity of the stability property of the real wage channel discussed by Rose (1967) which arises if despite of the incorporation of specific measures of demand and cost pressure on both the labor and the goods markets, the dynamics of the employment rate and the the output gap are linked and if inflationary cross-over expectations are incorporated in both Phillips curves.

We note that the unique steady state of the system, due to its specific formulation, can be supplied exogenously. The goods markets are in equilibrium when $y^{\mathrm{D}} = 0$ and $y = y_o = 1$. Inserting these values in the dynamic law of the employment rate delivers

$$\begin{aligned} \dot{e} &= \mu\left[\nu(1-(1-\rho)e) + (1-\nu)(1-(1-\rho)e)\right] - \rho e \\ &= \mu(1-(1-\rho)e) - \rho e \end{aligned}$$

For $\dot{e} = 0$, we obtain

$$e_o = \phi = \frac{\mu}{(1-\rho)\mu + \rho}. \tag{4.21}$$

If $e = \phi = e_o$, the labor markets are in equilibrium and do not exert any pressures on the dynamics of wages and prices, so that $\hat{p} = \pi_o$ and $\hat{w} = \pi_o$.

4.3.4 Closing the Model

For the model to be fully formulated an explicit specification of the nominal interest rate dynamics is still needed. This in fact will be undertaken in the next section following the work on optimal monetary policy by Svensson (1997) for the case of two-country monetary union. However, in order to address the consequences of labor markets asymmetries in a currency union for the efficiency of the monetary union's central bank (MUCB) policy in a preliminary manner, for starting a simple monetary instrument rule of the form

$$i_{\mathrm{T}} = i_o + \phi_\pi(\hat{p}^{\mathrm{av}} - \pi^*) + \phi_y(y^{\mathrm{av}} - y^*) \tag{4.22}$$

is assumed, where i_o denotes the steady state nominal interest rate. π^* the inflation target (which in the following will be assumed to be equal to steady state inflation rate π_o, and y^* the target output (also assumed in the following to be equal to y_o)). As usual, ϕ_π and ϕ_y represents the responsiveness of the monetary policy instrument interest rate to deviations of inflation and output, respectively, from their target levels (with $\phi_\pi > 1$ and $\phi_y \geq 0$).[10]

The monetary union's target average inflation rate $\hat{p}^{\mathrm{av}}$ (which in the case of the EMU is the aggregate Monetary Union Index of Consumer Prices (MUICP)) and the average output y^{av} are given by

$$\hat{p}^{\mathrm{av}} = \lambda_{\mathrm{a}}\hat{p}^{\mathrm{a}} + (1-\lambda_{\mathrm{a}})\hat{p}^{\mathrm{b}} \tag{4.23}$$

$$y^{\mathrm{av}} = \lambda_{\mathrm{a}} y^{\mathrm{a}} + (1-\lambda_{\mathrm{a}}) y^{\mathrm{b}}, \tag{4.24}$$

where λ^{a} represents the weighting parameter for the member country **a**, which is normally given by the relative country size of the respective economy in the monetary union.

[10] In the dynamic simulation of the next section, however, we will set $\phi_y = 0$ in order to be consistent with the rest of this chapter, where only the strict inflation targeting case is analyzed.

With respect to the nominal interest rate dynamics an interest rate smoothing strategy by the MUCB with a strength given by α_i is assumed. By inserting i_{T} and rearranging terms the following dynamic law for the nominal interest rate can be obtained:

$$\dot{i} = -\alpha_i(i - i_o) + \gamma_{ip}(\hat{p}^{\mathrm{av}} - \pi_o) + \gamma_{iy}(y^{\mathrm{av}} - y_o) \tag{4.25}$$

where we have $\gamma_{ip} = \alpha_i\phi_\pi$, i.e., $\phi_\pi = \gamma_{ip}/\alpha_i$ and $\gamma_{iy} = \alpha_i\phi_y$. Furthermore, the actual (perfectly foreseen) rate of inflation $\hat{p}$ is used to measure the inflation gap with respect to the inflation target π_o of the central bank.

Taken together, our two-country theoretical model consists of the three laws of motion for each country and two linking laws of motion (of the nominal interest rate and of the real exchange rate) which together form the following autonomous 8D dynamical system

The Two-Country Model

$$\begin{aligned}
\dot{e}^{\mathrm{a}} &= \mu^{\mathrm{a}}\left(\nu(1-(1-\rho)e^{\mathrm{a}}) + (1-\nu)\left(L^{\mathrm{D,a}}/\bar{L} - (1-\rho)e^{\mathrm{a}}\right)\right) - \rho e^{\mathrm{a}} \\
\hat{v}^{\mathrm{a}} &= \kappa\left[(1-\kappa_{pw})\beta_{we}(e^{\mathrm{a}} - e^{\mathrm{a}}_o) - (1-\kappa_{wp})\beta_{py}(y^{\mathrm{a}} - y_o) + (\kappa_{wz}-1)(1-\kappa_{pw})g_z\right] \\
\dot{\pi}^{\mathrm{a}}_c &= \beta_{\pi_c}\gamma(\hat{p}^{\mathrm{b}} - \pi_c) + \beta_{\pi_c}(1-\gamma)(\hat{p}^{\mathrm{a}} - \pi_c) \\
\dot{i} &= -\alpha_i(i - i_o) + \gamma_{ip}(\hat{p}^{\mathrm{av}} - \pi_o) + \gamma_{iy}(y^{\mathrm{av}} - y_o) \\
\dot{\eta} &= \hat{p}^{\mathrm{b}} - \hat{p}^{\mathrm{a}} \\
\dot{e}^{\mathrm{b}} &= \mu^{\mathrm{b}}\left(\nu(1-(1-\rho)e^{\mathrm{b}}) + (1-\nu)\left(L^{\mathrm{D,b}}/\bar{L} - (1-\rho)e^{\mathrm{b}}\right)\right) - \rho e^{\mathrm{b}} \\
\hat{v}^{\mathrm{b}} &= \kappa\left[(1-\kappa_{pw})\beta_{we}(e^{\mathrm{b}} - e^{\mathrm{b}}_o) - (1-\kappa_{wp})\beta_{py}(y^{\mathrm{b}} - y_o) + (\kappa_{wz}-1)(1-\kappa_{pw})g_z\right] \\
\dot{\pi}^{\mathrm{b}}_c &= \beta_{\pi_c}\gamma(\hat{p}^{\mathrm{b}} - \pi_c) + \beta_{\pi_c}(1-\gamma)(\hat{p}^{\mathrm{a}} - \pi_c)
\end{aligned}$$

with $L^{\mathrm{D}}_t/\bar{L} = Y^{\mathrm{D}}_t/Y^f$, $Y^{\mathrm{D}}/Y^f = 1 + y^{\mathrm{D}}$ and

$$\begin{aligned}
y^{\mathrm{D,a}} &= \alpha_y(y^{\mathrm{a}} - y_o) - \alpha_{yr}(i - \hat{p}^{\mathrm{a}} + (i_o - \pi_o)) - \alpha_{yv}(v^{\mathrm{a}} - v_o) + \alpha_{u\eta}\eta \\
y^{\mathrm{D,b}} &= \alpha_y(y^{\mathrm{b}} - y_o) - \alpha_{yr}(i - \hat{p}^{\mathrm{b}} + (i_o - \pi_o)) - \alpha_{yv}(v^{\mathrm{b}} - v_o) - \alpha_{u\eta}\eta \\
\hat{p}^j &= \kappa\left[\beta_{py}(y^j - y_o) + \kappa_{pw}(\beta_{we}(\phi^j y^j - \phi^j))\right] + \pi_c \quad \text{for} \quad j = \mathbf{a}, \mathbf{b}
\end{aligned}$$

It should be pointed out that due to the formulation of our model and the role that labor market frictions play in it, the degree of labor markets rigidity affects the output determination in a twofold manner: In the first place, through the restrictions they impose concerning the level of output the firms can actually produce; and in the second place, due to the effect they have on the reduced form of the price Phillips curve described by eq.(4.19). Concerning this second channel (the real interest rate), note that, through our formulation of the reduced form Phillips curve equation to be inserted in eq.(4.9) price inflation is determined not only by the goods, but also by the labor market situations and the weighting coefficients of both wage and price Phillips curves equations concerning the cross-over expectations mechanism.

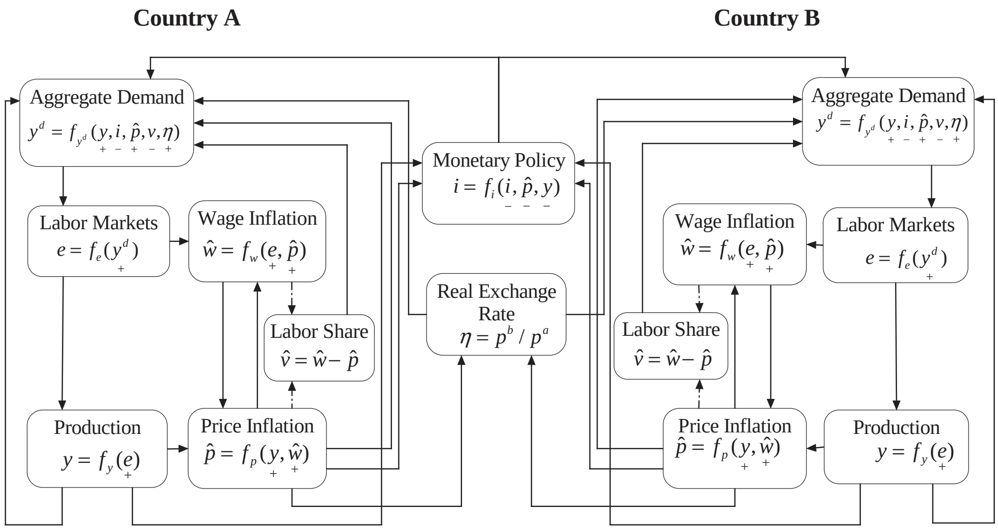


Fig. 4.1: The Two-Country Model Structure

4.3.5 One-Size-Fits-All Monetary Policy and Asymmetric Monetary Policy Effects

In order to highlight the role of labor markets asymmetry in the effectiveness of monetary policy in a currency union and to motivate the discussion of country-specific inflation targeting of the next section, two basic shock scenarios are analyzed in the following: In the first scenario the dynamic adjustments of the two economies to an identical aggregate demand shock are investigated, and in the second scenario the effect of a nominal interest rate shock by the MUCB for the dynamics of the two members economies is analyzed. In both scenarios the two economies are assumed to be identical in all aspects, with the only exception being the parameter μ, which represents the asymmetry in the degree of labor market rigidity.[11]

In a similar manner to the ECB practice, the weighting of the individual national price inflation rates in the MUCB's target variable $\hat{p}^{\text{av}}$ is oriented to the relative economic size of the individual economies within the monetary union. Given that the same economic size of both economies is assumed in this chapter, the country weighting is simply $\lambda_a = 0.5$, despite of the different degrees of labor market flexibility assumed for both economies.

For the following dynamic simulations the following parameter values are used: Concer-

Tab. 4.1: Baseline calibration parameters

Labor Markets	α	μ (**a**)	μ (**b**)	ρ	ν
	0.70	1	0.6	0.1	0.4
Goods Markets	α_{yy}	α_{yr}	α_{yv}		
	0.7	0.05	0.1		
Wage Phillips Curve	β_{we}		κ_{wp}		$1-\kappa_{wp}$
	0.510		0.420		0.580
Price Phillips Curve	β_{we}		κ_{wp}		$1-\kappa_{wp}$
	0.210		0.550		0.450
Standard Taylor Rule	ϕ_π	ϕ_y			
	1.5	0.0			

ning the labor markets, in country **a** the matching technology factor is $\mu^a = 0.8$ and in country **b** $\mu^b = 0.6$ (Christoffel and Linzert (2006) choose $\mu = 0.4$). For the job separation rate ρ (exogenously given in this model), a value of 0.1 was chosen, which is consistent with the empirical findings (on quarterly frequency) by Hall (1995, 2005) and Shimer (2005). For the choice of the weighting parameter of the linear search and matching function ν, a lower value ($\nu = 0.2$) is set than in Walsh (2005), where the corresponding Cobb-Douglas parameter equals 0.4. For the choice of the parameters α_{yy}, α_{yr} and α_{yv} in the goods markets equation, we rely on the system GMM parameter estimates of Proaño, Flaschel, Ernst and Semmler (2006) and Franke et al. (2006), which are consistent with other studies as Goodhart and Hofmann (2005) who also perform

[11] It should be clear to the reader that for the case of identical member countries, union-wide oriented monetary policy would have exactly the same effects across all country members. For the case of being optimally designed, it would be optimal for *both* countries.

system GMM estimations of Phillips curve and IS equations, including however also expected values of future variables in their specification. Concerning the parameters in the wage and price Phillips curve equations (assumed to be equal across all labor market specifications), we also use the empirical parameter estimates obtained for the U.S. economy by Proaño, Flaschel, Ernst and Semmler (2006) and Franke et al. (2006).

For starters, Figure 4.2 shows the dynamic adjustments to a symmetric one-percent aggregate demand shock in the two economies.

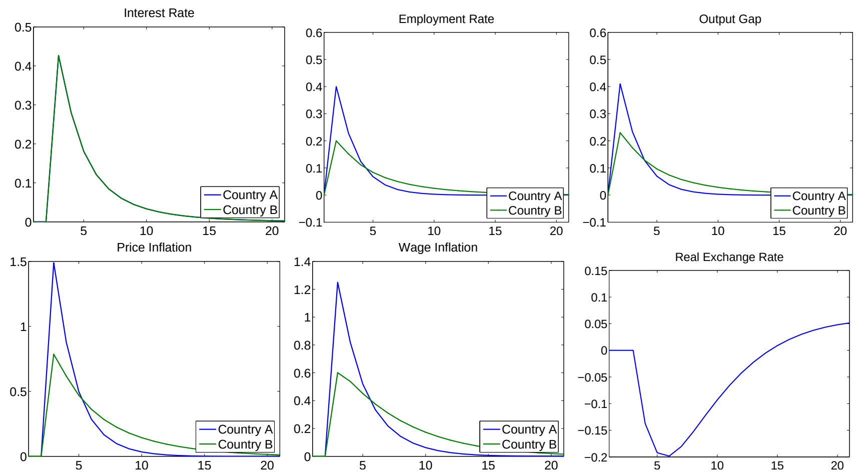


Fig. 4.2: Impulse-response functions to an identical one-percent aggregate demand shock in both countries **a** and **b** (annualized data, in quarters, percent values)

As it can be observed, despite the fact that the aggregate demand shock is identical in both economies and that both economies are controlled by the same monetary policy rule, the asymmetry in the national labor markets (modeled by different numerical values of the matching technology factor μ) leads to a differentiated shock processing in both economies. The reaction of employment, output and wage and price inflation in economy **b** (which features the more rigid labor market) is of a much lower dimension but nevertheless larger persistence than in economy **a**.

Interesting is also the reaction of the log real exchange rate between both economies $\eta = \ln(p^b/p^a)$. As it can be observed in the last panel of Figure 4.2, a symmetric aggregate demand shock in both economies leads, through the larger reaction of country **a**'s output and inflation (and wages and prices), to an initial deterioration of its relative competitiveness position with respect to country **b**. This development is however reversed over time due to the longer deviation of **b** from baseline resulting from the higher degree of rigidity of its labor market.

The same qualitative responses can be observed in the second scenario where the dynamic responses of economies **a** and **b** to a one-percent monetary shock by the MUCB are simulated.

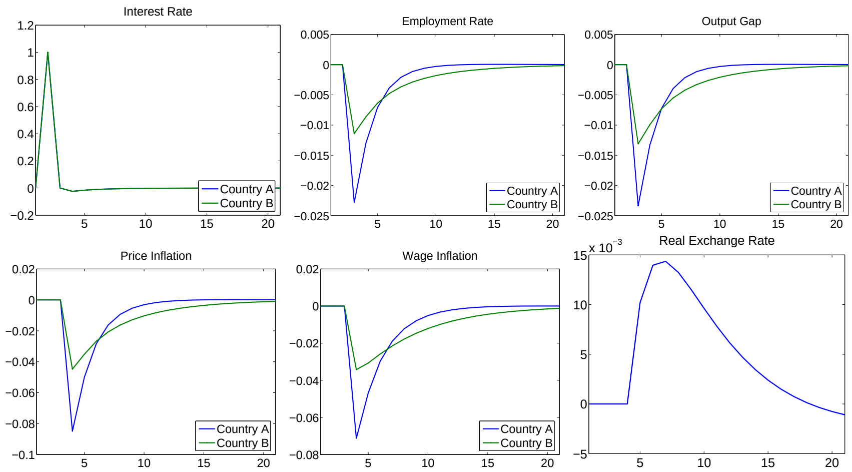


Fig. 4.3: Impulse-response functions to a one-percent monetary policy shock by the MUCB for economies **A** and **B** (annualized data, in quarters, percent values)

In this second case depicted in Figure 4.3, the reaction of all macroeconomic variables in the more flexible economy **a** is again larger and its return to baseline faster than in economy **b**. As in the previous case, this asymmetry not only in the initial reaction but also in the *persistence* effect leads to a shift in the relative competitiveness between the two economies which is in fact of larger duration than the individual reactions of wage and price inflation in **a** and **b**, as it can be observed in the last panel of Figure 4.3.

It should be noted that that no interest rate smoothing term was included in the monetary policy rule of the MUCB, and that these simple simulations underlie one-time shocks which were not assumed to exhibit any autocorrelation. Under this perspective, the significant and persistent shift in the relative competitiveness of the two economies highlight the importance that asymmetries between the national labor markets of currency union members have for the effectiveness of monetary policy in such a macroeconomic environment. Furthermore, these dynamic simulations open up the question whether a MUCB should indeed take into account these asymmetries when conducting monetary policy. In the next section we attempt to shed some light on this issue.

4.4 Inflation Targeting in Monetary Unions

As previously stated, the aim of this section is to conceptualize an optimal monetary policy rule which would take into account the structural differences of the member countries of a monetary union. This idea is not new; Beningno (2004), for example, shows within a DSGE framework that in a currency area with countries featuring different degrees of nominal rigidity (represented by a longer staggering period in the price setting), an inflation targeting policy in which a higher weight is put on the inflation of the country with the highest degree of nominal rigidity is nearly optimal. Alternatively, Lombardo (2006) focuses on the role of product market competition for the design of monetary policy. He concludes that *ceteris paribus*, the welfare-maximizing central bank should react more aggressively to the inflation pressure generated by the more competitive economy. Beetsma and Jensen (2005), on the contrary, while assuming that monetary policy is oriented solely on currency union aggregate developments, focus on the role of fiscal policy as the main equilibrating mechanism against macroeconomic asymmetry among the member economies.

In contrast to the previous section, where the dynamics of the nominal interest rate were modeled through a simple instrument rule obeying the inflation gap solely, in this section the interest rate will be the result of an optimizing targeting rule. This differentiation is not trivial. As stated in Rudebusch and Svensson (1999), an *instrument rule* is a rule which expresses the monetary policy instrument as an explicit function of available information. A *targeting rule*, in contrast, underlies an explicit loss function over the deviations of a specific goal from a target level which is assigned to the central bank, being thus only *implicitly* an instrument rule.

The explicit formulation of a *loss function* of the monetary authorities represents in fact the main advantage of *targeting rules* over *instrument rules*, since they provide some metrics for the analysis of the dynamic adjustments of the model to shocks. It should be noted, however, that these metrics do not need to underlie an explicit formulation of the agents' and firms' utility and profit maximization problems, in contrast for example to Woodford (2003, p.382) states: "An important advantage of using a model founded upon private-sector optimization to analyze the consequences of alternative policy rules is that there is a natural welfare criterion in the context of such a model, provided by the preferences of private agents, which are displayed in the structural relations that determine the effects of alternative policies." This reasoning, though appealing at first sight, is based on three questionable assumptions: First, that the economy's welfare can indeed be comprised in terms of representative agents' and firm' utility and profit functions, ignoring the heterogeneity and interest conflicts which come about in the real world. Second, even if the previous assumption would actually be true, this statement requires the monetary policy authorities to actually *know* the exact specification of such a utility function, something that is highly unrealistic to assume and lastly, that the preferences of the private sector in fact coincide with those of the monetary authorities.

Due to these and other critical issues, we stick here to the rather descriptive approach pursued throughout this dissertation. We thus focus in the following on an ad hoc loss function of the central monetary authorities as for example done in Svensson (1997).

In the following we assume that the central bank's objective in period t is to choose a sequence of current and future nominal interest rates $\{i_{\mathrm{T}}\}_{s=t}^{\infty}$ so as to minimize

$$E_t \sum_{s=t}^{\infty} \delta^{s-t} \mathcal{L}(\hat{p}_s^{\mathrm{T}}) \tag{4.26}$$

where E_t denotes expectations conditional upon (the central bank's) information available in year t, the discount factor δ fulfills $0 < \delta < 1$, $\hat{p}_t^{\mathrm{T}}$ is the inflation rate targeted by the MUCB (to be defined below); and the period loss function $\mathcal{L}(\hat{p}_t^{\mathrm{T}})$ is

$$\mathcal{L}(\hat{p}_t^{\mathrm{T}}) = \lambda_\pi (\hat{p}_t^{\mathrm{T}} - \pi^*)^2 \tag{4.27}$$

As observed in eq.(4.27), a strict inflation forecast targeting regime is assumed here, since the loss function of the MUCB only comprises the deviation of the inflation rate from its target level. Due to the implicit focus of this chapter on the EMU, this specification seems to be appropriate since it describes a *systematic* conduction of monetary policy which comprises literally the mandate of the European Central Bank as determined by Article 105 of the Maastricht Treaty, whereafter "the primary objective of the ESCB [European System of Central Banks] is to maintain price stability."[12]

Due to the fact that the nominal interest rate affects price inflation with a two-period lag, it is possible to find the optimal nominal interest rate at t (which would allow the

[12] This quote, however, goes on as following: "Without prejudice of the objective of price stability the ESCB shall support the general economic policies in the Community with a view to contributing to the achievement of the objectives of the Community [...]."

economy to hit the inflation forecast of $t+2$) as the solution of the following simplified problem (see Svensson (1997))

$$\min_{i_t} E_t \delta^2 \mathcal{L}(\hat{p}^{\mathrm{T}}_{t+2})$$

with the corresponding first-order-condition

$$\frac{\partial E_t \delta^2 L(\hat{p}^{\mathrm{T}}_{t+2})}{\partial i_t} = E_t \left[2\lambda_\pi (\hat{p}^{\mathrm{T}}_{t+2} - \pi^*) \frac{\partial \hat{p}^{\mathrm{T}}_{t+2}}{\partial i_t} \right].$$

As demonstrated in Svensson (1999, p.618), due to the certainty-equivalence that holds in linear models with quadratic loss functions and additive shocks, the stochastic optimization problem of minimizing the expected loss function over future random target variables is equivalent to the deterministic problem of minimizing the deterministic loss function over the deterministic paths of conditional forecasts of the target variables. Due to this, we can reformulate the minimization problem of the central monetary authorities in terms of the two-period ahead inflation *forecast*

$$\min_{i_t} \delta^2 \mathcal{L}(\hat{p}^{\mathrm{T}}_{t+2|\,t}) \tag{4.28}$$

with the first-order-condition

$$\frac{\partial \delta^2 L(\hat{p}^{\mathrm{T}}_{t+2|\,t})}{\partial i_t} = \left[2\lambda_\pi (\hat{p}^{\mathrm{T}}_{t+2|\,t} - \pi^*) \frac{\partial \hat{p}^{\mathrm{T}}_{t+2|\,t}}{\partial i_t} \right]. \tag{4.29}$$

From eq.(4.29) it follows that

$$\hat{p}^{\mathrm{T}}_{t+2|\,t} = \pi^*. \tag{4.30}$$

According to eq.(4.30), the MUCB is thus supposed to set the nominal interest rate so as to lead the forecast of price inflation two periods ahead to be equal to its target inflation rate level. In the following the performance of two different specifications for $\hat{p}^{\mathrm{T}}$.

4.4.1 Alternative I: Inflation Targeting of Average Developments

For starters we analyze the case where the MUCB, using as its target variable the country-size weighted average monetary union price inflation rate

$$\hat{p}^{\mathrm{T}} = \hat{p}^{\mathrm{av}} = \lambda_{\mathrm{a}} \hat{p}^{\mathrm{a}} + (1 - \lambda_{\mathrm{a}}) \hat{p}^{\mathrm{b}},$$

would conduct its monetary policy based on the simple average inflation and output developments of both economies **a** and **b** (to be again denoted by $\hat{p}^{av}$ and y^{av}, respectively, for *average*).[13]

The central bank looks thus to minimize the expected sum of discounted squared future deviations of inflation from the target level subject to

$$\hat{p}^{\text{av}}_{t+1} = \kappa\left[\beta_{py}(y^{\text{av}}_t - y_o) + \kappa_{pw}(\beta_{we}(\phi^{\text{av}} y^{\text{av}}_t - \phi^{\text{av}}_o))\right] + \epsilon^p_{t+1} \tag{4.31}$$

$$\begin{aligned} y^{\text{av}}_{t+1} = {} & \mu^{\text{av}}(\phi^{\text{av}})^{-1}\left[\nu\left(1-(1-\rho)\phi^{\text{av}} y^{\text{av}}_t\right) + (1-\nu)\left(1 + y^{\text{av,d}}_{t+1} - (1-\rho)\phi^{\text{av}} y^{\text{av}}_t\right)\right] \\ & + (1-\rho) y^{\text{av}}_t \end{aligned} \tag{4.32}$$

with $\phi^{\text{av}} = e^{\text{av}}_o = \lambda_{\text{a}} e^{\text{a}}_o + (1-\lambda_{\text{a}})e^{\text{b}}_o$, $e^{\text{av}}_t = \phi^{\text{av}} y^{\text{av}}_t$ and

$$\begin{aligned} y^{\text{D,av}}_{t+1} &= \lambda_{\text{a}} y^{\text{D,a}}_{t+1} + (1-\lambda_{\text{a}}) y^{\text{D,b}}_{t+1} \\ &= \alpha_y y^{\text{av}}_t - \alpha_{yr}(i_t - \hat{p}^{\text{av}}_{t+1} - (i_o - \pi_o)) - \alpha_{yv}(v^{\text{av}} - v_o) + \epsilon^y_{t+1} \end{aligned} \tag{4.33}$$

being ϵ^p_{t+1} and ϵ^y_{t+1} i.i.d. errors.

Note that due to the symmetry concerning the parameters in eq.(4.11) in both countries **a** and **b** and the equal weights of both economies resulting from their same economic size, the term concerning the real exchange rate η and therefore the relative competitiveness between the two economies disappears in eq.(4.33). This type of aggregation, as we will see below, will have important consequences for the effectiveness of this baseline monetary policy strategy.

Using (4.30) we obtain the following expression

$$\pi^* = \kappa\left[\beta_{py}(y^{\text{av}}_{t+1|\,t} - y_o) + \kappa_{pw}(\beta_{we}(\phi^{\text{av}} y^{\text{av}}_{t+1|\,t} - e^{\text{av}}_o))\right]. \tag{4.34}$$

In order for eq.(4.34) to hold, the MUCB has to set the optimal nominal interest rate i^*_t at time t so that, at $t+1$, the output level is equal to

$$y^{\text{av,opt}}_{t+1} = \frac{\beta_{py} y_o + \beta_{we}\kappa_{pw}\phi^{\text{av}} + \pi^*/\kappa}{\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\text{av}}}. \tag{4.35}$$

Inserting eqs.(4.31), (4.32) and (4.33) into (4.35) and solving for $i^{\text{av,opt}}_t$ leads (after some

[13] Note that we have assumed two economies of identical economic size.

algebra) to

$$\begin{aligned} i_t^{\mathrm{av,opt}} &= i_o - \pi^* + (\alpha_{yr}^{-1}\alpha_{yy} + \beta_{py}\kappa)(y_t^{\mathrm{av}} - y_o) + \beta_{we}\kappa_{pw}\kappa\phi^{\mathrm{av}}(y_t^{\mathrm{av}} - 1) \\ &+ \frac{\beta_{py}\phi^{\mathrm{av}}((1-\rho)(1-\mu^{\mathrm{av}})y_t^{\mathrm{av}} - y_o) + \beta_{we}\kappa_{pw}\phi^{\mathrm{av}}((1-\rho)(1-\mu^{\mathrm{av}})\phi^{\mathrm{av}}y_t^{\mathrm{av}} - \phi^{\mathrm{av}})}{\alpha_{yr}(1-\nu)(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{av}})\mu^{\mathrm{av}}} \\ &+ \frac{(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{av}})\mu^{\mathrm{av}} - \phi^{\mathrm{av}}\pi^*/\kappa}{\alpha_{yr}(1-\nu)(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{av}})\mu^{\mathrm{av}}} - \alpha_i^{-1}\alpha_{yv}(v_t^{\mathrm{av}} - v_o) \end{aligned} \tag{4.36}$$

As it can be observed, despite the simplicity of the model and the fact that output does not enter explicitly into the loss function of the central bank, the determination of the – under an inflation forecast targeting regime – "optimal" nominal interest rate is of a significant complexity. Due to our specification of the wage and price inflation and labor market dynamics there are actually three "gaps" which, being the determinants of aggregate demand and of wage and price inflation, have to be taken into account by the central bank[14] in order to fulfill its minimization problem: the goods market gap $(y^{\mathrm{av}} - y_o)$, the labor markets gap $e^{\mathrm{av}} - e_o^{\mathrm{av}}$ and the wage share gap $v_t^{\mathrm{av}} - v_o$. Additionally, eq.(4.36) shows that, in the circumstance that the MUCB knows the nature and structure of the employment function, its structural coefficients (more precisely, the average of both economies) also determine the optimal interest rate level. However, as previously discussed, due to the stage at which the aggregation of the member economies takes place, the relative competitiveness between them is not taken into account in eq.(4.36).

4.4.2 Alternative II: Inflation Targeting of Country-Specific Developments

As previously stated, in the one-country-one-currency case under a strict inflation forecast targeting regime the instrument interest rate is to be set so that the two-period ahead (due to the assumed transmission lag) inflation forecast equals the goal inflation rate set by the central bank. In a monetary union, however, the MUCB has to take into account all the price inflation developments in the member countries, being its target variable at the end of the day a weighted average of the member countries' national inflation rates as in the previous section. The natural question that arises is: How should these weights be determined? Is economic size (as in the baseline case just discussed and as actually practiced by the ECB) the best criterion, or should a MUCB

[14] but just to the extent that these would affect the forecast of inflation two periods ahead.

rather take into account other structural factors such as the different degrees of labor market rigidity in the member countries? And at which stage should this aggregation take place?

The main proposal of this chapter is that a MUCB should take into account and explicitly weight the individual, country-specific structural factors and developments of the respective countries in its loss function. This strategy would act in a more welfare-enhancing manner than in the case where only the relative economic size of the member economies is the only relevant criterion for the country weighting as previously discussed.

In order to prove this hypothesis, the period loss function of the central monetary authorities is re-expressed for the two-country monetary union case (with $\hat{p}^{\text{fw}}$ denoting the *flexibly weighted* monetary union price inflation) as

$$\mathcal{L}(\hat{p}^{\text{fw}}) = \lambda_\pi(\lambda_{\text{a}}^{\text{fw}}\hat{p}_t^{\text{a}} + (1-\lambda_{\text{a}}^{\text{fw}})\hat{p}_t^{\text{b}} - \pi^*)^2 \tag{4.37}$$

subject to

$$\begin{aligned}
\hat{p}_{t+1}^{\text{a}} &= \kappa\left[\beta_{py}(y_t^{\text{a}} - y_o) + \kappa_{pw}(\beta_{we}(\phi^{\text{a}}y_t^{\text{a}} - \phi^{\text{a}}))\right] + \epsilon_{t+1}^{p} && (4.38)\\
y_{t+1}^{\text{a}} &= \Big[\mu^{\text{a}}(\nu\,(1-(1-\rho)\phi^{\text{a}}y_t^{\text{a}}) + (1-\nu)(1+y_{t+1}^{d,a} - (1-\rho)\phi^{\text{a}}y_t^{\text{a}})) \\
&\quad +(1-\rho)\phi^{\text{a}}y_t^{\text{a}}\Big]/\phi^{\text{a}} && (4.39)\\
\hat{p}_{t+1}^{\text{b}} &= \kappa\left[\beta_{py}(y_t^{\text{b}} - y_o) + \kappa_{pw}(\beta_{we}(\phi^{\text{b}}y_t^{\text{b}} - \phi^{\text{b}}))\right] + \epsilon_{t+1}^{p} && (4.40)\\
y_{t+1}^{\text{b}} &= \Big[\mu^{\text{b}}(\nu\,(1-(1-\rho)\phi^{\text{b}}y_t^{\text{b}}) + (1-\nu)(1+y_{t+1}^{d,b} - (1-\rho)\phi^{\text{b}}y_t^{\text{b}})) \\
&\quad +(1-\rho)\phi^{\text{b}}y_t^{\text{b}}\Big]/\phi^{\text{b}} && (4.41)
\end{aligned}$$

with

$$\begin{aligned}
y_{t+1}^{\text{D,a}} &= \alpha_y(y_t^{\text{a}} - y_o) - \alpha_{yr}(i_t - \hat{p}_{t+1}^{\text{a}} - (i_o - \pi_o)) - \alpha_{yv}(v_t^{\text{a}} - v_o) + \alpha_\eta\eta_t + \epsilon_{t+1}^{y} && (4.42)\\
y_{t+1}^{\text{D,b}} &= \alpha_y(y_t^{\text{b}} - y_o) - \alpha_{yr}(i_t - \hat{p}_{t+1}^{\text{b}} - (i_o - \pi_o)) - \alpha_{yv}(v_t^{\text{b}} - v_o) - \alpha_\eta\eta_t + \epsilon_{t+1}^{y} && (4.43)
\end{aligned}$$

being ϵ_{t+1}^{p} and ϵ_{t+1}^{y} again i.i.d. errors.

Analogously to the simple average inflation targeting case discussed in the previous section, the first-order condition for the (simplified) minimization problem of the MUCB is

$$\frac{\partial\delta^2\mathcal{L}(\hat{p}_{t+2|\,t}^{fw})}{\partial i_t} = \left[2\lambda_\pi(\lambda_{\text{a}}^{\text{fw}}\hat{p}_{t+2|\,t}^{\text{a}} + (1-\lambda_{\text{a}}^{\text{fw}})\hat{p}_{t+2|\,t}^{\text{b}} - \pi^*)\frac{\partial\hat{p}_{t+2|\,t}^{\text{fw}}}{\partial i_t}\right] = 0, \tag{4.44}$$

implying

$$\begin{aligned}\pi^* &= \lambda_{\rm a}^{\rm fw}\kappa\left[\beta_{py}(y^{\rm a}_{t+1|\,t}-y_o)+\kappa_{pw}(\beta_{we}(\phi^{\rm a}y^{\rm a}_{t+1|\,t}-\phi^{\rm a}))\right]\\ &\quad (1-\lambda_{\rm a}^{\rm fw})\kappa\left[\beta_{py}(y^{\rm b}_{t+1|\,t}-y_o)+\kappa_{pw}(\beta_{we}(\phi^{\rm b}y^{\rm b}_{t+1|\,t}-\phi^{\rm b}))\right] \qquad (4.45)\end{aligned}$$

Solving eq.(4.45) for i_t subject to (4.38)–(4.41) – inserting (4.42) and (4.43) accordingly – delivers an analogous expression of the instrument interest rate in the average inflation targeting- for the country-specific inflation targeting case, now indeed with an explicit inclusion of the individual developments of both economies, namely

$$\begin{aligned}i_t^{\rm fw,opt} &= i_o-\pi^*+\frac{1}{\alpha_{yr}(1-\nu)(\lambda_{\rm a}^{\rm fw}\beta^{\rm a}_{pw}+(1-\lambda_{\rm a}^{\rm fw})\beta^{\rm b}_{pw})}\\ &\quad \big[(1-\nu)(\alpha_{yy}+\alpha_{yr}\beta_{py}\kappa)(\lambda_{\rm a}^{\rm fw}\beta^{\rm a}_{pw}(y^{\rm a}_t-y_o)+(1-\lambda_{\rm a}^{\rm fw})\beta^{\rm b}_{pw}(y^{\rm b}_t-y_o))\\ &\quad +(1-\nu)\beta_{we}\kappa_{pw}\alpha_{yr}\kappa(\lambda_{\rm a}^{\rm fw}\beta^{\rm a}_{pw}(\phi^{\rm a}y^{\rm a}_t-\phi^{\rm a})+(1-\lambda_{\rm a}^{\rm fw})\beta^{\rm b}_{pw}(\phi^{\rm b}y^{\rm b}_t-\phi^{\rm b}))\\ &\quad +\phi^{\rm a}\phi^{\rm b}\beta_{py}((1-\rho)(\lambda_{\rm a}^{\rm fw}(1-\mu^{\rm a})y^{\rm a}_t+(1-\lambda_{\rm a}^{\rm fw})(1-\mu^{\rm b})y^{\rm b}_t)-y_o)\\ &\quad +\phi^{\rm a}\phi^{\rm b}\beta_{we}\kappa_{pw}((1-\rho)(\lambda_{\rm a}^{\rm fw}(1-\mu^{\rm a})\phi^{\rm a}y^{\rm a}_t+(1-\lambda_{\rm a}^{\rm fw})(1-\mu^{\rm b})\phi^{\rm b}y^{\rm b}_t)-(\lambda_{\rm a}^{\rm fw}\phi^{\rm a}+(1-\lambda_{\rm a}^{\rm fw})\phi^{\rm b}))\\ &\quad -(1-\nu)\alpha_{yv}(\lambda_{\rm a}^{\rm fw}\beta^{\rm a}_{pw}(v^{\rm a}_t-v_o)-(1-\lambda_{\rm a}^{\rm fw})\beta^{\rm b}_{pw}(v^{\rm b}_t-v_o))+\alpha_{y\eta}(\lambda_{\rm a}^{\rm fw}\beta^{\rm a}_{pw}-(1-\lambda_{\rm a}^{\rm fw})\beta^{\rm b}_{pw})\,\eta_t\\ &\quad +\beta_{py}(\lambda_{\rm a}^{\rm fw}\mu^{\rm a}\phi^{\rm b}+(1-\lambda_{\rm a}^{\rm fw})\mu^{\rm b}\phi^{\rm a})+\phi^{\rm a}\phi^{\rm b}(\beta_{we}\kappa_{pw}(\lambda_{\rm a}^{\rm fw}\mu^{\rm a}+(1-\lambda_{\rm a}^{\rm fw})\mu^{\rm b})-\pi^*/\kappa)\big] \qquad (4.46)\end{aligned}$$

with

$$\beta^{\rm a}_{pw}=(\beta_{py}+\beta_{we}\kappa_{pw}\phi^{\rm a})\mu^{\rm a}\phi^{\rm b} \qquad \text{and} \qquad \beta^{\rm b}_{pw}=(\beta_{py}+\beta_{we}\kappa_{pw}\phi^{\rm b})\mu^{\rm b}\phi^{\rm a}.$$

Alternatively to eq.(4.36) – which shows the optimal nominal interest rate under inflation forecast targeting for the case where the MUCB responded only to average (monetary union-wide) inflation developments – the solution for the optimal nominal interest rate given by eq.(4.46) shows that in the case where the MUCB takes into account the country-specific developments of a monetary union characterized by national labor markets with different degrees of labor market flexibility, all structural factors of both economies (and not simply their averages) enter explicitly into the nominal interest rate expression. But beyond this, eq.(4.46) takes also into account the relative competitiveness between **a** and **b** (expressed by the term $\alpha_{y\eta}(\alpha_{yr}(1-\nu))^{-1}\eta_t$).

Note that for $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 1$, eq.(4.46) reduces to

$$\begin{aligned} i_t^{\mathrm{fw,opt}} &= i_o - \pi^* + \frac{1}{\alpha_{yr}(1-\nu)\beta_{pw}^{\mathrm{a}}} \\ &\quad \big[(1-\nu)(\alpha_{yy} + \alpha_{yr}\beta_{py}\kappa)\beta_{pw}^{\mathrm{a}}(y_t^{\mathrm{a}} - y_o) + (1-\nu)\beta_{we}\kappa_{pw}\alpha_{yr}\kappa\beta_{pw}^{\mathrm{a}}(\phi^{\mathrm{a}}y_t^{\mathrm{a}} - \phi^{\mathrm{a}}) \\ &\quad + \phi^{\mathrm{a}}\phi^{\mathrm{b}}\beta_{py}((1-\rho)(1-\mu^{\mathrm{a}})y_t^{\mathrm{a}} - y_o) + \phi^{\mathrm{a}}\phi^{\mathrm{b}}\beta_{we}\kappa_{pw}((1-\rho)(1-\mu^{\mathrm{a}})\phi^{\mathrm{a}}y_t^{\mathrm{a}} - \phi^{\mathrm{a}}) \\ &\quad + \beta_{py}\mu^{\mathrm{a}}\phi^{\mathrm{b}} + \phi^{\mathrm{a}}\phi^{\mathrm{b}}(\beta_{we}\kappa_{pw}\mu^{\mathrm{a}} - \pi^*/\kappa) - (1-\nu)\alpha_{yv}\beta_{pw}^{\mathrm{a}}(v_t^{\mathrm{a}} - v_o) + \alpha_{y\eta}\beta_{pw}^{\mathrm{a}}\ \eta_t\big] \\ &= i_o - \pi^* + (\alpha_{yr}^{-1}\alpha_{yy} + \beta_{py}\kappa)(y_t^{\mathrm{a}} - y_o) + \beta_{we}\kappa_{pw}\kappa(\phi^{\mathrm{a}}y_t^{\mathrm{a}} - \phi^{\mathrm{a}}) \\ &\quad + \frac{\phi^{\mathrm{a}}\beta_{py}((1-\rho)(1-\mu^{\mathrm{a}})y_t^{\mathrm{a}} - y_o) + \phi^{\mathrm{a}}\beta_{we}\kappa_{pw}((1-\rho)(1-\mu^{\mathrm{a}})\phi^{\mathrm{a}}y_t^{\mathrm{a}} - \phi^{\mathrm{a}})}{\alpha_{yr}(1-\nu)(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{a}})\mu^{\mathrm{a}}} \\ &\quad + \frac{(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{a}})\mu^{\mathrm{a}} - \phi^{\mathrm{a}}\pi^*/\kappa}{\alpha_{yr}(1-\nu)(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{a}})\mu^{\mathrm{a}}} - \alpha_{yr}^{-1}\alpha_{yv}(v_t^{\mathrm{a}} - v_o) + (\alpha_{yr}(1-\nu))^{-1}\alpha_{y\eta}\ \eta_t, \end{aligned} \tag{4.47}$$

and equivalently, for $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 0$,[15]

$$\begin{aligned} i_t^{\mathrm{fw,opt}} &= i_o - \pi^* + (\alpha_{yr}^{-1}\alpha_{yy} + \beta_{py}\kappa)(y_t^{\mathrm{b}} - y_o) + \beta_{we}\kappa_{pw}\kappa(\phi^{\mathrm{b}}y_t^{\mathrm{b}} - \phi^{\mathrm{b}}) \\ &\quad + \frac{\phi^{\mathrm{b}}\beta_{py}((1-\rho)(1-\mu^{\mathrm{b}})y_t^{\mathrm{b}} - y_o) + \phi^{\mathrm{b}}\beta_{we}\kappa_{pw}((1-\rho)(1-\mu^{\mathrm{b}})\phi^{\mathrm{b}}y_t^{\mathrm{b}} - \phi^{\mathrm{b}})}{\alpha_{yr}(1-\nu)(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{b}})\mu^{\mathrm{b}}} \\ &\quad + \frac{(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{b}})\mu^{\mathrm{b}} - \phi^{\mathrm{b}}\pi^*/\kappa}{\alpha_{yr}(1-\nu)(\beta_{py} + \beta_{we}\kappa_{pw}\phi^{\mathrm{b}})\mu^{\mathrm{b}}} - \alpha_{yr}^{-1}\alpha_{yv}(v_t^{\mathrm{b}} - v_o) - (\alpha_{yr}(1-\nu))^{-1}\alpha_{y\eta}\ \eta_t. \end{aligned} \tag{4.48}$$

Eq.(4.46), as well as the special cases described by eqs.(4.47) and (4.48), show the advantage of the explicit incorporation of the individual structural factors of the member countries of a monetary union in the loss function of the MUCB. As eq.(4.46) demonstrates, this alternative specification of the MUCB's monetary policy conduction allows for a more precise control of the macroeconomic dynamics in the individual countries by an appropriate management of the country-weighting parameter $\lambda_{\mathrm{a}}^{\mathrm{fw}}$.

Note that in contrast to eq.(4.36), which came about under the assumption that, due to the almost perfect symmetry between country **a** and **b**, in the average aggregate demand – given by eq.(4.33) – of the two countries can be expressed as

$$y_{t+1}^{\mathrm{av,d}} = \alpha_y y_t^{\mathrm{av}} - \alpha_{yr}(i_t - \hat{p}_{t+1}^{\mathrm{av}} - (i_o - \pi_o)) + \epsilon_{t+1}^y,$$

the log real exchange rate $\eta = \ln(p^{\mathrm{b}}/p^{\mathrm{a}})$ was canceled out, in eqs. (4.48) and (4.47) even in the case where $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 0.5$, the term concerning η_t does not disappear from the optimal interest rate equation.

[15] In the appendix of this chapter the dynamic responses of all variables in the economy to an aggregate demand shock according to eq.(4.36) for $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 0.5$, as well as to eq.(4.46) for the cases $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 0$ and $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 1$ are depicted.

As we will see in the next section, this difference concerning the stage at which the aggregation of the inflation and output developments of the member economies takes place as well as the choice of the country-weights in the MUCB's loss function, will turn out to be by no means trivial for the dynamics and effectiveness of monetary policy in a common currency area.

4.4.3 Dynamic Adjustments under Alternative Weighting Schemes

It should intuitive that for the case where both countries are perfectly identical – also in their degree of labor market rigidity –, the solution and dynamics of both economies under inflation targeting in the *average-* and the *country-specific* cases are equivalent for any value of the country weight $\lambda_{\mathrm{a}}^{\mathrm{fw}}$, since, given the symmetry of both countries, both strategies are equally efficient at the country level. Therefore solely the case where the two member countries feature a different degree of labor market rigidity, with $\mu^{\mathrm{a}} > \mu^{\mathrm{b}}$, will be analyzed here.

For starters and in order to clarify the effects of an alternative country-weighting for the dynamics of both countries, Figure 4.4 shows the deviations of the dynamic responses to a symmetric aggregate demand shock in both economies resulting under an MUCB instrument rule with $\hat{p}^{\mathrm{T}} = 0.5\hat{p}^{a} + 0.5\hat{p}^{b}$ from those which would occur if each country would be controlled by its own instrument rule (that is, $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 0$ for country **b** and $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 1$ for country **a** in eq.(4.22)). The sum of the two is shown in the third graph column.

As it can be observed, such a MUCB instrument rule is sub-optimal for *both* member economies for all values of $\lambda_{\mathrm{a}}^{\mathrm{fw}} > 0$. So we can see that for $\lambda_{\mathrm{a}}^{\mathrm{fw}} < 0.5$, while the more flexible economy (here country **a**) is subjected to an insufficient reaction by the policy instrument of the MUCB, the more rigid economy (country **b**) experiences an excessive tightening of its real interest rate.

In Figure 4.5, in contrast, the dynamic responses in the flexible weighting, country-specific inflation targeting case are illustrated *as deviations from the individual, country-specific optimal paths* (which would take place in the one-country-one-currency case, that is, where $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 1$ and $\lambda_{\mathrm{a}}^{\mathrm{fw}} = 0$ in eq.(4.36), respectively). By and large the same qualitative individual behavior after some quarters as in the standard instrument rule case can be observed (with positive deviations of price inflation and output in country **a** and the opposite holding for country **b**). However, in the first quarters following the

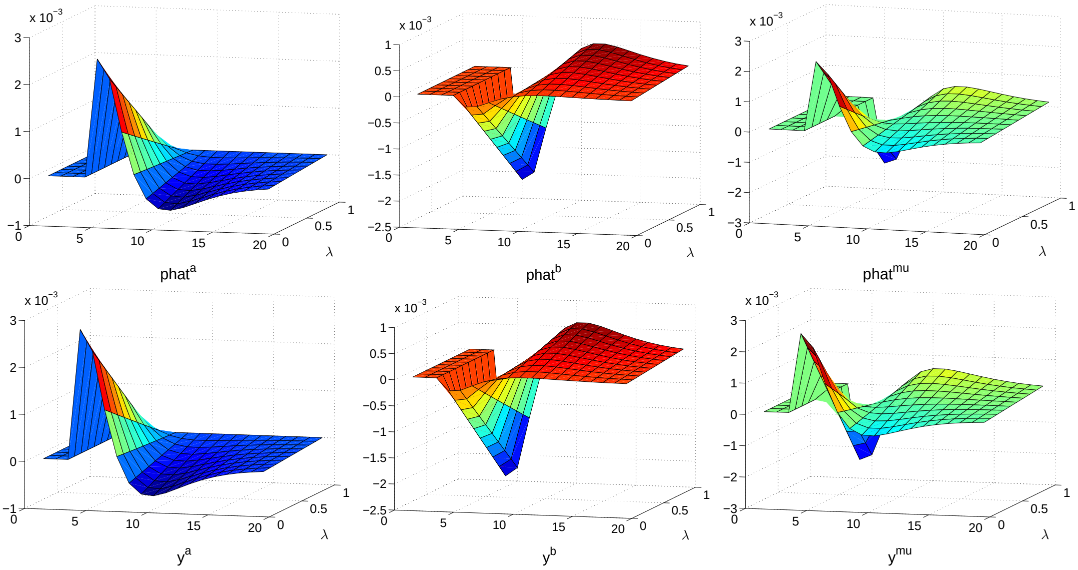


Fig. 4.4: Price Inflation and Output Responses under Standard Instrument Rule (Deviations from Country-Specific Instrument Rule Responses)

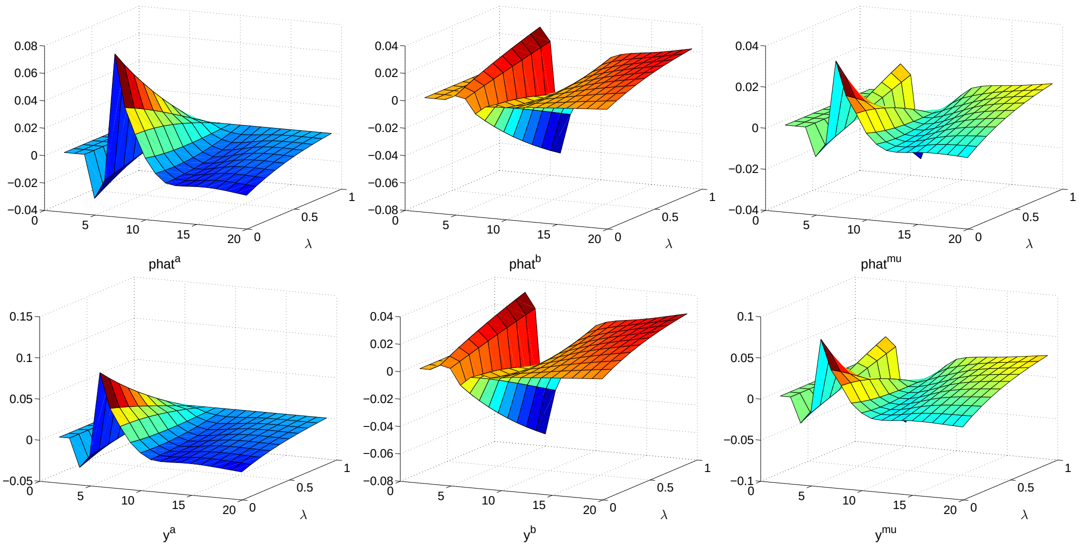


Fig. 4.5: Inflation and Output Responses under Flexibly-Weighted Inflation Targeting (Deviations from Optimal Country-Specific Paths)

symmetric aggregate demand shock in **a** and **b** both price inflation and output react the oppositive way in the two countries. This results from the determination of the optimal interest rate for country **a** (country **b**), and shows thus the inadequacy of the respective optimal policies for the other economies.

The cumulated absolute deviations of the price inflation rates in the member economies **a** and **b** from their respective optimal paths – which could be considered as proxies for the welfare decrease which the entrance into a monetary union and the loss of an independent monetary policy represent for the joining countries – for the two alternative inflation targeting rules are illustrated in Table 4.2 and Figure 4.6.

Tab. 4.2: Welfare Losses at Different Horizons (Cumulated Absolute Deviations, in percent)

Horizon		Country-Specific Inflation Targeting			Average Inflation Targeting		
(Quarters)	λ_a^{fw}	Country A	Country B	MU	Country A	Country B	MU
4	0.1	0.0893	0.0465	0.0679	0.1243	0.0138	0.0690
	0.2	0.0856	0.0468	0.0662	0.1072	0.0268	0.0670
	0.3	0.0817	0.0489	0.0653	0.0911	0.0390	0.0651
	0.4	0.0776	0.0522	0.0649	0.0759	0.0506	0.0632
	0.5	0.0734	0.0554	0.0644	0.0615	0.0615	0.0615
	0.6	0.0689	0.0586	0.0638	0.0479	0.0718	0.0599
	0.7	0.0643	0.0617	0.0630	0.0350	0.0817	0.0583
	0.8	0.0595	0.0648	0.0621	0.0227	0.0910	0.0568
	0.9	0.0545	0.0679	0.0612	0.0110	0.0998	0.0554
8	0.1	0.1380	0.0991	0.1185	0.1896	0.0199	0.1048
	0.2	0.1350	0.0992	0.1171	0.1684	0.0391	0.1037
	0.3	0.1318	0.1005	0.1162	0.1490	0.0575	0.1032
	0.4	0.1284	0.1025	0.1155	0.1289	0.0751	0.1020
	0.5	0.1249	0.1039	0.1144	0.1082	0.0920	0.1001
	0.6	0.1211	0.1046	0.1128	0.0870	0.1082	0.0976
	0.7	0.1172	0.1047	0.1109	0.0655	0.1237	0.0946
	0.8	0.1130	0.1043	0.1087	0.0438	0.1386	0.0912
	0.9	0.1087	0.1034	0.1060	0.0219	0.1547	0.0883
12	0.1	0.2070	0.1093	0.1581	0.2544	0.0222	0.1383
	0.2	0.2057	0.1100	0.1579	0.2290	0.0442	0.1366
	0.3	0.2037	0.1118	0.1578	0.2046	0.0657	0.1352
	0.4	0.2010	0.1141	0.1575	0.1788	0.0874	0.1331
	0.5	0.1917	0.1150	0.1562	0.1516	0.1092	0.1304
	0.6	0.1931	0.1149	0.1540	0.1231	0.1310	0.1271
	0.7	0.1880	0.1142	0.1511	0.0936	0.1529	0.1233
	0.8	0.1821	0.1126	0.1474	0.0632	0.1749	0.1191
	0.9	0.1755	0.1103	0.1429	0.0319	0.1988	0.1154

Both show in a quite clear manner the advantages of the country-specific inflation targeting strategy, and especially of the endogenization of the instrument interest rate

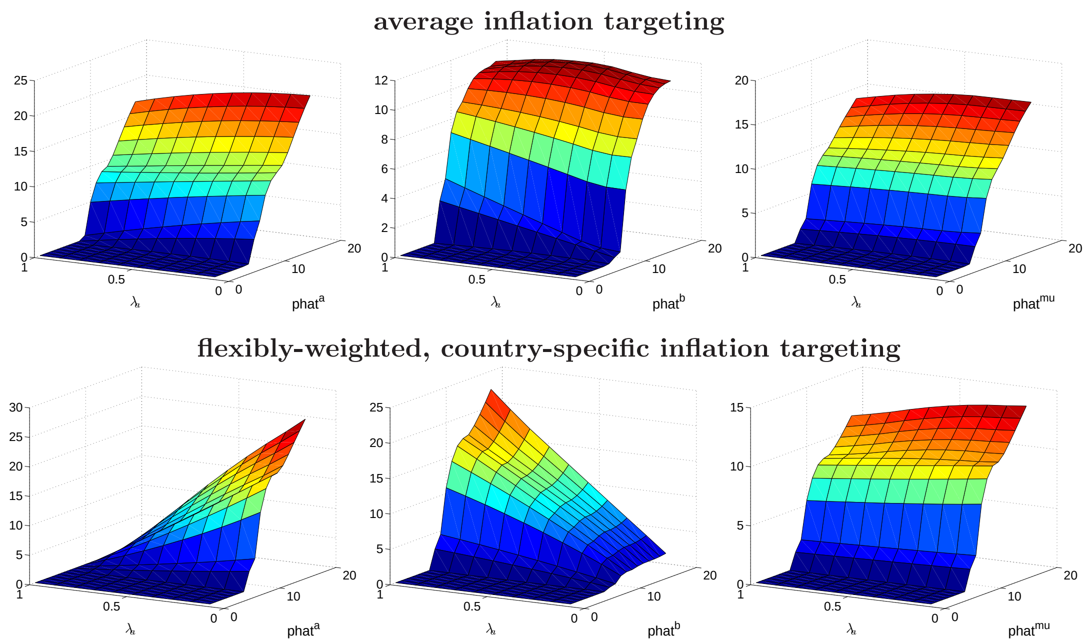


Fig. 4.6: Price Inflation Responses under Flexibly-Weighted, Country-Specific Inflation Targeting (Cumulated Absolute Deviations from Optimal Country-Specific Paths)

as a function of the country weighting parameter $\lambda_{\mathrm{a}}^{\mathrm{fw}}$ compared to the average inflation targeting strategy. So it can be clearly observed in Figure 4.6 in the first place that while in the average inflation targeting case the control of inflation and output developments of the individual member countries by the choice of the weighting parameter λ_a is not possible anymore, alternative II provides the MUCB enough flexibility to focus eventually on individual price inflation and output developments, taking however the trade-off of such a handling into account (namely the increase in the welfare loss of the other country). In the second place, both Table 4.2 and Figure 4.6 show that at all analyzed horizons the proxy for welfare loss concerning the whole monetary union – represented by the average of the cumulated absolute deviations of price inflation from the respective optimal country-specific paths in the two member economies – under alternative II is strictly lower than under alternative I, primarily due to the explicit incorporation of the relative competitiveness between the two member economies in the optimal nominal interest rate expression. And finally, they also highlight the fact that a value of λ_{a} close to one (a higher weight of the more flexible country **a** in the MUCB loss function) seems to dominate all other weighting schemes in the respective alternatives at all horizons.

4.5 Concluding Remarks

In this chapter the conduction of monetary policy in a monetary union with asymmetric labor markets such as the euro area was analyzed. Using the strict inflation targeting approach introduced by Svensson (1997), it was possible to derive an analytical solution for the optimal instrument interest rate which was intended to stabilize the price inflation dynamics at both the country-specific and the monetary union-level under two different specifications of the loss function of the MUCB. While in the first specification the MUCB focused on the average developments of the monetary union (not only concerning inflation but also all other macroeconomic variables), in the second specification the MUCB responded to the individual developments of the member economies, with inflation rates and all other variables entering explicitly in its loss function.

The simulated dynamic responses to a symmetric aggregate demand shock highlighted the advantages of an explicit endogenization of the instrument interest rate as a function of the country-weight $\lambda_{\mathrm{a}}^{\mathrm{fw}}$ and therefore of the country-specific developments in the MUCB loss function. Under such a specification, the MUCB would be capable of eventually addressing country-specific developments by the adequate choice of the country weight in a more efficient manner than in the simple average case. Additionally, it could be shown that the first strategy was able to attain a lower welfare loss precisely due to the explicit accounting of the individual country developments and specially of the relative competitiveness between the union member countries.

The implications of this analysis are quite relevant for actual policy-making. They open up the question whether an alternative, time-varying accounting of the individual member countries of a currency union such as the EMU would indeed be more welfare enhancing that the targeting of the simple average inflation in the monetary union as long as not only of the national labor markets, as it was the case here, but also of macroeconomic characteristics in the member economies significantly differ from each other. Indeed, if the main goal of the MUCB is to stabilize (minimize) price inflation at the monetary union level, an exclusive focussing on the developments of the most flexible country (where inflation reacts more strongly to shocks) would be the optimal strategy to follow in the limit. However, whether the exclusive focussing on price inflation (and not on employment) at the monetary union level is the strategy which would indeed maximize welfare is still a question to be answered.

Appendix A

The Baseline Impulse-Response Functions under Optimal Monetary Policy

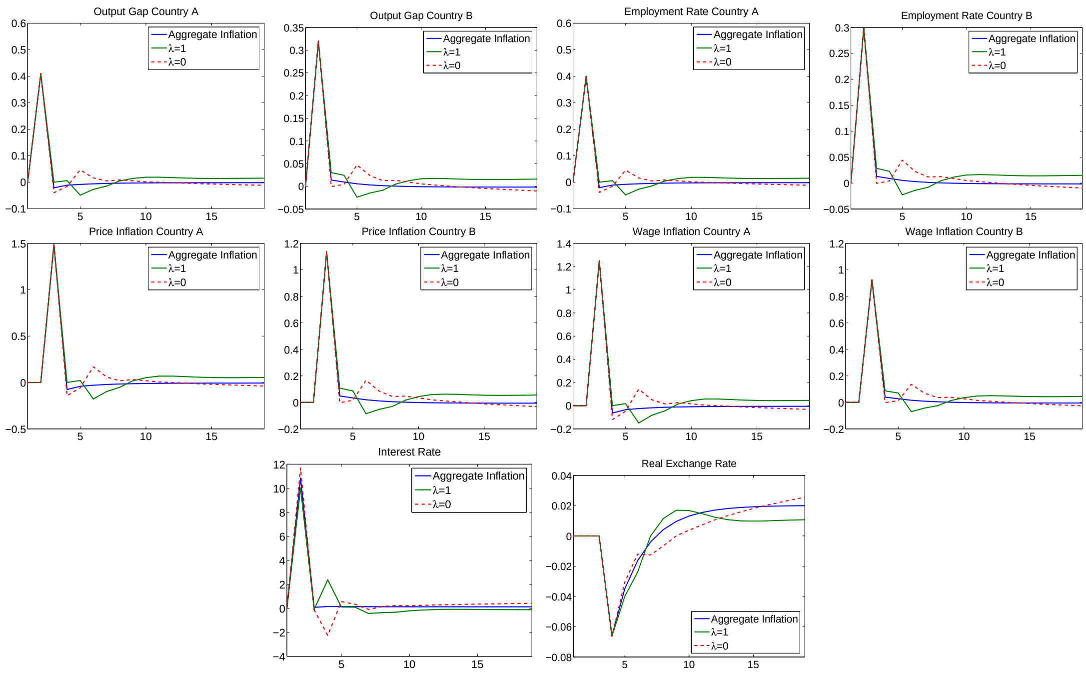


Fig. 4.7: Individual Inflation and Output Responses under Individual Inflation Targeting (Deviations from Responses under Union-Wide Optimal Monetary Policy)

Part II

Gradual Wage-Price Adjustments and Exchange Rate Fluctuations in Open Economies

5. Heterogenous Expectations, FX Fluctuations and Macroeconomic Stability

5.1 Introduction

During the last decade and especially after the prominent contribution by Obstfeld and Rogoff (1995), an important paradigm change concerning the theoretical modeling approach of open-economy issues has taken place. After the long-lasting predominance of Mundell-Fleming-Dornbusch type of models in the academic as well as in the more policy-oriented literature, the so-called "New Open Economy Macroeconomics" approach has become the workhorse for open-economy issues in recent years.

As in their closed-economy DSGE counterparts, such as the ones discussed in Blanchard and Kiyotaki (1987) and Erceg et al. (2000), a central feature in these type of models is the assumption of rational expectations. However, even though theoretically appealing, the notion of fully rational agents is still quite controversial in the academic literature, and especially in the literature on nominal exchange rate dynamics. As pointed out e.g. by De Grauwe and Grimaldi (2005), efficient markets rational expectations models are unable to match empirical data on foreign exchange (hereafter FX) rate fluctuations as well as the occurrence of speculative bubbles, herding behavior and runs. "Non-rational" models, that is models which feature economic agents with heterogenous beliefs, attitudes or trading schemes, seem much more successful in this task. Such models, however, often constrain themselves on the analysis of the FX markets and do not analyze the effects of such non-rational behavior by FX market participants for the dynamics stability at the macroeconomic level.

In this chapter an attempt is made to fill in this gap by setting up a two-country semi-structural macroeconomic model with a foreign exchange market consisting of two types of traders with different beliefs concerning the future development of the nominal exchange rate: fundamentalists and chartists. As the model is formulated, it reacts to disequilibrium situations in both goods and labor markets in a sluggish manner primarily due to the gradual adjustment of nominal wages and prices to such situations. This is the first logical step for the understanding of real effects of monetary and fiscal policy in economies which are highly interrelated with each other through a variety of markets and channels, when the general equilibrium requirement is abandoned and instead the view is accepted that markets rather adjust to disequilibrium situations in a gradual manner.

To do so the theoretical disequilibrium model of AS-AD growth investigated in Chen, Chiarella, Flaschel and Semmler (2006) and Proaño, Flaschel, Ernst and Semmler (2006) is reformulated for the case of two large open economies, first each in isolation and then in their interaction as two subsystems within a large closed dynamical system. The proposed model structure is similar in spirit to the two-country KMG model considered in Asada, Chiarella, Flaschel and Franke (2006), but is appropriately simplified in order to have a framework more suitable for empirical estimation and also for the study of the role of contemporary interest rate policy rules.

The remainder of the chapter is organized as following: In section 5.2 the theoretical two-country semi-structural framework for the case of an open economy is described. Section 5.3 integrates two open economies and discusses in more detail the linking channels between both economies, as well as the dynamics of the nominal exchange rate (the financial link) and the steady state conditions. In that section the model is also estimated and the resulting dynamic adjustments of the variables from the calibrated model are compared with some stylized facts from previous VAR studies on open economies. In section 5.4 the consequences of wage and price flexibility, of monetary policy as well as of the structure in the foreign exchange markets for the stability of the dynamical system are investigated by means of eigen-value analysis. Section 5.5 draws some concluding remarks from this chapter.

5.2 The Baseline Open-Economy Framework

In this section the closed economy, semi-structural macroeconomic model discussed in Chen, Chiarella, Flaschel and Semmler (2006) is extended to a macroeconomic two-country framework through the incorporation of trade, price and financial links between two similar economies with imperfectly flexible nominal wages and prices. Hereby it is assumed that both economies have the same macroeconomic structure and are additionally conducted with the same type of monetary policy. Therefore only the structure of the domestic economy will be discussed in this section, denoting with the superscript f foreign economy variables and assuming equivalent formulations for the foreign economy (with the effect of the log real exchange rate $\eta = s + \ln(p^f) - \ln(p)$ adequately adjusted).

5.2.1 The Goods and Labor Markets

Concerning the real part of the economy, a semi-structural approach is pursued assuming that the dynamics of output and employment can be summarized by the following laws of motion:

$$\hat{u} = -\alpha_{uu}(u - u_o) - \alpha_{ur}(i - \hat{p} - (i_o - \pi_o)) - \alpha_{uv}(v - v_o) + \alpha_{u\eta}\eta + \alpha_{uu^f}\hat{u}^f \quad (5.1)$$

$$\hat{e} = \alpha_{e\hat{u}}\hat{u} - \alpha_{ev}(v - v_o) \quad (5.2)$$

The first law of motion is of the type of a dynamic backward-looking open economy IS-equation, here represented by the growth rate of the capacity utilization rate of firms. Concerning the closed economy dimension, it has three important domestic characteristics: (i) it reflects the dependence of output changes on aggregate income and thus on the rate of capacity utilization by assuming a negative, i.e., stable dynamic multiplier relationship in this respect; (ii) it shows the joint dependence of consumption and investment on the domestic income distribution, which in the aggregate in principle allows for positive or negative signs before the parameter α_{uv}, depending on whether consumption, investment or the next exports are more responsive to relative real wage and wage share changes;[1] and (iii) it incorporates the negative influence of the real rate of interest on the evolution of economic activity. Additionally, in contrast to the closed economy model discussed investigated in Proaño, Flaschel, Ernst and Semmler (2006) (and also in Chapter 2 of this dissertation), we incorporate (iv) the positive effect of foreign goods demand (proxied by the *growth rate* of capacity utilization in the foreign economy) and (v) the positive influence of the deviation of the log real exchange rate $\eta = s + \ln(p^f) - \ln(p)$ (s being the log nominal exchange rate, which law of motion will be defined below) from its PPP consistent steady state level $\eta_o = 0$.

[1] We will, however, not engage into this debate here but rather adopt the most traditional view according to which $\partial\hat{u}/\partial v$ is unambiguously negative.

In the second law of motion, which describes the growth rate of the rate of employment, we assume that the employment policy of firms follows – in the form of a generalized Okun's Law – the growth rate of capacity utilization (with a weight $\alpha_{e\hat{u}}$).[2] Moreover, we additionally assume that an increasing wage share has a negative influence on the employment policy of firms. Employment is thus in particular assumed to adjust to the level of current activity since this dependence can be shown to be equivalent to the use of a term $(u/\bar{u})^{\alpha_{e\hat{u}}}$ when integrated, i.e., the form of Okun's law in which this law was originally specified by Okun (1970) himself.

5.2.2 The Wage-Price Dynamics

As for example Barro (1994) observes, perhaps the most important feature that theoretical Keynesian models should comprise is the existence of imperfectly flexible wages as well as prices. This is a common characteristic between the approach pursued here and advanced New Keynesian models such as Erceg et al. (2000) and Woodford (2003). However, even though the resulting structural wage and price Phillips Curves equations of our approach resemble to a significant extent those included in those theoretical models, their theoretical foundations are completely different. Despite of assuming monopolistic power in the price and wage (!) setting of forward-looking, purely rational firms and households under a Calvo (1983) pricing scheme,[3] our wage and price inflation adjustment equations are based on the more descriptive structural approach proposed by Chiarella and Flaschel (2000) and Chiarella et al. (2005). As previously pointed out, this alternative framework of aggregate demand fluctuations, which allows for under- (or over-)utilized labor *as well as* capital, is based on gradual adjustments to disequilibrium situations of all real variables of the economy. By allowing for disequilibria in both goods and labor markets, the dynamics of wages and prices can be discussed separately from each other in their structural forms, assuming that both react to their own measure of demand pressure, namely $e - e_o$ and $u - u_o$, in the market for

[2] Despite of being largely criticized due to its "lack of microfoundations", in a large number of microfounded, "rational expectations" models such as Taylor(1994), Okun's law is used to link production with employment.

[3] Recently, the overly unrealistic assumption in DSGE models as Erceg et al. (2000) of wages set by the households in a monopolistic manner has been replaced through more realistic wage setting schemes based on job search wage bargaining considerations by Trigari (2004) and Gertler and Trigari (2006).

labor and for goods, respectively.[4] Hereby e represents the rate of employment on the labor market and by e_o the NAIRU-equivalent level of this rate, and similarly by u the rate of capacity utilization of the capital stock and by u_o the normal rate of capacity utilization of firms are denoted.

As in the previous chapters, the expectations in both wage and price Phillips curve are modeled in a hybrid way, with crossover myopic perfect foresight (model-consistent) expectations with respect to short-run wage and domestic price inflation on the one hand and an adaptive updating inflation climate expression (symbolized by π_c) concerning the evolution of the CPI inflation ($\hat{p}_c$), on the other hand. Note that though the specification our model features may not be rational, it nevertheless has model consistent expectations concerning the evolution of the wage and price inflation and also incorporates a similar degree of inertia obtained in New Keynesian models only through also ad-hoc "rules-of-thumb" or price indexation assumptions.[5]

More specifically, concerning the wage Phillips curve it is assumed that the short-run price level considered by workers in their wage negotiations is set by the producer, so that producer price inflation gives the rate of inflation that is perfectly foreseen by workers as their short-run cost-push term. Additionally, in order to incorporate the role of import price inflation in the dynamics of the economy, we assume that the measure that is taken by workers to judge the medium-run evolution of prices in their respective economies is the Consumer Price Index, defined as

$$p_c = p^{\xi}(Sp^f)^{1-\xi},$$

the geometric average of domestic and import prices – with p^f being foreign price level and S the nominal exchange rate.

Consequently, the CPI inflation $\hat{p}_c$ includes both domestic inflation (with a specific weight ξ) and imported goods price inflation (with weight $1-\xi$), so that

$$\hat{p}_c = \xi\hat{p} + (1-\xi)(\dot{s} + \hat{p}^f), \tag{5.3}$$

with $s = \ln(S)$. Because of the uncertainty linked with nominal exchange rate movements, we assume for both workers and firms' decision taking processes, that CPI

[4] As pointed out by Sims (1987), such strategy allows to circumvent the identification problem which arises when both wage and price inflation equations have the same explanatory variables.

[5] See e.g. Galí and Gertler (1999) and Galí et al. (2001).

inflation is updated in an adaptive manner according to[6]

$$\dot{\pi}_c = \beta_{\pi_c}(\hat{p}_c - \pi_c) = \beta_{\pi_c}\xi(\hat{p} - \pi_c) + \beta_{\pi_c}(1 - \xi)(\hat{p}^f + \dot{s} - \pi_c) \tag{5.4}$$

We thereby arrive at the following two Phillips Curves for wage and price inflation, which in this core version of Keynesian AS-AD dynamics are – from a qualitative perspective – formulated in a fairly symmetric way.

The structural form of the wage-price dynamics is:

$$\hat{w} = \beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o) + \kappa_{wp}\hat{p} + (1 - \kappa_{wp})\pi_c + \kappa_{wz}\hat{z}, \tag{5.5}$$

$$\hat{p} = \beta_{pu}(u - u_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\hat{w} - \hat{z}) + (1 - \kappa_{pw})\pi_c, \tag{5.6}$$

where $\hat{z}$ denotes the growth rate of labor productivity (which we assume here just to be equal to $g_z = \hat{z} =$ const. (g_z denoting the trend labor productivity growth).

Note that as the wage-price mechanisms are formulated, the development of the CPI inflation does not matter for the evolution of the domestic wage share $v = (w/p)/z$, measured in terms of producer prices, the law of motion of which is given by (with $\kappa = 1/(1 - \kappa_{wp}\kappa_{pw})$):

$$\hat{v} = \kappa\left[(1 - \kappa_{pw})f_w(e, v) - (1 - \kappa_{wp})f_p(u, v) + (\kappa_{wz} - 1)(1 - \kappa_{pw})g_z\right]. \tag{5.7}$$

with

$$f_w(e, v) = \beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o) \quad \text{and}$$
$$f_p(y, v) = \beta_{pu}(u - u_o) + \beta_{uv}\ln(v/v_o)$$

which follows easily from the following obviously equivalent representation of the above two Phillips Curves:

$$\hat{w} - \pi_c = \beta_{we}(e - e_o) - \beta_{wv}\ln(v/v_o) + \kappa_{wp}(\hat{p} - \pi_c),$$
$$\hat{p} - \pi_c = \beta_{pu}(u - u_o) + \beta_{pv}\ln(v/v_o)) + \kappa_{pw}(\hat{w} - \pi_c)$$

by solving for the variables $\hat{w} - \pi_c$ and $\hat{p} - \pi_c$. It also implies the following two across-

[6] In the empirical applications of this adaptive revision of the CPI inflation we will simply use a moving average of the CPI inflation with linearly declining weights.

markets or *reduced form Phillips Curves*:

$$
\begin{aligned}
\hat{w} &= \kappa\,[\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o) + \kappa_{wp}(\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o)) \\
&\quad +(\kappa_{wz} - \kappa_{wp}\kappa_{pw})g_z] + \pi^c, \\
\hat{p} &= \kappa\,[\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o)) \\
&\quad +\kappa_{pw}(\kappa_{wz}-1)g_z] + \pi^c,
\end{aligned}
$$

which represent a considerable generalization of the conventional view of a single-market price PC with only one measure of demand pressure, that is the one in the labor market, as used in the majority of New Keynesian models.

Eq.(5.7) shows the ambiguity of the stabilizing role of the real wage channel, already discussed by Rose (1967) which arises – despite the incorporation of specific measures of demand and cost pressure on both the labor and the goods markets – if the dynamics of the employment rate and the workforce utilization are linked to the fluctuations of the firms' capacity utilization rate via Okun's law. As already discussed in various places throughout this dissertation, a real wage increase taken by itself can act in a stabilizing or destabilizing manner. Its final effect will depend among others on whether the dynamic of the capacity utilization rate depends positively or negatively on the real wage (i.e. on whether consumption reacts more strongly to real wage changes than investment and, in an open economy, net exports, or viceversa) *and* whether price flexibility is greater than nominal wage flexibility with respect to their own demand pressure measures.

5.2.3 Monetary Policy

As standard in modern macroeconomic models, we assume that money supply accommodates the interest rate policy pursued by the central bank and thus does not feedback into the core laws of motion of the model. As interest rate policy we assume a classical Taylor rule:

$$i_{\mathrm{T}} = i_o + \phi_\pi(\hat{p} - \pi_o) + \phi_y(u - u_o). \tag{5.8}$$

The target rate of the central bank i_{T} is thus assumed to depend on the steady state real rate of interest – augmented by actual inflation back to a nominal rate –, on the inflation gap and on the capacity utilization gap (as a measure of the output gap). We assume furthermore that the monetary authorities, when pursuing this target rate, do not react automatically but rather adjust to it in a smooth manner according to

$$\dot{i} = \alpha_{ii}(i_{\mathrm{T}} - i), \tag{5.9}$$

with α_{ii} determining the adjustment speed of the nominal interest rate.[7] Inserting i_{T} in and rearranging terms we obtain from this expression the following dynamic law of motion for the nominal interest rate

$$\dot{i} = -\gamma_{ii}(i - i_o) + \gamma_{ip}(\hat{p} - \pi_o) + \gamma_{iu}(u - u_o) \tag{5.10}$$

where we have $\gamma_{ii} = \alpha_{ii}, \gamma_{ip} = \alpha_{ii}\phi_\pi$, i.e., $\phi_\pi = \gamma_{ip}/\alpha_{ii}$ and $\gamma_{iu} = \alpha_{ii}\phi_y$.

5.2.4 The Real Exchange Rate Dynamics

As stated before, despite of the empirical inability of rational expectations models to explain the dynamics of the nominal exchange rate, the majority of theoretical macroeconomic frameworks (and especially in the nowadays quite popular DSGE models) still assume the rational expectations and a rational behavior of economic agents concerning the dynamics of the nominal exchange rate. A common procedure in these types of models is to assume that the dynamics of the nominal exchange rate are driven by the validity of the purchasing power parity (PPP) postulate, see e.g. Obstfeld and Rogoff (1995). Through a log-linearization around the general equilibrium "rational expectations" steady state of the system, the – correctly – expected depreciation rate of the nominal exchange rate between two economies is simply determined by

$$E_t[s_{t+1} - s_t] = \pi_t - \pi_t^f,$$

with s_t denoting the log of the nominal exchange rate and π_t and π_t^f the domestic and foreign price inflation rates, respectively. Under the assumption that the price inflation rate is determined by the difference between money- and consumption growth differentials, the actual nominal exchange rate can be expressed (applying the no-bubbles condition) as (see Walsh (2003b, p.277))

$$s_t = \frac{1}{1+\delta}\sum_{i=0}^{\infty}\left(\frac{1}{1+\delta}\right)^i [(m_{t+i} - m^*_{t+i}) - (c_{t+i} - c^*_{t+i})]$$

[7] In the academic literature there is an ongoing and still unsolved debate about whether there is an interest smoothing parameter in the monetary policy reaction rule of the central banks or whether the observed high autocorrelation in the nominal interest rate is simply the result of highly correlated shocks or only slowly available information, see e.g. Rudebusch (2002) and Rudebusch (2006) for a throughout discussion.

with δ as the intertemporal discount rate; m and m^* as the money supplies; and c and c^* as the consumption levels in the domestic and foreign economies. Thus, in the New Keynesian framework, the actual nominal exchange rate between two countries depends on the current and future paths of the nominal money supply- and consumption differentials between both economies.

Though straightforward in a theoretical rational expectations general equilibrium, this solution implies nevertheless the existence of (solely) purely rationally handling agents in the financial markets, an assumption that has been proven to be unable to explain major stylized facts of the nominal exchange rate dynamics. As shown for example in Ehrmann and Fratzscher (2005), the volatility of fundamentals (modeled in that study through an index of interest rate and output growth differentials and current account deficits) is by far not as large as the dynamics of the corresponding nominal exchange rates.

Due to the empirical failure of rational expectations models, a large literature based on the assumption of heterogenous expectations or beliefs among the traders in the foreign exchange market has arisen in the last decade. The inclusion of such heterogeneity, and therefore of a somewhat "nonrational" behavior by the economic agents has proven quite valuable in providing insights and explanations concerning some of the "puzzles" which arise when "rationality" is assumed.[8]

In the most basic heterogenous expectations framework, see e.g. Frankel and Froot (1990), two basic types of traders with different belief patterns (or expectations) concerning the future behavior of the nominal exchange rate are modeled: the fundamentalists and the chartists. The fundamentalists typically believe that the nominal exchange rate is driven by macroeconomic fundamentals such as interest rate differentials, different developments of production and employment and/or the validity of the PPP postulate and consequently trade conforming to this belief. In contrast, the chartists are assumed to follow the market tendencies, acting thus in principle in a destabilizing manner. The dynamics and stability of the resulting nominal exchange rate, therefore, depend on the relative strength and proportion of these two groups in the foreign exchange market.

[8] See De Grauwe and Grimaldi (2006, ch.1) for an extensive discussion of the advantages of the heterogenous agents-approach with respect to the rational-expectations approach in the explanation of empirical financial market data.

In more advanced theoretical frameworks about heterogenous beliefs a wide variety of extensions concerning the endogenous determination of the trader groups composition can be found: in Kirman (1993) for example the determination of the two groups is determined by a purely stochastic factor; in Lux (1995) the "contagion" effect, that is, the change in the trading strategy, depends on the overall "mood" of the market and on the observed realized returns. De Grauwe and Grimaldi (2005), in a similar manner, assume the *group change* probability as a function of the relative probability of the forecasting rules of the two groups and the *risk* associated with their use.[9]

However, in the actual theoretical framework, these possible model extensions are left for future research, assuming for simplicity that the composition of the two groups of traders in the FX markets, the chartists and the fundamentalists, is given. The fundamentalists will primarily orient their nominal exchange rate expectations towards levels which would be consistent with the equilibrium real exchange rate. In contrast, the chartists will act in a rather destabilizing manner, paying attention solely to the past patterns of the nominal exchange rate.

Using the notation of Manzan and Westerhoff (2007), we assume that the log of the nominal exchange expected by the fundamentalists is determined by

$$E_t^f(s_{t+1}) = s_t + \beta_s^f(f_t - s_t) \tag{5.11}$$

where f_t represents the value of the macroeconomic fundamentals at time t. By rearranging this equation we obtain for the nominal exchange depreciation rate expected by the fundamentalists

$$E_t^f(s_{t+1} - s_t) = \beta_s^f(f_t - s_t). \tag{5.12}$$

Now, as usually done in the literature, we assume that the macroeconomic variables which serve as reference for the fundamentalists is the PPP postulate, that is

$$f_t = \ln(p_t) - \ln(p_t^f) \tag{5.13}$$

with p_t and p_t^f denoting the price levels in the domestic and foreign economies, respectively. Inserting this expression in eq. (5.12) delivers

$$\begin{aligned} E_t^f(s_{t+1} - s_t) &= \beta_s^f(\ln(p_t) - \ln(p_t^f) - s_t) && (5.14)\\ &= \beta_s^f(-\eta_t) && (5.15) \end{aligned}$$

[9] See Samanidou, Zschischang, Stauffer and Lux (2007) for a comprehensive survey article on this strain of research.

with η_t as the log of the real exchange rate at time t.

Concerning the second group of traders, the chartists, I assume that their expected nominal exchange rate depreciation for $t+1$ is simply determined by

$$E_t^c(s_{t+1} - s_t) = \beta_s^c(s_t - s_{t-1}). \tag{5.16}$$

Assuming that the factual nominal exchange rate depreciation rate is determined by

$$s_{t+1} - s_t = i^f - i + \lambda\beta_s^f(-\eta_t) + (1-\lambda)\beta_s^c(s_t - s_{t-1}) \tag{5.17}$$

where the relative influence of both groups is represented by the factor λ, and taking the continuous time aproximation for $s_{t+1} - s_t$, we obtain

$$\dot{s} = i^f - i - \lambda\beta_s^f\eta + (1-\lambda)\beta_s^c\dot{s}_t, \tag{5.18}$$

which, after some manipulation, delivers

$$\dot{s} = \frac{i^f - i - \lambda\beta_s^f\eta}{1-(1-\lambda)\beta_s^c}. \tag{5.19}$$

Eq.(5.19) clearly shows that for

$$\beta_s^c > \frac{1}{1-\lambda}$$

we have explosive nominal exchange rate dynamics, while otherwise they are intrinsically stable as a reverting process towards the steady state, PPP consistent nominal exchange rate level.

This law of motion, together with the price inflation adjustment equations for the domestic and the foreign economies deliver

$$\begin{aligned}\dot{\eta} &= \dot{s} + \hat{p}^f - \hat{p} \\ &= \frac{i^f - i - \lambda\beta_s^f\eta}{1-(1-\lambda)\beta_s^c} + \hat{p}^f - \hat{p}.\end{aligned} \tag{5.20}$$

Note that in this formulation the real exchange rate dynamics are determined by a wide variety of macroeconomic factors, as well as by the composition of fundamentalists and traders in the foreign exchange markets. Note that through the effect of η on u, the real exchange rate acts intrinsically in a stabilizing manner. This nevertheless might, at the end, not hold if the influence of the chartists in the foreign exchange markets is predominant.

Altogether the model of this section consists of the following six laws of motion (with the derived reduced form expressions as far as the wage-price spiral is concerned):[10]

The One-Country Sub-Module

$$\hat{u} \overset{Dynamic\ IS}{=} -\alpha_{uu}(u-u_o) - \alpha_{ur}(i - \hat{p} - (i_o - \pi_o))$$
$$-\alpha_{uv}(v - v_o) + \alpha_{u\eta}\eta + \alpha_{uu^f}\hat{u}^f \quad (5.21)$$
$$\hat{e} \overset{Okun's\ Law}{=} \alpha_{e\hat{u}}\hat{u} - \alpha_{ev}(v - v_o) \quad (5.22)$$
$$\hat{v} \overset{Wage\ Share}{=} \kappa[(1-\kappa_{pw})(\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o))$$
$$-(1-\kappa_{wp})(\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o)) + \delta g_z], \quad (5.23)$$
$$\text{with } \delta = (\kappa_{wz} - 1)(1-\kappa_{pw})$$
$$\dot{\pi}_c \overset{CPIClimate}{=} \beta_{\pi_c}(\hat{p}_c - \pi_c), \quad \hat{p}_c = \gamma\hat{p} + (1-\gamma)(\dot{s} + \hat{p}^f) \quad (5.24)$$
$$\dot{i} \overset{Taylor\ Rule}{=} -\gamma_{ii}(i - i_o) + \gamma_{ip}(\hat{p} - \pi_o) + \gamma_{iu}(u - u_o) \quad (5.25)$$
$$\dot{\eta} \overset{Real\ Exchange}{=} \frac{i^f - i - \lambda\beta_s^f\eta}{1-(1-\lambda)\beta_s^c} + \hat{p}^f - \hat{p}. \quad (5.26)$$

The above equations represent, in comparison to the baseline model of New Keynesian macroeconomics, the IS goods market dynamics, here augmented by Okun's Law as link between the goods and the labor market, the Taylor Rule, a law of motion for the wage share v that makes use of the same explaining variables as in the New Keynesian model with both staggered prices and wages,[11] and the law of motion that describes the updating of the inflationary climate expression. In addition, we have to make use of the reduced form expression for the price inflation rate or the price PC,

$$\hat{p} = \kappa[\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\beta_{we}(e-e_o) - \beta_{wv}\ln(v/v_o))] + \pi_c \quad (5.27)$$

which has to be inserted into the above laws of motion in various places in order to get an autonomous nonlinear system of differential equations in the state variables: capacity utilization u, the rate of employment e, the nominal rate of interest i, the wage share v, and the inflationary climate expression π_c. Eq.(5.27) could be considered as a sixth law of motion of the considered dynamics which however – when added –

[10] As the model is formulated we have no real anchor for the steady state rate of interest and thus have to assume here that it is the monetary authority that enforces a certain steady state values for the nominal rate of interest.

[11] but with inflation rates $\hat{p}, \hat{w}$ in place of their time rates of change and with no accompanying sign reversal concerning the influence of output and wage gaps.

leads a system determinant which is zero, allowing therefore for zero-root hysteresis for certain variables of the model. The laws of motion have been written in an order that first presents the dynamic equations also present in the baseline New Keynesian model of inflation dynamics, and then our formulation of the dynamics of income distribution and of the inflationary climate in which the economy is operating.

In sum, therefore, our dynamic AS-AD growth model exhibits a variety of features that are much more in line with a Keynesian understanding of the characteristics of the trade cycle than is the case for the conventional modeling of AS-AD growth dynamics or its radical reformulation by the New Keynesians.

5.2.5 Local Stability Analysis: The Small-Open Economy Case

We start our analysis of the stability properties of the system with the small-open economy case, assuming that the foreign economy is and remains at its steady state level ($u^f = u^f_o$, $e^f = e^f_o$, $v^f = v^f_o$). Since we assume the same structure for both economies, the local stability of one subsystem would imply the same for the other subsystem, assuming that similar parameter dimensions. Due to its specific formulation, the steady state of the 5D subdynamics can be supplied exogenously. It exhibits five gaps, to be closed in the steady state and has five laws of motion, which when set equal to zero, exactly imply this result.

As discussed in Chen, Chiarella, Flaschel and Semmler (2006), the steady state of the dynamics of the closed-economy version of this model is asymptotically stable under certain sluggishness conditions that are reasonable from a Keynesian perspective, loses its asymptotic stability cyclically (by way of so-called Hopf-bifurcations) if the system becomes too flexible, and becomes sooner or later globally unstable if (generally speaking) adjustment speeds become too high. If the model is subject to explosive forces, it requires extrinsic nonlinearities in economic behavior – like downward money wage rigidity – to manifest themselves at least far off the steady state in order to bound the dynamics to an economically meaningful domain in the considered 5D state space. Chen, Chiarella, Flaschel and Hung (2006) provide a variety of numerical studies for such an approach with extrinsically motivated nonlinearities through detailed numerical investigation.

In order to investigate the role of heterogenous expectations in the foreign exchange market and the main international transmission channels for the stability of the whole macroeconomic system analytically, the dimensions of our theoretical framework are reduced through the following simplifying assumptions:

- The monetary authorities do not pursue an interest rate smoothing strategy, so that $i = i_{\mathrm{T}}$ always holds. This is the case when $\alpha_{ii} \to \infty$.
- $\beta_{\pi_c} = 0$. In this case the inflationary climate is constant ($\pi_c = 0$ is assumed).
- We can replace e through $\alpha_{eu}u$ in the wage and price inflation adjustment equations without loss of generality.

Under the simplifying assumptions, the initial 5D dynamical system can be reduced to the following 3D subsystem

$$\begin{aligned}
\hat{u} &= -\alpha_{uu}(u-u_o) - \alpha_{ur}((i_o-\pi_o) - \hat{p} + \phi_\pi(\hat{p}-\pi_o) + \phi_y(u-u_o)) \\
&\quad -\alpha_{uv}(v-v_o) + \alpha_{u\eta}\eta && (5.28)\\
\hat{v} &= \kappa[(1-\kappa_{pw})(\beta_{we}(\alpha_{eu}u - e_o) - \beta_{wv}\ln(v/v_o)) \\
&\quad -(1-\kappa_{wp})(\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o)) + \delta g_z], && (5.29)\\
\dot{\eta} &= \frac{i_o^f - (i_o + \phi_\pi(\hat{p}-\pi_o) + \phi_y(u-u_o)) - \lambda\beta_s^f\eta}{1-(1-\lambda)\beta_s^c} - \hat{p}. && (5.30)
\end{aligned}$$

with

$$\hat{p} = \kappa[\beta_{pu}(u-u_o) + \beta_{pv}\ln(v/v_o) + \kappa_{pw}(\beta_{we}(\alpha_{eu}u - u_o) - \beta_{wv}\ln(v/v_o))] \qquad (5.31)$$

to be inserted in several places.

The corresponding Jacobian of this reduced 3D subsystem

$$J_{3D} = \begin{bmatrix} J_{11} & J_{12} & J_{13} \\ J_{21} & J_{22} & J_{23} \\ J_{31} & J_{32} & J_{33} \end{bmatrix}.$$

with

$$J_{11} = \frac{\partial \hat{u}}{\partial u} = -\alpha_{uu} - \alpha_{ur}\left(\phi_y + \phi_\pi \kappa \left(\beta_{pu} + \kappa_{pw}\beta_{we}\alpha_{eu}\right)\right) < 0 \quad (5.32)$$

$$J_{12} = \frac{\partial \hat{u}}{\partial v} = -\alpha_{uv} - \phi_\pi \kappa \left(\frac{\beta_{pv} - \kappa_{pw}\beta_{wv}}{v_o}\right) < 0 \quad (5.33)$$

$$J_{13} = \frac{\partial \hat{u}}{\partial \eta} = \alpha_{u\eta} > 0 \quad (5.34)$$

$$J_{21} = \frac{\partial \hat{v}}{\partial u} = \kappa((1-\kappa_{pw})\beta_{we}\alpha_{eu} - (1-\kappa_{wp})\beta_{pu}) \quad (5.35)$$

$$J_{22} = \frac{\partial \hat{v}}{\partial v} = -\kappa\left(\frac{(1-\kappa_{pw})\beta_{wv} + (1-\kappa_{wp})\beta_{pv}}{v_o}\right) < 0 \quad (5.36)$$

$$J_{23} = \frac{\partial \hat{v}}{\partial \eta} = 0 \quad (5.37)$$

$$J_{31} = \frac{\partial \dot{\eta}}{\partial u} = \frac{\lambda \beta_f^s(\alpha_{ur} + \phi_\pi \kappa(\beta_{pu} + \kappa_{pw}\beta_{we}\alpha_{eu}))}{1 - \beta_c^s(1-\lambda)} \quad (5.38)$$

$$J_{32} = \frac{\partial \dot{\eta}}{\partial v} = \frac{\beta_f^s \phi_\pi \kappa \lambda \left(\frac{\beta_{pv} - \beta_{wv}\kappa_{pw}}{v_o}\right)}{1 - \beta_c^s(1-\lambda)} - \kappa\left(\frac{\beta_{pv} - \beta_{wv}\kappa_{pw}}{v_o}\right) \quad (5.39)$$

$$J_{33} = \frac{\partial \dot{\eta}}{\partial \eta} = -\frac{\beta_f^s \lambda}{1 - \beta_c^s(1-\lambda)} < 0 \quad (5.40)$$

has the following sign structure

$$J_{3D} = \begin{bmatrix} - & ? & + \\ ? & - & 0 \\ ? & ? & ? \end{bmatrix}.$$

According to the Routh-Hurwitz stability conditions for a 3D dynamical system, asymptotic local stability of a steady state is fulfilled when

$$a_i > 0, \quad i = 1, 2, 3 \quad \text{and} \quad a_1 a_2 - a_3 > 0,$$

where $a_1 = -\text{trace}(J)$, $a_2 = \sum_{k=1}^{3} J_k$ with

$$J_1 = \begin{vmatrix} J_{22} & J_{23} \\ J_{32} & J_{33} \end{vmatrix}, J_2 = \begin{vmatrix} J_{11} & J_{13} \\ J_{31} & J_{33} \end{vmatrix}, J_3 = \begin{vmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{vmatrix}.$$

and $a_3 = -\det(J)$.

Our reduced 3D dynamical system is stable around its interior steady state, if the following proposition is fulfilled:

Proposition 1:

Assume that the influence of the chartists in the foreign exchange market is not predominant, i.e., that (i) $\beta_c^s(1-\lambda) < 1$ *holds. Additionally, assume that (ii)* $(\lambda\beta_s^f\phi_\pi)/(1-\beta_c^s(1-\lambda) < 1$. *Furthermore, assume that (iii)* $\beta_{we}\alpha_{eu} > \beta_{pu}$*, that is, that wage inflation reacts more strongly to changes in capacity utilization than price inflation. And finally, assume that (iv)* κ_{pw} *is of a sufficiently small dimension, so that* $\partial\hat{u}/\partial v < 0$ *and* $\partial\dot{\eta}/\partial v < 0$ *hold.*

Then: The Routh-Hurwitz conditions are fulfilled and the unique steady state of the reduced 3D dynamical system is locally asymptotic stable.

Sketch of Proof:

As already state, as long as the influence of the chartists in the foreign exchange market is not predominant, the dynamics of the nominal exchange rate are asymptotically stable. In this case $\partial\dot{\eta}/\partial\eta < 0$, and the trace of J is unambiguously negative (and $a_1 > 0$ holds), since

$$\mathrm{tr}(J) = J_{11} + J_{22} + J_{33} < 0. \tag{5.41}$$

if condition (i) in Proposition 1 is fulfilled.

Condition (ii) ensures the partial derivative of $\dot{\eta}$ with respect to u to be negative and, together with condition (iv), that $\partial\dot{\eta}/\partial v < 0$. Condition (iii) ensures that $\partial\hat{v}/\partial u$. In this case, J_1, J_2 and J_3, the second-order minors of J are given by

$$\begin{aligned}
J_1 &= J_{22}\cdot J_{33} - J_{32}\cdot J_{23}\\
&= \frac{\beta_f^s\lambda\kappa\left(\beta_{wv}(1-\kappa_{pw}) + \beta_{pv}(1-\kappa_{wp})\right)}{v(1-\beta_c^s(1-\lambda))} > 0 && (5.42)\\
J_2 &= J_{11}\cdot J_{33} - J_{31}\cdot J_{13}\\
&= \frac{\lambda\beta_f^s\left[\alpha_{uu} + (\alpha_{ur}+\alpha_{u\eta})\left(\phi_y + \phi_\pi\kappa\left(\beta_{pu}+\kappa_{pw}\beta_{we}\alpha_{eu}\right)\right)\right]}{(1-\beta_c^s(1-\lambda))}\\
&\quad +\alpha_{u\eta}\kappa\left(\beta_{pu} + \alpha_{eu}\beta_{we}\kappa_{pw}\right) && (5.43)\\
J_3 &= J_{11}\cdot J_{22} - J_{21}\cdot J_{12}\\
&= \frac{\kappa}{v}\left[\alpha_{uv} + \alpha_{ur}\phi_\pi\kappa(\beta_{pv} - \beta_{wv}\kappa_{pw})\right]\left(\alpha_{eu}\beta_{we}(1-\kappa_{pw}) - \beta_{pu}(1-\kappa_{wp})\right)\\
&\quad +\frac{\kappa}{v}\left[\alpha_{uu} + \alpha_{ur}(\alpha_{ur} + \phi_\pi\kappa(\beta_{pu} + \alpha_{eu}\beta_{we}\kappa_{pw}))\right]\\
&\quad \cdot(\beta_{wv}(1-\kappa_{pw}) + \beta_{pv}(1-\kappa_{wp})). && (5.44)
\end{aligned}$$

If conditions (i)-(iv) hold, the sign structure of the Jacobian matrix is given by

$$J_{3D} = \begin{bmatrix} - & - & + \\ + & - & 0 \\ - & - & - \end{bmatrix}.$$

It can be easily confirmed that under such a sign structure, $a_2 = \sum_{k=1}^{3} J_k > 0$ and $a_3 = -\det(J) > 0$, as well as the critical condition $a_1 a_2 - a_3 > 0$ for local asymptotic stability of the steady state of the system hold under the assumed parameter dimensions.

Concerning the determinant of J, from the sign structure of the 3D Jacobian it can be easily seen that it is negative, so that $a_3 = -\det(J) > 0$.

Concerning the local asymptotic stability properties of the 6D subsystem, we can infer without an analytical proof that it will lose stability if a) the conditions (i)-(iv) in Proposition 1 are no longer fulfilled, b) the adjustment speed of the inflationary climate β_{π^c} approaches infinity or c) the nominal interest rate does not adjust sufficiently fast to the target rate pursued by the monetary authorities, that is, when the interest rate smoothing parameter α_{ii} is insufficiently low.

5.3 The Two-Country Framework: Estimation and Analysis

After having set up the basic structure of an open-economy framework of Keynesian nature, in this section we integrate two economies (and therefore, two small-open-economy dynamic models if considered separately) with similar characteristics (as the U.S. and the euro area) into a consistent two country framework.

Considering both economies as a single macroeconomic framework, the resulting 11D dynamical system comprises 11 dynamic variables with the gaps

$$u - u_o, \quad e - e_o, \quad v - v_o, \quad i - i_o, \quad \hat{p} - \pi_o, \quad \eta - \eta_o,$$

plus the five ones for the foreign economy that correspond to the first (domestic) five of the list shown above.

For the unique determination of the steady state position we set $\hat{u}, \hat{e}, \hat{v}, \dot{i}$ equal to zero (and of course have the same situation for the foreign economy). This holds only when all gaps are zero simultaneously, what additionally delivers (for $\eta = \eta_o = 0$) $\dot{s} = 0$.

Assuming a constant steady state log nominal exchange rate s, we obtain from the reduced form price Phillips curves

$$\begin{aligned}
\hat{p}_o &= \pi_{co} = \xi \pi_{co} + (1-\xi)\pi^f_{co} \\
\hat{p}^f_o &= \pi^f_{co} = \xi^f \pi^f_{co} + (1-\xi^f)\pi_{co} \Longleftrightarrow \\
\pi_c &= \pi^f_c.
\end{aligned}$$

By inserting again eq.(5.3) and its foreign economy counterpart, we obtain

$$\xi \hat{p}_o + (1-\xi)\hat{p}^f_o = \xi^f \hat{p}_o + (1-\xi^f)\hat{p}^f_o$$

which only holds true for $\hat{p} = \hat{p}^f$. At the steady state, thus, both countries share the same inflationary climate and equilibrium inflation rate, independently of the actual composition of the CPI index in both economies. Under this condition, the nominal exchange rate equation (5.19) delivers indeed a constant nominal exchange rate at the steady state, and therefore also a constant real exchange rate, since $\eta = \eta_o$.

The Two-Country Model

$$
\begin{aligned}
\hat{u} &= -\alpha_{uu}(u-u_o) - \alpha_{ur}(i-\hat{p}-(i_o-\pi_o)) - \alpha_{uv}(v-v_o) + \alpha_{u\eta}\eta + \alpha_{uu^f}\hat{u}^f \\
\hat{e} &= \alpha_{e\hat{u}}\hat{u} - \alpha_{ev}(v-v_o) \\
\hat{v} &= \kappa[(1-\kappa_{pw})f_w(e,v) - (1-\kappa_{wp})f_p(u,v) + \delta g_z], \\
\dot{\pi}_c &= \beta_{\pi_c}(\hat{p}_c-\pi_c), \quad \hat{p}_c = \xi\hat{p} + (1-\xi)(\dot{s}+\hat{p}^f) \\
\dot{i} &= -\gamma_{ii}(i-i_o) + \gamma_{ip}(\hat{p}-\pi_o) + \gamma_{iu}(u-u_o) \\
\dot{\eta} &= \frac{i^f - i - \lambda\beta_s^f\eta}{1-(1-\lambda)\beta_s^c} + \hat{p}^f - \hat{p} \\
\hat{u}^f &= -\alpha_{uu}(u^f-u_o) - \alpha_{ur}(i-\hat{p}-(i_o-\pi_o)) - \alpha_{uv}(v-v_o) + \alpha_{u\eta}\eta + \alpha_{uu^f}\hat{u}^f \\
\hat{e}^f &= \alpha_{e\hat{u}}\hat{u}^f - \alpha_{ev}(v^f-v_o) \\
\hat{v}^f &= \kappa[(1-\kappa_{pw})f_w(e^f,v^f) - (1-\kappa_{wp})f_p(u^f,v^f) + \delta g_z^f] \\
\dot{\pi}_c^f &= \beta_{\pi_c}(\hat{p}_c^f-\pi_c^f), \quad \hat{p}_c^f = \xi\hat{p}^f + (1-\xi)(-\dot{s}+\hat{p}) \\
\dot{i}^f &= -\gamma_{ii}(i^f-i_o) + \gamma_{ip}(\hat{p}^f-\pi_o) + \gamma_{iu}(u^f-u_o)
\end{aligned}
$$

The 11D dynamical system described above has the following Jacobian Matrix

$$
J = \begin{bmatrix}
J_{1,1} & J_{1,2} & J_{1,3} & J_{1,4} & J_{1,5} & J_{1,6} & J_{1,7} & 0 & J_{1,9} & 0 & 0 \\
J_{2,1} & J_{2,2} & J_{2,3} & J_{2,4} & J_{2,5} & J_{2,6} & J_{2,7} & 0 & J_{2,9} & 0 & 0 \\
J_{3,1} & J_{3,2} & J_{3,3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
J_{4,1} & J_{4,2} & J_{4,3} & J_{4,4} & J_{4,5} & 0 & 0 & 0 & 0 & 0 & 0 \\
J_{5,1} & J_{5,2} & J_{5,3} & 0 & J_{5,5} & J_{5,6} & J_{5,7} & J_{5,8} & J_{5,9} & 0 & J_{5,11} \\
J_{6,1} & J_{6,2} & J_{6,3} & J_{6,4} & J_{6,5} & J_{6,6} & J_{6,7} & J_{6,8} & J_{6,9} & J_{6,10} & J_{6,11} \\
J_{7,1} & 0 & J_{7,3} & 0 & 0 & J_{7,6} & J_{7,7} & J_{7,8} & J_{7,9} & J_{7,10} & J_{7,11} \\
J_{8,1} & 0 & J_{8,3} & 0 & 0 & J_{8,6} & J_{8,7} & J_{8,8} & J_{8,9} & J_{8,10} & J_{8,11} \\
0 & 0 & 0 & 0 & 0 & 0 & J_{9,7} & J_{9,8} & J_{9,9} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & J_{10,7} & J_{10,8} & J_{10,9} & J_{10,10} & J_{10,11} \\
J_{11,1} & J_{11,2} & J_{11,3} & 0 & J_{11,5} & J_{11,6} & J_{11,7} & J_{11,8} & J_{11,9} & 0 & J_{11,11}
\end{bmatrix}
$$

The structure of the model is summarized in Figure 5.1. This figure shows at its top the interaction of the foreign exchange market with the two economies and towards the bottom the interaction of both economies through their goods markets.

As this diagrammatic exposition of quantity and price trade channels linking the two

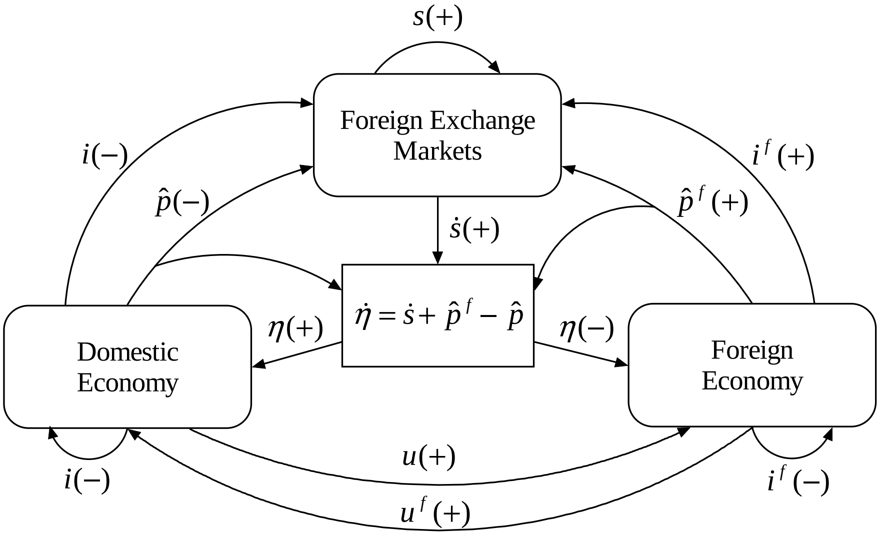


Fig. 5.1: The real and financial links of the two country model

economies shows, the macroeconomic interaction between them seems intrinsically stable with the sole obvious source of instability (or even chaos) is from the foreign exchange markets. Indeed, in the absence of predominant unstable nominal exchange rate dynamics (which would occur if the FX market would be governed by the chartists), the dynamics of the two-country framework seem to be of a self-regulating nature through the interaction of quantity and price trade linkages. This, however, is not necessarily the case: So for example leads an exogenous increase in the foreign demand ($u^f \uparrow$) on the one hand to an increase of price and (through the related increase in foreign employment) wage inflation abroad, which in turn leads to a loss of competitiveness ($\eta \uparrow$) and to a cooling down of the foreign economy. On the other hand, an increase in u^f leads (through the "locomotive" effect) to an increase in the domestic level of economic activity, to an increase in domestic wage and price inflation and subsequently to a fall of η, which, in turn, is likely to boost furthermore the economic activity abroad. The net effect of these two opposite effects – and therefore the stability of the system – depends thus to an important degree on the degree of wage and price flexibility in both economies. However, since a throughout analytical calculation of the Routh-Hurwitz local stability conditions for a 11D system would be an extremely complicated and, more importantly, nontransparent task, the stability of the 11D system concerning variations of the structural parameters will be investigated in a numerical manner by means of eigen-value analysis in section 5.4.

5.3.1 Stylized Facts of Monetary Policy

Since the seminal contribution by Sims (1980), vector autoregressive (VAR) models have become a standard tool for the study of the transmission of monetary policy in industrialized economics.

In the majority of existing studies the VAR analysis is performed under the implicit assumption that the studied economies have "closed" or "small open economy" characteristics due to the possible collinearity and identification problems which can arise if a large number of variables is incorporated in the VAR model. From the econometric perspective, this means that foreign variables, if included in the estimated VAR model, are assumed to be exogenously determined. Indeed, most of the prominent studies on monetary policy transmission such as Bernanke and Blinder (1992), Bernanke and Mihov (1998) and Christiano, Eichenbaum and Evans (1999) for the U.S. economy, Kim (1999) for the G-7 countries and Peersman and Smets (2003) for the euro area are based on a "small open economy" assumption.

Under such a specification the main stylized facts concerning the monetary policy transmission mechanism can be summarized as follows:

- An unexpected increase in the U.S. nominal interest rate (a contractionary monetary policy shock) leads to a slowdown of economy activity, which reaches its peak after five quarters, approximately.
- The response of employment resembles the output reaction, though in a somewhat delayed manner.
- Price inflation initially increases (the price puzzle discussed, e.g., by Sims (1992)), but, after some quarters, an unambiguously negative effect can be observed.
- The domestic currency appreciates due to, among other things, the interest rate parity.

Concerning the international transmission of monetary policy, Kim (2001) discusses two main findings from his VAR estimations: First, that monetary policy in the non-US G-6 countries follows U.S. monetary policy shocks (a result which corroborates the findings of Eichenbaum and Evans (1995) concerning the dynamic behavior of spread between foreign and U.S. interest rates after such types of shocks). Second, that U.S. monetary expansions have a positive spill-over effect on the remaining G-7 countries primarily due to the resulting reduction in the world interest interest. This result is also found by Bluedorn and Bowdler (2006) and Eickmeier (2007), the latter concerning the effect of U.S. monetary shocks on Germany.

The empirical evidence on the reaction of nominal exchange rates to monetary policy shocks is, on the contrary, not as undisputed. While Eichenbaum and Evans (1995, p.976) for example find that "the maximal effect of a contractionary monetary policy shock on U.S. exchange rates is not contemporaneous; instead the dollar continues to appreciate for a substantial period of time [a finding which] is inconsistent with simple rational expectations overshooting models of the sort considered by Dornbusch (1976)", Kim and Roubini (2000), Kalyvitis and Michaelides (2001) and Bluedorn and Bowdler (2006) find little evidence on such a behavior for the G-7 nominal exchange rates after the inclusion of alternative measures of monetary policy shocks as well as of relative output and prices in their specifications.

Next the strength of international transmission channels between the U.S. and the euro area, two large economies which are likely to indeed influence each other by a variety of macroeconomic channels are investigated by means of econometric methods.

5.3.2 Structural Estimation Results

The empirical data of the corresponding time series stem from the Federal Reserve Bank of St. Louis data set (see http:/www.stls.frb.org/fred) and the OECD database for the U.S. and the euro area, respectively. The data is quarterly, seasonally adjusted and concern the period from 1980:1 to 2004:4.

The logarithms of wages and prices are denoted $\ln(w_t)$ and $\ln(p_t)$, respectively. Their first differences (backwardly dated), i.e. the current rate of wage and price inflation, are denoted $\hat{w}_t$ and $\hat{p}_t$ as in the theoretical framework. The inflationary climate π_c of the theoretical part of this paper is approximated here in a very simple way, by a linearly declining moving average of price inflation rates with linearly decreasing weights over the past twelve quarters, denoted π_t^{12}.[12] Figure 5.2 shows the time series of both the

[12] We also estimated the structural model shown in Table 5.4 with other proxies for the inflationary climate which also covered the four, six and eighteen last quarters. These estimates could be rejected

Tab. 5.1: Data Set

Variable	Description of the original series
e	U.S. : Employment rate
	Euro area : Employment Rate (HP cyclical component, $\lambda = 640000$)
u	U.S. : Capacity utilization: Manufacturing, percent of capacity
	Euro area : Output Gap
w	U.S. : Nonfarm Business Sector: Compensation per hour, 1992=100
	Euro area : Business sector: Wage Rate Per Hour,
p	U.S. : Gross Domestic Product: Implicit Price Deflator, 1996=100
	Euro area : Gross Domestic Product: Implicit Price Deflator, 2000=100
z	U.S. : Nonfarm Business Sector; Output per hour of all persons, 1992=100
	Euro area : Labor Productivity of the business economy,
v	U.S. : Nonfarm Business Sector: Real compensation per output unit, 1992=100
	Euro area : Business Sector: Real compensation per output unit
	(HP cyclical component, $\lambda = 640000$)
i	U.S. : Federal Funds rate
	Euro Area : Short-term interest rate
s	EUR/USD Nominal exchange rate

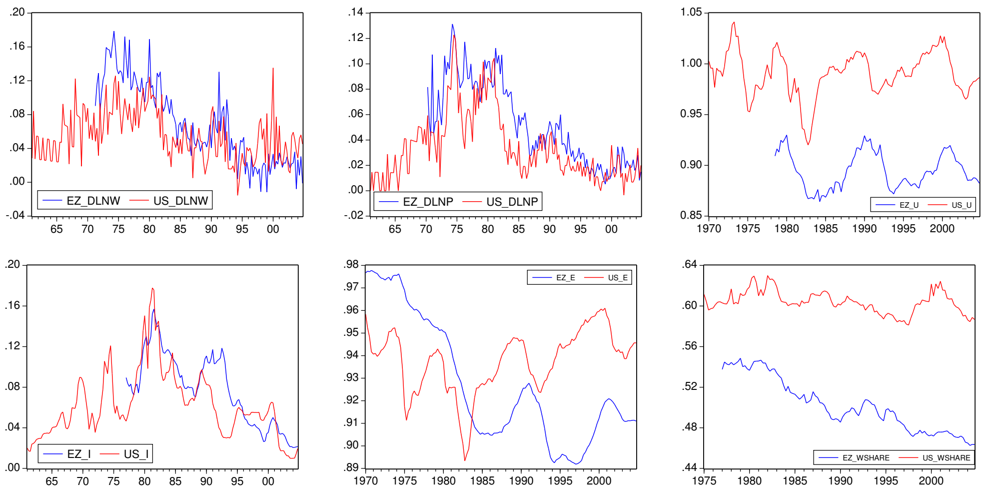


Fig. 5.2: U.S. and Euro Area Aggregate Time Series

U.S. and the Euro Area described in Table 5.1. As it can be observed there, the U.S. and the Euro Area have featured in the last two decades a remarkable similarity in their

even at the 10% significance level.

respective wage and price inflation developments, as well as – to a somewhat lesser extent – in the dynamics of the capacity utilization and the output gap, respectively.

This, however, does not hold for the dynamics of the employment rate and the wage share of both economies. As it can be observed in Figure 5.2, while the U.S. unemployment rate has fluctuated, roughly speaking, around a constant level over the last two decades, the European employment (unemployment) rate displayed a persistent downwards (upwards) trend over the same time period. This particular European development has been explained by Layard et al. (1991) and Ljungqvist and Sargent (1998) by an over-proportional increase in the number of long-term unemployed (i.e. workers with an unemployment duration over 12 months) with respect to short term unemployed (workers with an unemployment duration of less than 12 months) and the phenomenon of hysteresis especially in the first group. Because the long-term unemployed become less relevant in the determination of nominal wages (since primarily the short-term unemployed are taken into account), the potential downward pressure on wages resulting from the unemployment of the former diminishes, with the result of a higher NAIRU level, see Blanchard and Wolfers (2000). When long-term unemployment is high, the aggregate unemployment rate of an economy thus, "becomes a poor indicator of effective labor supply, and the macroeconomic adjustment mechanisms – such as downward pressure on wages and inflation when unemployment is high – will then not operate effectively" (OECD (2002, p.189)).

In order to take into account the lower influence of the long-term unemployed in the determination of wage and price inflation, we proceed as in Chapter 2 of this dissertation and use, for the euro area, the adjusted cyclical component of the unemployment rate as a proxy for the short-term unemployment, since time series data for long-term unemployment in the euro area are not available for the analyzed sample period.

In order to check the stationarity of the analyzed time series, Phillips-Perron unit root tests were carried out in order to account for residual autocorrelation (as done by the standard ADF Tests), and also for possible residual heteroskedasticity. The Phillips-Perron test specifications and results are shown in Table 5.2.

The applied unit root tests reject the hypothesis of a unit root for all series with exception of the euro area nominal interest rate i. Although the test cannot reject the null of a unit root, there is no reason to expect this time series to possess a unit root. We reasonably expect these rates to be constrained to certain limited ranges

Tab. 5.2: Phillips-Perron Unit Root Test Results. Sample: 1980:1-2004:4

Country	Variable	Lag Length	Determ.	Adj. Test Stat.	Prob.*
	$\hat{w}$	-	const.	-6.7769	0.0000
U.S.	$\hat{p}$	-	const.	-2.7647	0.0671
	$\hat{u}$	-	-	-7.0655	0.0000
	$\hat{e}$	-	-	-4.8206	0.0000
	i	-	-	-1.8553	0.0608
	$\hat{w}$	-	const.	-3.4982	0.0100
euro area	$\hat{p}$	-	none	-2.3617	0.0183
	$\hat{u}$	-	const.	-8.0891	0.0000
	$\hat{e}$	-	-	-3.1516	0.0019
	i	-	-	-1.4810	0.1290

*McKinnon (1996) one-sided p-values.

in the euro area. Due to the general low power of the unit root tests, these results can be interpreted as only providing a hint that the nominal interest exhibit a strong autocorrelation.

As discussed in the previous section, the law of motion for the real wage rate, given by eq.(5.7), represents a reduced form expression of the two structural equations for $\hat{w}_t$ and $\hat{p}_t$. Noting again that the inflation climate variable is defined in the estimated model as a linearly declining function of the past twelve price inflation rates, the dynamics of the system (5.21)–(5.24) can be reformulated as

$$\begin{aligned}
\hat{w}_t^j &= \beta_{we}(e_{t-1}^j - e_o^j) - \beta_{wv}\ln(v_{t-1}^j/v_o^j) + \kappa_{wp}\hat{p}_t^j + \kappa_{w\pi^{12}}\pi_t^{12,j} + \kappa_{wz}\hat{z}_t^j + \epsilon_{wt} \\
\hat{p}_t^j &= \beta_{pu}(u_{t-1}^j - u_o^j) + \beta_{pv}\ln(v_{t-1}^j/v_o^j) + \kappa_{pw}(\hat{w}_t^j - \hat{z}_t^j) + \kappa_{p\pi^{12}}\pi_t^{12,j} + \epsilon_{pt} \\
\ln u_t^j &= \ln u_{t-1}^j + \gamma_u(u_{t-1}^j - u_o^j) - \alpha_{ur}(i_{t-1}^j - \hat{p}_t^j) \pm \alpha_{uv}(v_t^j - v_o^j) + \alpha_{u\eta}\eta_{t-4} + \epsilon_{ut} \\
\hat{e}_t^j &= \alpha_{eu-1}\hat{u}_{t-1}^j + \alpha_{eu-2}\hat{u}_{t-2}^j + \alpha_{eu-3}\hat{u}_{t-3}^j + \epsilon_{et} \\
i_t^j &= \phi_i i_{t-1}^j + (1-\phi_i)\phi_\pi\hat{p}_t^j + (1-\phi_i)\phi_y u_{t-1}^j + \epsilon_{it}, \quad \text{with} \quad j = us, ez. \\
s_t &= i_{t-1}^{us} - i_{t-1}^{ez} + \alpha_{ss}s_{t-1} - \lambda\beta_s^f\eta_t + (1-\lambda)\beta_s^c\hat{s}_{t-1}.
\end{aligned}$$

with $\gamma_{uu} = 1 - \alpha_u$ and sample means denoted by a subscript o.

In order to investigate the differences between a single-country system estimation and a two-country system estimation for the values of the parameters of the model for the U.S. and euro area, the structural equations are estimated by means of Three-Stage-Least-Squares (3SLS) in order to account for a possible regressor endogeneity and heteroskedasticity.

Tab. 5.3: 3SLS Parameter Estimates: One-Country Specification

Estimation Sample: 1980 : 1-2004 : 4							
$\hat{w}_t$	β_{we}	β_{wv}	κ_{wp}	$\kappa_{w\pi^{12}}$	κ_{wz}	$\bar{R}^2$	DW
Euro Area	0.499	-0.454	0.844	0.287	0.245	0.706	1.593
	[2.763]	[-3.883]	[3.438]	[1.233]	[2.908]		
U.S.	0.726	-0.372	0.692	0.629	0.369	0.317	1.805
	[3.644]	[-2.897]	[2.649]	[2.447]	[5.239]		
$\hat{p}_t$	β_{pu}	β_{pv}	κ_{pw}	$\kappa_{p\pi^{12}}$		$\bar{R}^2$	DW
Euro Area	0.269	0.133	0.079	0.873		0.898	1.516
	[4.626]	[2.453]	[1.996]	[23.813]			
U.S.	0.250	0.103	0.087	0.831		0.774	1.352
	[4.608]	[1.872]	[2.357]	[18.034]			
$\ln u_t$	γ_{uu-1}	α_{ur}	α_{uv}	$\alpha_{u\eta}$	α_{uuf}	$\bar{R}^2$	DW
Euro Area	-0.137	-0.061	-0.206	0.012	0.066	0.927	1.838
	[-3.935]	[-2.942]	[-3.338]	[2.212]	[0.934]		
U.S.	-0.067	-0.042	-0.044	-0.001	0.177	0.904	1.485
	[-2.366]	[-1.426]	[-1.426]	[-1.332]	[1.768]		
$\hat{e}$	α_{eu-1}	α_{eu-2}	α_{eu-3}			$\bar{R}^2$	DW
Euro Area	0.137	0.128	0.069			0.614	1.104
	[7.246]	[6.761]	[3.780]				
U.S.	0.137	0.093	0.045			0.357	1.369
	[4.679]	[3.152]	[1.565]				
i	ϕ_i	ϕ_π	ϕ_y			$\bar{R}^2$	DW
Euro Area	0.930	1.540	1.500			0.981	1.369
	[44.084]	[10.378]	[2.413]				
U.S.	0.820	2.222	0.622			0.927	1.886
	[29.684]	[15.718]	[2.622]				
s	α_{ss}	λ	β_s^c			$\bar{R}^2$	DW
Euro Area	0.839	0.108	0.209			0.917	1.575
	[18.609]	[1.812]	[2.410]				
U.S.	0.831	0.117	0.218			0.917	1.579
	[18.214]	[1.945]	[2.493]				

As it can be observed in Table 5.3, we find a wide support for the theoretical formulation discussed in the previous section. In the first place we find similar and statistically significant coefficients for $\ln(v/v_o)$, the Blanchard-Katz error correction terms, in both the wage and price adjustment equations of both the U.S. and the euro area.

In the second place, our cross-over formulation of the inflationary expectations cannot be statistically rejected in the wage inflation equation of both economies and the U.S. price inflation equation. For the euro area, the cross over term of actual wage inflation determining the actual price inflation seems not to be significant.[13]

Furthermore, the influence of the market specific demand pressure terms (the capacity utilization in the price- and the employment rate in the wage Phillips curve equations) is also corroborated by our estimations, as well as the fact that wage flexibility is higher than price flexibility (concerning their respective demand pressure measures) in both the U.S. and the Euro Area, a result in line with the findings of Chen and Flaschel (2006), Flaschel et al. (2007) and Proaño, Flaschel, Ernst and Semmler (2006).

Concerning the estimated open economy IS equation, our 3SLS estimations show, as expected, the negative influence of the expected real interest rate on the dynamics of capacity utilization in both economies. The same holds true for the effect of $v - v_o$ the deviation of the labor share from its steady state level, in both U.S. and Euro Area, showing that a relatively high labor share (or real average unit labor costs) has a negative impact on the domestic rate of capacity utilization, something that holds for a profit led economy. The coefficient α_{uu^f}, which represents the effect of foreign goods demand on the dynamics of the domestic capacity utilization rate, are both positive and significant (with the U.S. coefficient of an unexpectedly high value) for both economies.

The parameter estimates in the dynamic Okun's law and Taylor rule equations of both economies are positive, statistically significant and of reasonable dimension, with nevertheless a higher reaction coefficient to the inflation in the U.S. than in the euro area for the analyzed sample period. Concerning the law of motion of the log nominal exchange rate, both the log real exchange rate and the interest rate differential influence the level of the log nominal exchange rate, the former in a negative and the latter in a positive manner.

Besides the one-country 3SLS estimations just discussed, we estimated both countries as a single system by means of 3SLS.[14] Compared with the single-country 3SLS esti-

[13] In Proaño, Flaschel, Ernst and Semmler (2006), where we investigated only the closed economy dimension of our theoretical model, almost identical results concerning both economies are reported. The only exception was the cross-over term (specified there not as $\hat{w}_t - \hat{z}_t$ – with $\hat{z}_t$ as the actual labor productivity growth rate, but only as $\hat{w}$) in the price inflation equation for the Euro Area, which there, turned out to be statistically significant.

[14] The set of instrumental variables in the 3SLS estimation consisted on the same lagged values of the two countries used in the previous estimations.

Tab. 5.4: 3SLS Parameter Estimates: Two-Country Specification

Estimation Sample: 1980 : 1-2004 : 4							
$\hat{w}_t$	β_{we}	β_{wv}	κ_{wp}	$\kappa_{w\pi^{12}}$	κ_{wz}	$\bar{R}^2$	DW
Euro Area	0.475	-0.437	0.862	0.270	0.239	0.706	1.603
	[2.664]	[-3.794]	[3.560]	[1.173]	[2.896]		
U.S.	0.689	-0.399	0.490	0.574	0.348	0.341	1.815
	[4.341]	[-3.033]	[1.827]	[3.072]	[5.059]		
$\hat{p}_t$	β_{pu}	β_{pv}	κ_{pw}	$\kappa_{p\pi^{12}}$		$\bar{R}^2$	DW
Euro Area	0.252	0.114	0.073	0.877		0.898	1.520
	[4.391]	[2.138]	[1.897]	[24.356]			
U.S.	0.130	0.144	0.109	0.579		0.788	1.389
	[2.748]	[2.550]	[3.243]	[19.274]			
$\ln u_t$	γ_{uu-1}	α_{ur}	α_{uv}	$\alpha_{u\eta}$	α_{uu^f}	$\bar{R}^2$	DW
Euro Area	-0.109	-0.062	-0.163	0.012	0.101	0.927	1.753
	[-3.416]	[-3.184]	[-2.724]	[2.353]	[1.531]		
U.S.	-0.091	-0.038	-0.112	-0.008	0.152	0.904	1.520
	[-3.387]	[-1.829]	[-2.088]	[-1.308]	[1.545]		
$\hat{e}$	α_{eu-1}	α_{eu-2}	α_{eu-3}			$\bar{R}^2$	DW
Euro Area	0.135	0.128	0.074			0.615	1.114
	[7.176]	[6.864]	[4.110]				
U.S.	0.151	0.101	0.045			0.369	1.436
	[5.250]	[3.439]	[1.575]				
i	ϕ_i	ϕ_π	ϕ_y			$\bar{R}^2$	DW
Euro Area	0.931	1.562	1.925			0.981	1.366
	[49.645]	[10.653]	[2.915]				
U.S.	0.823	2.168	0.404			0.928	1.892
	[31.659]	[15.328]	[1.892]				
s	α_{ss}	λ	$\alpha_{s\hat{s}}$			$\bar{R}^2$	DW
	0.834	0.115	0.232			0.917	1.608
	[19.110]	[1.978]	[2.771]				

mations just described, Table 5.4 delivers quite similar values concerning all estimated parameters, corroborating the robustness of our results. There is nevertheless one remarkable difference: While in the 3SLS estimations we obtained a quite high coefficient for α_{uu^f} in the U.S. equation (representing the role of the growth rate of capacity utilization in the Euro Area for the dynamics of the same variable in the U.S.), in Table 5.4 we obtained a parameter estimate of more reasonable dimension (though still too high if compared with the coefficient in the euro area $\ln u$ equation, if one takes into account that the U.S. influence is probably higher for the euro area in this respect than otherwise).[15]

5.3.3 Dynamic Adjustments

In order to evaluate the empirical plausibility of our theoretical framework, we simulate an approximate discrete time version of the semi-structural model discussed in section 5.2 based on the estimated 3SLS structural model parameters discussed in the last section.[16] Additionally, the parameters concerning the theoretical CPI inflationary climate for both countries were calibrated with the following values:

$$\beta_{\pi_c} = 0.5 \qquad \kappa_{\pi_c} = 0.5 \qquad \xi = 0.85.$$

Both countries have thus the same degree of inflation climate inertia (represented by β_{π_c}, the adjustment coefficient of the CPI inflationary climate), whereafter each new (monthly) CPI inflation rate observation updates with only a 0.5 weight the inflationary climate. Both countries have also the same degree of credibility in the monetary policy target (κ_{π_c}) as well as the same composition of domestic and foreign goods in the CPI index.[17]

A U.S. monetary policy shock

In Figure 5.3 the dynamic adjustments of two artificial economies based on the structural parameters estimates of both the U.S. and the euro area depicted in table 5.4 to a one percent (100 basis points) U.S. monetary policy shock are shown.

As Figure 5.3 shows, the numerical simulations of the calibrated theoretical discrete time model deliver, to a large extent, the stylized facts on monetary policy shocks discussed in the last section (the time axis shows the *months* after the shock). As expected, a positive monetary policy shock in the U.S. leads to an increase in the EUR/USD nominal exchange rate primarily via the uncovered interest rate parity (UIP) condition

[15] In the dynamic adjustments simulations of the next section we will calibrate this coefficient to be if not *lower*, at least *equal* to that of the euro area.

[16] The numerical simulations of this section were performed using MATLAB. The simulation code is available upon request.

[17] This specific value is taken from Rabanal and Tuesta (2006).

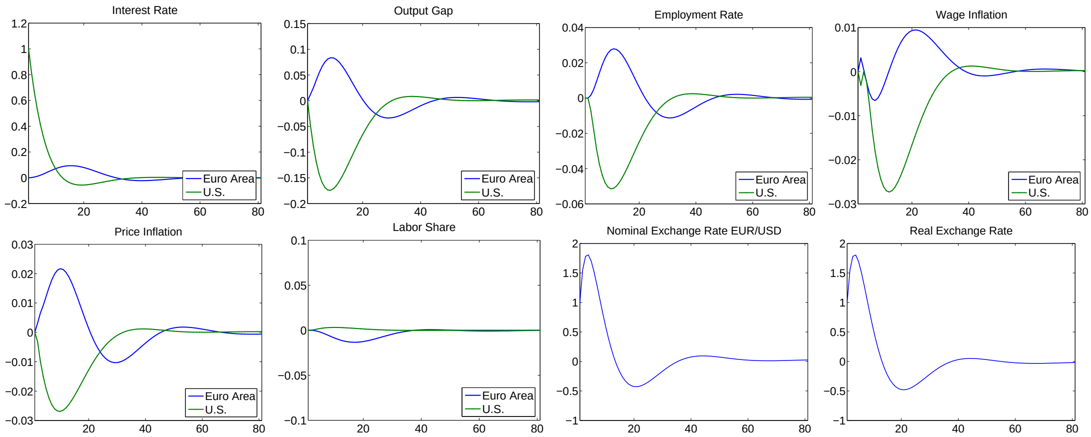


Fig. 5.3: Simulated Impulse-Responses to a One Std. Dev. U.S. Monetary Policy Shock

comprised in the law of motion of the log nominal exchange rate. This nominal appreciation of the US Dollar, together with the effect of the interest rate increase, leads to an economic slowdown, observable in the decrease in the capacity utilization rate (the output gap). Following the downturn of this variable, employment also falls, followed by wage and price inflation. These variables return back to baseline in approximately 40 months, or nearly four years. Concerning the reaction of the euro area variables to a U.S. monetary policy shocks, Figure 5.3 shows that the euro area is affected by the contractionary U.S. monetary policy shock through two macroeconomic channels: Firstly, by the drop in foreign aggregate demand and secondly, by the gain of relative competitiveness resulting from the nominal (and real, due to the sluggishness in the wage an price adjustment) depreciation of the euro. As figure 5.3 shows, in the calibrated two-country model underlying these simulations the increase in relative competitiveness of the euro area clearly dominates the fall in the U.S. foreign goods demand, with economic activity in the euro area increasing after a contractionary monetary shock in the U.S. economy.[18]

Concerning the dynamic reaction of the nominal exchange rate, in the model discussed here, there is indeed a somewhat delayed reaction of this variable, with the maximum effect taking place not instantaneously but after one or two periods.

[18] This result contradicts the findings of Kim (2001) discussed in the previous section, whereafter a contractionary monetary policy shock in the U.S. leads to an economic downturn in the G-7 countries due to the increase in the world interest rate. This channel, though, is not incorporated in the simple semi-structural two-country model discussed here.

A Euro Area monetary policy shock

Concerning the effects of euro area monetary shocks (depicted in Figure 5.4), the dynamic responses of both the euro area and the U.S. economy resemble, by and large, the dynamic adjustments to a U.S. monetary shock previously discussed, with both output and employment, as well as wage and price inflation (with some delay) falling after such a shock in the euro area and increasing in the U.S. economy. However, an

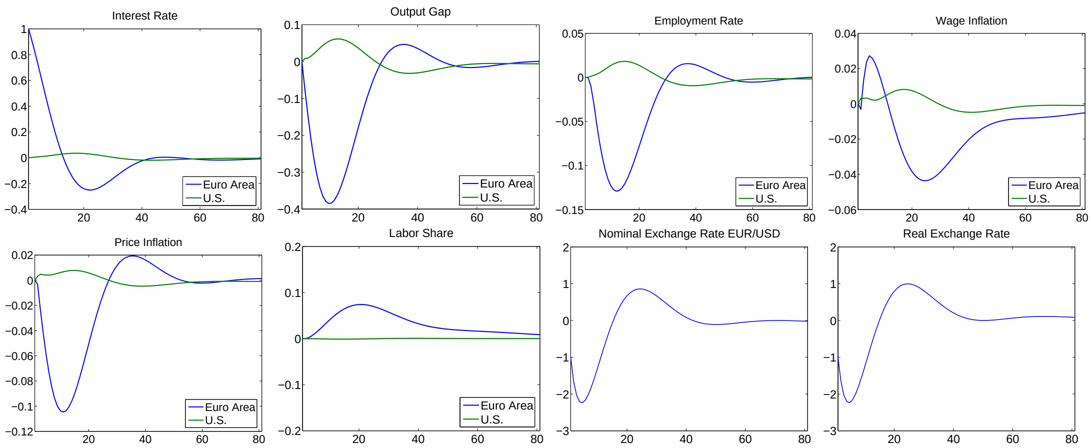


Fig. 5.4: Simulated Impulse-Responses to a One Std. Dev. Euro Area Monetary Policy Shock

interesting and important difference can be observed in Figure 5.4, namely the fact that while the Euro Area was largely affected by the contractionary U.S. monetary policy shock, the extent of opposite influence is largely not that important primarily due to the lower real exchange rate $\alpha_{u\eta}$ in the estimated U.S. goods markets equation.

Next we focus on the stability properties of this two-country macrodynamic system concerning variations in the parameter values.

5.4 Eigen-Value-Based Stability Analysis

As previously mentioned, if the stability of a macrodynamic system is not simply imposed through the rational expectations assumption, the relative strength of the different macroeconomic channels interacting in an economy (and in this case, between two economies) become central for the local and global stability properties of the system analyzed.

The main purpose of this section is to highlight this issue within the semi-structural two-country macro-framework discussed and estimated in the previous section. For this an eigen-value stability analysis is used taking as the benchmark parameters the estimated values presented in the previous section. After calibrating the 11D continuous time system, the eigen-values of the system are calculated ceteris paribus for different parameter of the models (mostly in the 0-1 interval) using the SND package discussed by Chiarella et al. (2002).

In Figure 5.5 the maximal eigen-values of the system for varying values of the respective parameters are sketched. For comparison, in Figure 5.6 the analogous sketches for the closed economy model (the one-country submodule under $\alpha_{uu^f}, \alpha_\eta, \xi = 1$) – calculated with the parameter estimates of the U.S. economy discussed in chapter 2 are depicted –.

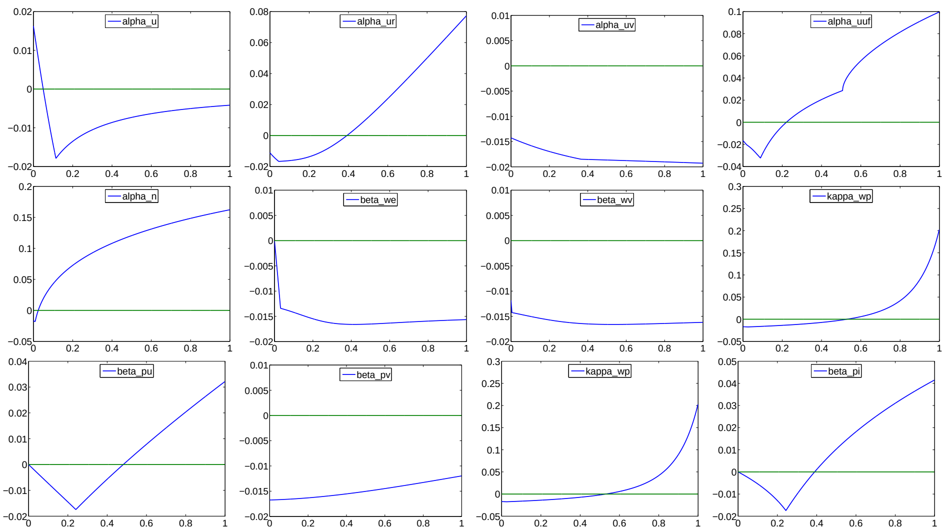


Fig. 5.5: Eigen-Value-based Stability Analysis: The Real Economy

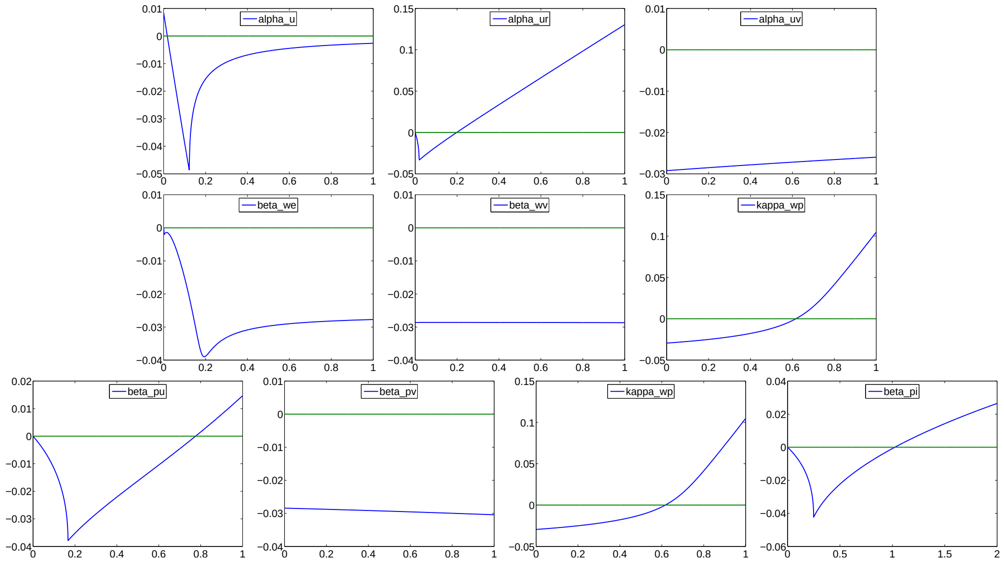


Fig. 5.6: Eigen-Value-based Stability Analysis: The Real Economy (The Closed Economy Case, using the U.S. parameter values discussed in chapter 2)

The comparison between Figures 5.5 and 5.6 reveals by and large the same qualitative implications of a variation of the analyzed coefficients for the stability of the system (in the two- and the one-country case): So, while the stability properties of the respective systems seem to be invariant for different parameters of α_{uv} (the reaction strength of capacity utilization to an increase in the wage share), β_{we} (the wage inflation reactiveness parameter with respect to labor marker disequilibrium situations), as well as β_{wv} and β_{pv} (the Blanchard-Katz error correction terms in both wage and price inflation adjustment equations), the same does not hold for the remaining real economy parameters. Indeed, high coefficients of α_{ur} (the real interest rate reactiveness of the capacity utilization), both κ_{wp} and κ_{pw} (the cross-over inflation terms in the wage and price Phillips Curve equations), a high price flexibility with respect to goods market disequilibrium situations (represented by the parameter β_{pu}) as well as as a high adjustment of the inflationary climate π_c, determined by β_{π_c} seem to induce instability in the system. Concerning the open-economy dimension of the model, Figure 5.5 shows that both a high reactiveness of capacity utilization towards the real exchange rate *and* the dynamics of the foreign economy (determined by α_η and α_{uu^f}, respectively), are likely to induce instability of the system due to an eventual over-synchronization of both economies which might feature reinforcing properties.

Figure 5.7 shows the eigen-value diagrams resulting from variations in the monetary policy parameters. As expected, while an increase in the α_{ii} (the adjustment speed of the actual nominal interest rate with respect to i_T) induces stability into both the closed and the open economy systems, the steady state stability properties seem to be invariant to changes in ϕ_y (the reaction coefficient of the monetary policy instrument with respect to the output gap).

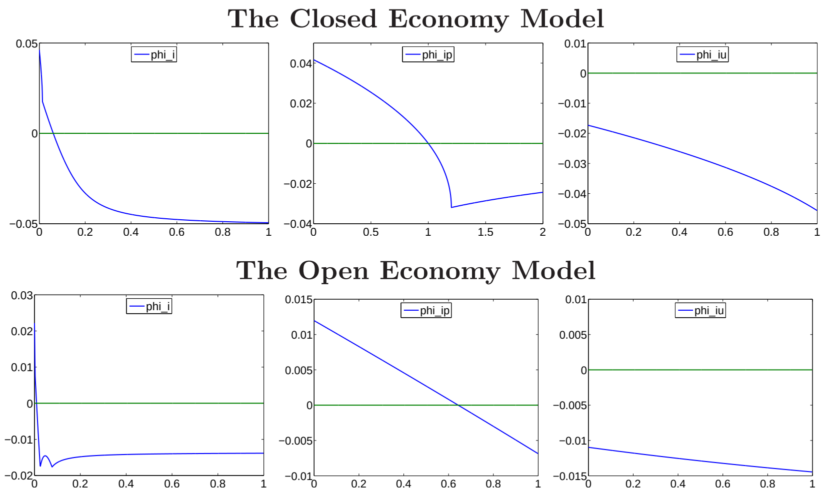


Fig. 5.7: Eigen-Value-based Stability Analysis: Monetary Policy

This, however, does not hold for ϕ_π, the reaction coefficient with respect to the inflation gap. Indeed, in line with the academic literature on monetary policy, we find in the closed economy case that the steady state of the economic system is be stable only if $\phi_\pi > 1$, that is, only if monetary policy reacts in a sufficiently active manner with respect to inflationary developments. The eigen-value diagram of ϕ_π, however, shows that the threshold value for stability in the open economy case lies much lower than in the closed-economy case, relativizing up to a certain extent the validity of the prominent Taylor Principle, at least for large economies such as the U.S. and the euro area.

This result, though somewhat surprising at first sight, is actually quite reasonable: In contrast to the closed economy case, in an open economy the monetary policy transmission mechanism is enriched by other transmission channels such as the nominal exchange rate and the competitiveness channels. So for example an interest rate increase leads not only to higher borrowing costs and therefore to a lower consumption and investment demand, but also, in an open economy, to a nominal (and real) appreciation of the domestic currency. This in turn leads to a decrease in the net exports. In an open economy, thus, monetary policy can rely on the activation of more transmission channels and therefore needs not to be as aggressive as in the closed-economy case in order to stabilize the economy.

In Figure 5.8 we can observe the eigen-value diagrams concerning the parameters of the nominal exchange rate dynamics. As it can be observed, an increase in β_s^f, the "fundamentalists" parameter (which was restricted to one in the estimations of the previous section) induces stability into the system. This is also the case for λ, the relative share of fundamentalists in the foreign exchange market, which ceteris paribus seems not needing to be particularly high in order to stabilize the system.

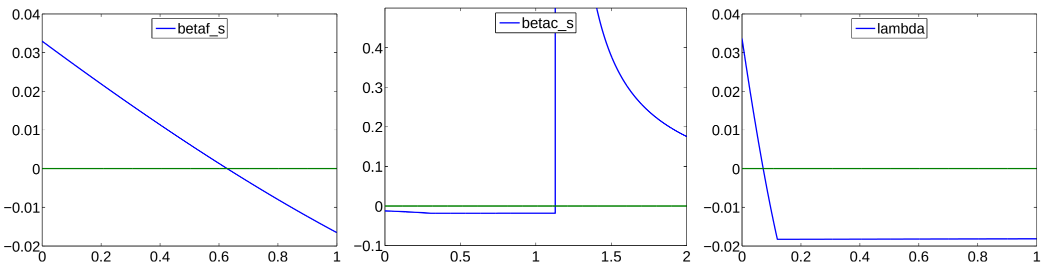


Fig. 5.8: Eigen-Value-based Stability Analysis: FX Dynamics

Last but not least, the middle graph in Figure 5.8 shows the eigen-value diagram for β_s^c, the parameter denoting the "trend-chasing" degree by the chartists. As expected, an increase in β_s^c brings about instability into the system. The switch from stability to instability, however, does not happen in a smooth manner but is rather of a quite nonlinear nature. This is due to the fact that an increase in β_s^c does not affect the stability of the system as long as the inequality $1 > (1-\lambda)\beta_s^c$ (the denominator in the nominal FX dynamics given by eq. (5.19)) is fulfilled. As it can be observed, there exists a threshold value of β_s^c for which this inequality is not fulfilled anymore and which causes a sign reversal in the nominal FX dynamics which leads to a total instability of the system.

5.5 Concluding Remarks

In this chapter a basic two-country theoretical framework in the line of the disequilibrium approach by Chiarella and Flaschel (2000) and Chiarella et al. (2005) was modeled where two large open economies interacted with each other and indeed influenced each other through trade, price and financial channels. The discrete time version of this theoretical framework (which was calibrated with estimated parameters of the U.S. and the euro area), while still quite basic in its structure, was nevertheless able to deliver dynamic responses in line with other empirical studies on the dynamics of open economies such as Eichenbaum and Evans (1995), Kim (1999) and Kim and Roubini (2000). Furthermore, through the calculation of the eigen-values of the 11D system, the effects of variations in the parameter values were investigated. Particularly with regard to the modeling of nominal exchange rate dynamics, this eigen-value analysis delivered three main results which are indeed of significant importance:

First, it corroborated the standard notion concerning the influence of the chartists for the stability not only of the FX dynamics, but also of the macroeconomic as a whole.

Second, it confirmed the findings of previous studies such as Chen, Chiarella, Flaschel and Semmler (2006) as well as chapter 2 of this dissertation concerning the role of wage and price flexibility for the stability of the economy.

And third, the maximum-eigenvalue-diagram concerning the inflation gap coefficient ϕ_π in the monetary policy rule showed that in an open economy the threshold value for the effectiveness of monetary policy is not one as discussed for example in Woodford (2003), but rather less than one, due to the functioning of other stabilizing macroeconomic channels such as the real exchange rate channel in an open economy. This last result, however, should indeed be further investigated in a more elaborated framework. This is though left for further research.

6. Currency Crises, Credit Rationing and Macroeconomic Dynamics in Economies with Dollarized Liabilities

6.1 Introduction

Since the breakdown of the Bretton-Woods exchange rate system and the subsequent liberalization of the international capital markets, a striking proliferation of currency and financial crises throughout the world has been observed, the majority of them though taking place in the so called "emerging market economies". Among these episodes of financial turmoil, the 1994-95 Mexican and the 1997-98 East Asian crises are quite important chapters not only due to the suddenness and extent of the resulting nominal exchange rate depreciations but also because of the severity by which the real side of the economy was affected in the concerned countries.

A variety of studies such as Krugman (2000a), Aghion, Bacchetta and Banerjee (2001), Céspedes, Chang and Velasco (2003) and Flaschel and Semmler (2006), for example, have elaborated on the mechanisms of how a currency crisis can trigger a financial crisis that may lead to a severe economic slowdown in such type of economies. This research has focused on the credit market problems that arise for firms after a strong currency devaluation in a country where credit market frictions exist and where a significant fraction of domestic banks and firms possesses unhedged foreign currency denominated liabilities. Yet, in those models the wage and the price levels have usually been assumed to remain constant over time.

The main contribution of this chapter to the currency crises literature is to introduce a macroeconomic framework with gradually adjusting domestic wages and prices which shows how not only nominal, but also (through domestic wages and price level changes) real exchange rate adjustments affect the dynamics of the macroeconomic activity after the occurrence of a currency crisis in the medium run. In our view wage and price dynamics are the missing link to explain the medium run dynamics of a country that has experienced — through a currency and financial crisis — a severe slowdown in its economic activity.

Our study is organized as follows: In section 6.2 we present a general version of the currency crises theoretical framework discussed in Flaschel and Semmler (2006) and Proaño, Flaschel and Semmler (2005). We discuss the dynamics of output and the nominal exchange rate after a currency crisis first, in section 6.3, under the assumption of fixed domestic wages and goods prices and then, in section 6.4, under the assumption of a gradual adjustment of these variables. Furthermore, in section 6.5, we discuss the more general case where nominal exchange rates as well as domestic prices adjust to the state of the economy, showing the different mechanisms that allow the economy to recover after a sharp credit tightening due to the occurrence of a sudden currency mismatch. The empirical results of a VARX analysis are presented and discussed in section 6.6. Section 6.7 draws some concluding remarks.

6.2 The General Framework

In order to analyze the effects of sharp currency devaluations in economies with unhedged dollarized liabilities in graphical though analytically nontrivial manner, we build on a modified version of the Mundell-Fleming-Tobin developed by Rødseth (2000) as the one discussed in Flaschel and Semmler (2006) and Proaño et al. (2005). We thus analyze a small open economy where output is basically demand-driven and, in the most general case, wages/prices as well as nominal exchange rates adjust gradually to disequilibrium situations in the labor and the financial markets, respectively. For now we abstract from international capital inflows as well as significant changes in the capital stock of the domestic economy K, in the domestic households' financial wealth W_h as well as in the foreign and domestic currency debt of the domestic entrepreneurial sector, assuming thus that the analyzed time span is short enough to allow considering these variables as basically unchanging despite the presence of positive or negative net investment and households' savings. Furthermore we assume a constant foreign price level p^*, which we normalize to one ($p^* = 1$) for simplicity. The real exchange rate is defined as $\eta = ep^*/p = e/p$, with e as the nominal exchange rate and p as the domestic price level.

6.2.1 The Goods Markets

As in Proaño, Flaschel and Semmler (2006), we assume that the domestic entrepreneurial sector can finance its investment projects through the issuance of bonds denominated in domestic (with capital costs i) as well as in foreign currency (with capital costs i^*) B_f and F_f, respectively (where $F_f < 0$ and $B_f < 0$, indicating a negative foreign and domestic currency bond stock held by domestic firms, or in other words, that firms are indebted). We assume that the domestic firms cannot hedge their exchange rate exposure, so that the domestic currency value of their dollarized liabilities eF_f evolves in a one-to-one manner with the evolution of the exchange rate. For simplicity we assume that each firm chooses just one investment financing option, so that in the aggregate the domestic entrepreneurial sector can be divided into two fractions: The one fraction, denominated by υ, finances its investment projects solely through foreign currency denominated credits, while the other fraction of domestic firms $(1-\upsilon)$ borrows only in domestic currency.

As usually done in similar currency crises models which analyze the observed output decline after the 1997-98 East Asian currency and financial crisis such as Aghion et al. (2001), Céspedes et al. (2003), Aghion, Bacchetta and Banerjee (2004) and Flaschel and Semmler (2006), we assume the existence of asymmetric information between the domestic firms (the potential borrowers) and the lending institutions which forces the latter to determine the level of credit awarding on the basis of some notion about the creditworthiness of the domestic firms, such as their net worth. In our theoretical framework the net worth of a firm is defined as the difference between its assets – which we assume to consist only of fixed capital K – and its liabilities $B_f + eF_f$ (both expressed here in domestic currency). Note that while the exchange rate influences the net worth of the firms with foreign currency liabilities, it does not affect the net worth of the firms indebted in domestic currency $(1-\upsilon)$.

Tab. 6.1: Business Sector's Balance Sheets

	Business Sector's Balance Sheets	
Firms' Fraction	**Assets**	**Liabilities**
υ	pK_υ	eF_f
$1-\upsilon$	$pK_{1-\upsilon}$	B_f

A glance at the balance sheet of the fraction of domestic firms υ can clarify why this holds: A rise of the nominal exchange rate (or an decrease of the domestic price level) leads to an increase in the nominal (and here also real) value of the liabilities of this group and therefore to a decrease in its net worth, without affecting the net worth of the other group of firms.[1]

Note that despite the fact that the share υ of domestic firms borrowing in foreign currency is kept constant here, one could think of it as being a function of the risk premium ξ. For now, though, we just assume that due to financial technology differences or firm size factors not the totality but only a constant fraction of the domestic entrepreneurial sector can actually obtain loans denominated in foreign currency.

We assuming that the lending institutions evaluate the creditworthiness of the domestic firms based on their respective debt-to-capital ratio

$$\tilde{q}_\upsilon = \frac{eF_f}{p\bar{K}_\upsilon} = \tilde{q}_\upsilon(\eta) \quad \text{and} \quad \tilde{q}_{1-\upsilon} = \frac{B_f}{p\bar{K}_{1-\upsilon}}.$$

Note that even though both groups might be subject to the imposition of credit constraints by the financial sector, only the debt-to-capital ratio of the fraction of firms indebted in foreign currency is affected by nominal exchange rate fluctuations.

Under the assumption that $\bar{K} = \bar{K}_\upsilon + \bar{K}_{1-\upsilon} = \text{const.}$, together with $B_f = \text{const.}$ and $F_f = \text{const.}$, we can represent the nonlinear relationship between the real exchange rate level and the extent of credit rationing in the economy through[2]

$$\mu_F = f(\eta) = \frac{1}{1+(\eta-1)^2} - 1 = -\frac{(\eta-1)^2}{1+(\eta-1)^2}. \tag{6.1}$$

According to eq.(6.1), the extent of credit rationing by the lending institutions depends on the actual deviation of the real exchange rate from its PPP consistent level: For $\eta \approx 1$, $\tilde{q}_\upsilon = eF_f/pK_\upsilon \approx F_f/K_\upsilon$, and $\mu_F \approx 0$. In the contrary case, as η increases,

[1] Again, we assume that the totality of the foreign currency debt is unhedged: As discussed e.g. in Röthig, Flaschel and Semmler (2007), with increasing currency hedging by the domestic firms, the fragility of the real side of the economy to unexpected exchange rate depreciation decreases.

[2] In our previously cited works we followed Krugman (2000a) by assuming that the elasticity of the investment function with respect to e (η) was high for "intermediate values" and low for extreme "low" and "high" exchange rate values. This specification, though maybe not completely theoretically founded, allowed us to analyze the consequences of a currency breakdown for the dynamics of output in a graphical manner. The nonlinear specification of the financial accelerator of this paper allows us to still do so, with the advantage of being more theoretically grounded and computationally feasible.

the measure of creditworthiness of the domestic firms $\tilde{q}_v = eF_f/pK$ becomes more and more relevant for the credit awarding decisions by the lending institutions, and consequently for the level of aggregate investment in the economy, because

$$\lim_{\eta \to \infty} \mu_F = -1.$$

A sharp currency devaluation (and therefore an increase in the debt-to-capital ratio of the domestic firms indebted in foreign currency) leads to the activation of credit constraints by the lending institutions (the "balance sheet channel" introduced by Bernanke, Gertler and Gilchrist (1996)) and thus to a decrease in the aggregate investment, since

$$\mu_F'(\eta) = -\frac{2(\eta - 1)}{(2 - 2\eta + \eta^2)^2} < 0 \quad \text{for} \quad \eta > 1.$$

This effect, nevertheless, is not unbounded, as the second partial derivative of I with respect to η shows:

$$\mu_F''(\eta) = \frac{2(2 - 6\eta + 3\eta^2)}{(2 - 2\eta + \eta^2)^3}.$$

since

$$\lim_{\eta \to \infty} \mu_F''(\eta) = 0.$$

As $\mu_F(\eta)$ is specified, it allows us to model the nonlinear nature of the credit rationing by the financial institutions as a reaction to a decline of the firms' net worth caused by a sudden sharp devaluation of the domestic currency. We sketch the dependence of the aggregate investment on the nonlinear financial accelerator term μ_F in Figure 6.1.

Note that even though the theory behind Figure 6.1 is of a very simple nature, it allows us to incorporate the basic implications of the theory of imperfect capital markets developed by Akerlof (1970) and Stiglitz and Weiss (1981) and to discuss manner the operation of the Bernanke et al. (1996) financial accelerator effect in a graphical in our framework.

Furthermore, such a specification opens up the possibility of multiple equilibria and, therefore, to the existence of "normal" and "crisis" steady states, respectively. Note that the magnitude of the balance sheet effect depends in a great manner on υ, that is on the degree of liability dollarization of the economy: For $\upsilon = 1$, i.e. in the case of total liability dollarization (as in Flaschel and Semmler (2006)), the balance sheet effect alone (except changes in the foreign interest rate) determines the level of aggregate

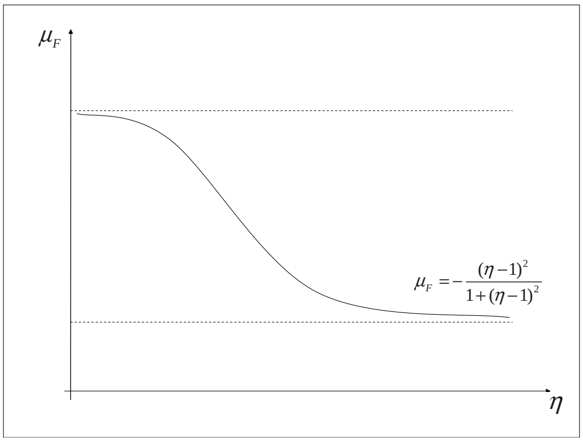


Fig. 6.1: A Real Exchange Rate State-Dependent Financial Accelerator Term

investment. For $\upsilon = 0$, on the contrary, changes in the real exchange rate do not directly affect the financial state of the domestic firms.

In the aggregate, the investment function is thus determined by

$$\begin{aligned} I &= i_o - (1-\upsilon)i_1(r) + \upsilon\mu_F \\ &= I((1-\upsilon)\underset{-}{r}, \upsilon\underset{-}{\mu_F}) \end{aligned} \tag{6.2}$$

with $r = i - \hat{p}$ as the real domestic interest rate and i_1 as the interest rate sensitivity of aggregate investment.

Concerning the rest of the economy, we assume quite standard consumption and net exports functions, so that the goods market equilibrium in the small open economy can be expressed as

$$Y = C(Y - \bar{T} - \delta\bar{K}) + I((1-\upsilon)r, \upsilon\mu_F) + \delta\bar{K} + \bar{G} + NX(Y^*, \eta, Y). \tag{6.3}$$

with $Y - \bar{T} - \delta\bar{K}$ denoting the disposable income, $\bar{T}$ lump sum taxes, $\bar{G}$ the government consumption and $\delta\bar{K}$ the capital depreciation. Net exports NX depend in a standard way positively on the foreign output level (assumed for simplicity to be at its natural level) and on the real exchange rate $\eta = e/p$ (the foreign goods price still set equal to one), and negatively on Y, the domestic output level.

As for example in Blanchard and Fischer (1989), we assume the following dynamic adjustment process in the goods markets:

$$\begin{aligned}\dot{Y} &= \beta_y(Y^d - Y) \\ &= \beta_y\left[C(Y - \delta\bar{K} - \bar{T}) + I((1-\upsilon)r, \upsilon\mu_F) + \delta\bar{K} + \bar{G} + NX(Y^*, \eta, Y) - Y\right] \qquad (6.4)\end{aligned}$$

with Y^d as the aggregate goods demand and β_y as a parameter representing the speed of adjustment in the goods markets.

Using the Implicit Function Theorem, it follows for the displacement of the DD-Curve with respect to nominal and real exchange rate increases

$$\left.\frac{\partial Y}{\partial \eta}\right|_{\dot{Y}=0} = -\frac{\partial_\eta I(\cdot)\upsilon\mu_F'(\eta) + \partial_\eta NX(\cdot)}{C'(Y) + \partial_Y NX(\cdot) - 1} \gtreqless 0.$$

Here we can observe one of the essential points of our model. The effect of a devaluation of the domestic currency on economic activity depends on the relative strength of the exports reaction as compared to the reaction of aggregate investment.[3] In the "normal case", where firms are not wealth constrained, the exchange rate effect on investment is supposed to be very weak and thus dominated by the exports effect. Then we have

$$\partial_\eta NX(\cdot) > \left|\partial_\eta I(\cdot)\upsilon\mu_F'(\eta)\right| \Longrightarrow \left.\frac{\partial Y}{\partial \eta}\right|_{\dot{Y}=0} > 0.$$

In the "fragile case", i.e. in a middle range for the exchange rate, the balance-sheet effect of a devaluation of the domestic currency is assumed to be large so that it overcomes the positive exports effect:

$$\left|\partial_\eta I(\cdot)\upsilon\mu_F'(\eta)\right| > \partial_\eta NX(\cdot) \Longrightarrow \left.\frac{\partial Y(\cdot)}{\partial \eta}\right|_{\dot{Y}=0} < 0.$$

The resulting DD-curve is depicted in Figure 6.2.

[3] The denominator is assumed to be unambiguously negative, so that the sign of the numerator is decisive for the slope of the DD-Curve.

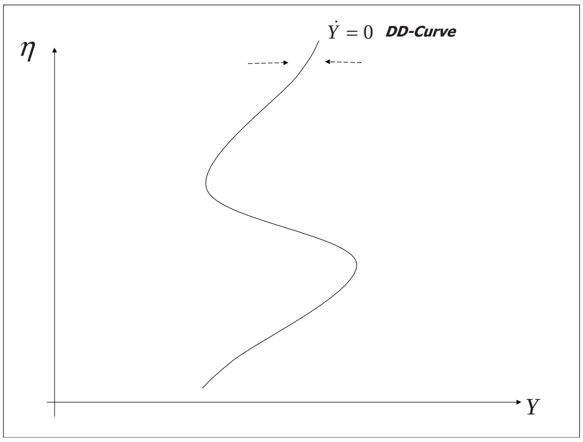


Fig. 6.2: The DD-Curve under State-Dependent Credit Awarding

6.2.2 The Financial Markets

Following Rødseth (2000), we follow a portfolio approach of Tobin type when modeling the financial markets in our framework. The defining financial market equations are:

$$\text{Households' Financial Wealth} \quad W_h = \frac{M + B_h + eF_h}{p} \tag{6.5}$$

$$\text{Risk Premium} \quad \xi = i(Y, \bar{M}/p) - \bar{i}^* - \epsilon \tag{6.6}$$

$$\text{Foreign Currency Bond Market} \quad eF_h = pf(\underset{-}{\xi}, \underset{+}{W_h}, \underset{+}{\kappa}), \tag{6.7}$$

$$\text{Money Market Equilibrium} \quad \bar{M}/p = kY + h_o - h_1 i = m(\underset{+}{Y}, \underset{-}{i}), \tag{6.8}$$

$$\text{Domestic Currency Bond Market} \quad B_h/p = W_h - f(\xi, W_h, \kappa) \tag{6.9}$$

$$\text{Equilibrium Condition} \quad F_h + F_c + \bar{F}_* = 0 \quad \text{or} \quad F_h + F_c = -\bar{F}_*. \tag{6.10}$$

Equation (6.5) describes the financial wealth of the private sector consisting of domestic money M, bonds in domestic currency B_h and bonds in foreign currency F_h, all expressed in domestic currency. Domestic and foreign currency denominated bonds are allowed to deliver different rates of return, meaning that the Uncovered Interest Rate Parity does not hold, at least in the short run.

The resulting risk premium of holding domestic currency bonds, i.e. the expected rate of return differential between the two interest bearing financial assets, is represented by eq.(6.6), with ϵ denoting the expected rate of currency depreciation, which is assumed to be determined by

$$\epsilon = \hat{e}^e = \beta_\epsilon(1 - \eta).$$

The agents in the financial markets are assumed to form their expectations concerning the future depreciation rate of the nominal exchange rate based on the long run validity of the Purchasing Power Parity (PPP) postulate: If η, the real exchange rate is below one (is overvalued), the long run PPP consistent level, the agents will expect a nominal depreciation of the domestic currency. In the contrary case, where $\eta > 1$, that is, when the domestic currency is undervalued, the economic agents will expect an appreciation of the nominal exchange rate. For the steady state real exchange rate level $\eta = 1$, $\epsilon(\eta_o) = 0$ obviously holds. This expectation formation mechanism can be considered as purely forward looking and in this respect asymptotically rational, since the economic agents, having perfect knowledge of the long run steady state real exchange rate level η_o, expect the actual exchange rate to converge monotonically to it after each shock that affects the economy.

Eq.(6.7) represents the market equilibrium for foreign currency denominated bonds. Hereby the demand for this type of financial assets is assumed to depend negatively on the risk premium, positively on the private financial wealth and positively on the parameter κ, which acts as a catch-all variable of foreign market pressures like political instability or speculative herding behavior. Eq.(6.8) represents the domestic money market equilibrium with the usual reactions of the money demand to changes in interest rates and output. The domestic bond market given by eq.(6.9) is then in equilibrium via Walras' Law of Stocks, if this holds for the bonds denominated in foreign currency.

The last equation describes the equilibrium condition for the foreign exchange market. It states that the aggregate demands of the three sectors — domestic private sector, the monetary authority and foreign sector — sum up to zero, see Rødseth (2000, p.18). Following the assumption that the supply of foreign-currency bonds from the foreign sector is constant ($-\bar{F}_*$), the additional amount of foreign-currency bonds available to the private sector (besides his own stocks) is solely controlled by the monetary authorities (This assumption can be justified by assuming as in Rødseth (2000) that domestic bonds cannot be traded internationally). The prevailing exchange rate regime thus depends on the disposition of the central bank to supply the private sector with foreign-currency bonds.

By inserting the money market equilibrium interest rate (the inverse function of eq.(6.8))

$$i(Y, \bar{M}/p) = \frac{kY + h_o - \bar{M}/p}{h_1}$$

in eq.(6.7) the Financial Markets Equilibrium- or AA-Curve is derived

$$eF_h/p = f\left(i(Y, \bar{M}/p) - \bar{i}^* - \beta_\varepsilon\,(1-\eta)\,, \frac{M + B_h + eF_h}{p}\right). \tag{6.11}$$

This equilibrium equation can be interpreted as a representation of the $\dot{e}$=0−isocline. Under the assumption that the exchange rate does not adjust automatically to foreign exchange market disequilibria, one may postulate as exchange rate dynamics:

$$\dot{e} = \beta_e\left[f\left(i(Y, \bar{M}/p) - \bar{i}^* - \beta_\varepsilon\,(1-\eta)\,, \frac{M + B_h + eF_h}{p}, \kappa\right) - \frac{eF_h}{p}\right]. \tag{6.12}$$

The slope of the $\dot{e}$=0−isocline is determined by the Implicit Function Theorem in the following way:

$$\left.\frac{\partial e}{\partial Y}\right|_{\dot{e}=0} = -\frac{\partial_\xi f(\cdot\,)\,\partial_Y i(\cdot\,)}{\partial_\xi f(\cdot\,)\,\epsilon'(\eta) + (\partial_{W_h} f(\cdot\,) - 1)\,F_h/p} < 0.$$

6.3 Dynamics under Fixed Prices and Flexible Exchange Rates

As a starting point we analyze the case where domestic (and foreign) goods prices are fixed ($p = p^* = 1$), and the nominal exchange rate, once set to float, adjusts according to eq.(6.12).

6.3.1 Local Stability Analysis

The case of fixed domestic goods prices ($p = 1$), where $\dot{\eta} = \dot{e}$ holds, was analyzed in Flaschel and Semmler (2006). In this case the differential equations of the currency crisis model are:

$$\begin{aligned}
\dot{Y} &= \beta_y\left[C(Y - \delta\bar{K} - \bar{T}) + I((1-\upsilon)r, \upsilon\mu_F) + \delta\bar{K} + \bar{G} + NX(Y^*, e, Y) - Y\right]\\
\dot{e} &= \beta_e\left[f\left(i(Y, \bar{M}) - \bar{i}^* - \beta_\varepsilon\,(1-e)\,, M + B_h + eF_h, \kappa\right) - eF_h\right].
\end{aligned}$$

The Jacobian of this system is

$$J = \begin{bmatrix} \beta_y\,[C'(Y) + \partial_Y NX(\,\cdot\,) - 1] & \beta_y\,[\partial_e I(\,\cdot\,)\mu'_F + \partial_e NX(\,\cdot\,)] \\ \\ \beta_e(\partial_\xi f(\,\cdot\,)\,\partial_Y i(\,\cdot\,)) & \beta_e(-\partial_\xi f(\,\cdot\,)\,\epsilon'(e) + (\partial_{W_p} f(\cdot) - 1)F_h) \end{bmatrix}.$$

Because of the nonlinearity of the $\dot{Y}$=0−isocline there exist three economically meaningful steady states in the considered situation, whose local stability properties can easily be calculated:

$$J_{E1} = \begin{bmatrix} - & + \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E1}) < 0, \quad det(J_{E1}) > 0 \Longrightarrow \text{stable steady state}$$

$$J_{E2} = \begin{bmatrix} - & - \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E2}) < 0, \quad det(J_{E2}) < 0 \Longrightarrow \text{saddle point}$$

$$J_{E3} = \begin{bmatrix} - & + \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E3}) < 0, \quad det(J_{E3}) > 0 \Longrightarrow \text{stable steady state.}$$

Steady state $E1$ represents the "normal" steady state, where the economy's output is high as well as the domestic investment activity. In this steady state, the standard case $|\partial_e I(\,\cdot\,)\upsilon\mu_F'| < \partial_e NX(\,\cdot\,)$ holds. Steady State $E2$ represents the fragile case with $|\partial_e I(\,\cdot\,)\upsilon\mu_F'| > \partial_e NX(\,\cdot\,)$: Because a slight deviation of the output level from this steady state level can lead the economy to a short-run investment boom or to a decline in the economic activity, this equilibrium point is unstable. Steady State $E3$ constitutes the "crisis equilibrium". At this equilibrium point the investment activity is highly depressed due to the high value of e. Nevertheless, the slope of the $\dot{Y}$−isocline is again positive because of $|\partial_e I(\,\cdot\,)\upsilon\mu_F'| < \partial_e NX(\,\cdot\,)$ describing the dominance of exports over (the remaining) investment demand in the considered situation.

Figure 6.3 shows the phase diagram of the complete DD-AA system for a floating nominal exchange rate regime.

Note that the AA-curve becomes only binding if the monetary authorities choose a flexible exchange rate regime. In a pegged exchange rate system the output level defined by the $\dot{Y}$=0−isocline at the given exchange rate level fully defines the unique equilibrium of the system. In such a currency system the $\dot{e}$=0−isocline can be interpreted as a "shadow curve" which represents the exchange rate level which would prevail if the currency was left to float freely. Because the monetary authorities are

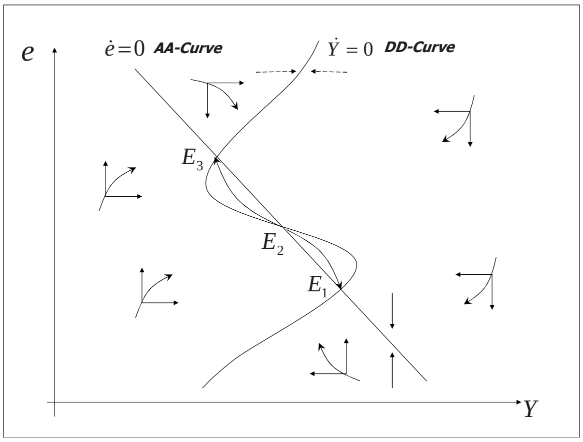


Fig. 6.3: The DD-AA Model

committed to remove any foreign exchange market disequilibria by buying or selling any amount of foreign currency bonds needed to defend the prevailing exchange rate level, the $\dot{e}$=0−isocline represents the over-demand or over-supply with which the central bank is confronted. Consequently, the larger the difference between the exchange rate level given by the "shadow curve" and the currency peg level, the higher is the demand for foreign currency bonds that the domestic central bank has to satisfy, and vice versa.

6.3.2 The Baseline Currency Crisis Scenario

In this section the macroeconomic dynamics resulting from a currency and financial crisis in economies with the totality of liabilities denominated in foreign currency under an initial fixed exchange rate regime and constant wages and prices (as it was assumed in the simple theoretical model by Flaschel and Semmler (2006)) will be discussed in order to give a first intuition in the way the model works. The results presented here will be useful to highlight the results of the different model extensions to be discussed below.

Assume the economy is initially at steady state $E1$ in Figure 6.4 and that The prevailing exchange rate system is a currency peg which is fully backed by the domestic central bank. Now suppose that the demand for foreign-currency bonds increases due to a rise in the "capital flight" parameter κ. As long as the central bank is disposed to defend the prevailing currency peg by selling foreign currency bonds there are no real effects on the domestic economic activity. In the case that the domestic monetary authorities decide

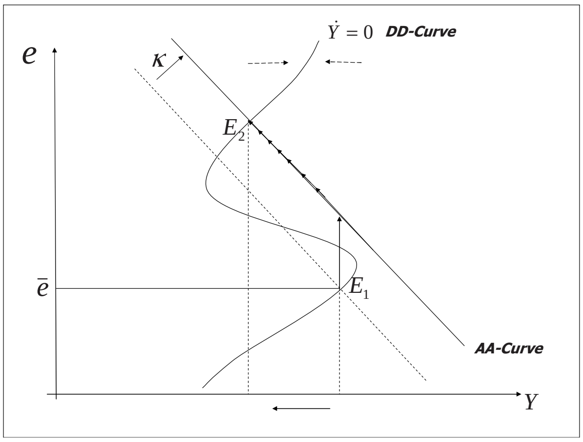


Fig. 6.4: The Macroeconomic Effects of a Currency and Financial Crisis under Fixed Domestic Goods Prices

to give in to the speculative pressures and to let the exchange rate float, the AA-Curve becomes the binding curve in the model. The exchange rate then jumps from the initial equilibrium $E1$ to the corresponding point at the AA-Curve (with a still unchanged output level). From this point on, two different scenarios which depend on the actual extent of the nominal exchange rate depreciation (or, in other words, the position of the AA-Curve by the time of the currency peg breakdown) are possible. In the first scenario, the corresponding point of the AA-Curve by the time of the depreciation lies below the backwards-sloped section of the DD-Curve. In this case, the depreciation and the resulting tightening of the credit conditions by the financial sector will not be of significant proportions so that the economy will, due to the temporary gain in competitiveness resulting from the depreciation, return to the equilibrium point $E1$.

In the second scenario, on the other hand, an increase in κ leads to a significant shift to the right of the AA-Curve, so that when the abandonment of the currency peg takes place, the corresponding point on the AA-Curve lies above the backwards-sloped section of the DD-Curve. As the trajectories sketched in Figure 6.3 show, if this shift is large enough, the equilibrium point $E2$ will be the attractor of the dynamics and the economy will converge to it. As it can be clearly observed in figure 6.4, this convergence, which will take place along the AA-Curve, will imply further nominal exchange rate depreciations as long as $E2$ lies left to $E1$. Indeed, location of the new steady state

$E2$ is central for the resulting dynamics not only of the nominal exchange rate but also of aggregate investment and output. If the new $E2$ lies left from the initial $E1$, the sharp nominal exchange rate depreciation will indeed lead to a breakdown of the economy due to the predominant effect of the depreciation on the credit awarding by banks and therefore on aggregate investment (and further nominal depreciations). But if on the contrary the new equilibrium point lies right from the old one, the gain in competitiveness and the resulting increase in the net exports will predominate the negative investment reaction. In this case the initial sharp depreciation of the currency will be followed by a revaluation of the currency and an increase in investment and output.

6.4 Dynamics under Gradually Adjusting Prices in Fixed Currency Regimes

Although the basic model just discussed is capable of describing the main sequence of events observed in the 1994-95 Mexican and 1997-98 East Asian currency and financial crises, it still neglects two central factors: the role of the price adjustments and the role of the domestic nominal interest rate. Indeed, because the domestic interest rate does not influence the level of domestic investment in a direct manner because the totality of domestic firms was assumed to borrow in foreign currency, the domestic monetary authorities are not confronted with an exchange-rate policy dilemma during a currency crisis. Theoretically, they are capable to increase the domestic interest rates indefinitely in order to defend the currency peg without producing any negative effects on the domestic economy. The decision to give in to a speculative attack on the domestic currency here relies more on the level of the foreign exchange reserves that the country has at the time of the currency run which may of course, dissipate during the currency run.

Despite the fact that during a currency and financial crisis price fluctuations probably do not play an important role because of the short time span in which such a twin crisis takes place, they surely are of great importance for the economic recovery process of such an economy. Real as well as nominal exchange rate fluctuations determine the international competitiveness of the domestic goods and the volume of the exports of the economy.

The assumption of constant domestic commodity prices in the context of sharp exchange rate fluctuations is also problematic because the exchange rate can affect the domestic price level through the following channels (see Svensson (2000)):

- The exchange rate level affects the domestic currency prices of imported goods, and therefore the CPI inflation rate.
- The exchange rate affects domestic currency prices of intermediate inputs.
- The exchange rate can also influence the nominal wage determination through CPI inflation and thus again the domestic inflation.

Given the above shortcomings of the basic model, we discuss now a first variant of the baseline currency crisis model of the previous section. The purpose of this extended model is to show how besides the exchange rate- also domestic price level fluctuations can influence the macroeconomic performance of a small open economy with dollarized liabilities and credit market constraints.

The core of this extended model still is the balance-sheet state-dependent investment function. Since domestic price fluctuations are now included, besides the role of the exchange rate, changes in the domestic price level p now also influence the aggregate investment level of the small open economy (while K, F_f are still kept constant). The inclusion of price fluctuations into the considered dynamics through a standard Phillips-Curve, coupled with the price level dependent investment function indeed brings considerable complexity into the system.

The aggregate consumption and export functions remain unchanged, with the only difference that the real exchange rate $\eta = e/p$ (the foreign goods price still set equal to one for simplicity) is now mainly driven by domestic price and not nominal exchange rate changes. The same holds also for the reaction of aggregate investment to changes in η.

On the assumption that a fixed exchange rate system prevails ($\bar{e} = 1$), the slope of the $\dot{Y}= 0-$isocline is described in the extended phase space (Y, p) (for output and the domestic price level now) by:

$$\left.\frac{\partial Y}{\partial p}\right|_{\dot{Y}=0} = -\frac{\partial_p I(\,\cdot\,)((1-\upsilon)i' + \upsilon\mu_F') + \partial_\eta NX(\cdot)}{C'(Y)\partial_Y NX(\cdot) - 1}$$

It can easily be seen that the slope of the $\dot{Y}$=0$-$isocline depends on which of the two opposite effects is the dominant one: the balance-sheet-effect $\partial_\eta I(\,\cdot\,) > 0$ or the competitiveness effect $\partial_\eta NX(\,\cdot\,) < 0$:

$$\partial_\eta I(\,\cdot\,)((1-\upsilon)i' + \upsilon\mu_F') > |\partial_\eta NX(\,\cdot\,)| \Longrightarrow \left.\frac{\partial Y}{\partial p}\right|_{\dot{Y}=0} > 0$$

and

$$\partial_\eta I(\,\cdot\,)((1-\upsilon)i' + \upsilon\mu_F') < |\partial_\eta NX(\,\cdot\,)| \Longrightarrow \left.\frac{\partial Y}{\partial p}\right|_{\dot{Y}=0} < 0.$$

From the shape of the assumed investment function there results (if its interior part is sufficiently steeper than its counterpart in the export function) that for intermediate values of $\tilde{q}$ the creditworthiness (the balance-sheet) effect is stronger than the "normal" competitiveness effect, changing the slope of the $\dot{Y}{=}0-$isocline and therefore opening up the possibility of multiple equilibria now in the (Y, p) phase space. The structure of the financial markets is as described in the baseline model.

Concerning the domestic price dynamics, we use a simple expectations augmented, open-economy wage-price Phillips-curve (on the assumption of a constant productivity production function and mark-up pricing) which can be written as

$$\hat{p} = \beta_p(Y - Y^n) + \hat{p}_c^e \text{ with } p_c = p^\theta(ep^*)^{1-\theta},\ \theta \in (0,1). \tag{6.13}$$

We now use p_c for the consumer price level, based on a geometric mean of the domestic and the foreign price level, both expressed in the domestic currency. Superscript e denotes expectations, implying that marked up domestic wage inflation is explained in this Phillips Curve by the output gap and the expected consumer price inflation rate. By keeping the foreign price level constant and assuming perfect foresight concerning domestic price level inflation and asymptotically rational nominal exchange rate depreciation expectations (implying thus that the domestic agents incorporate their expected exchange rate changes in their price setting behavior) we can reformulate the open-economy wage-price Phillips-curve as

$$\hat{p} = \beta_p(Y - Y^n) + \theta\hat{p} + (1-\theta)\beta_\epsilon(1-\eta)$$

or, after rearranging,

$$\hat{p} = \frac{1}{1-\theta}\beta_p(Y - Y^n) + \frac{(1-\theta)}{(1-\theta)}\beta_\epsilon(1-\eta)$$

Defining $\tilde{\beta}_p = \beta_p/(1-\theta)$, we thus obtain

$$\hat{p} = \tilde{\beta}_p(Y - Y^n) + \beta_\epsilon(1-\eta) \quad \text{or} \quad \dot{p} = \Big(\tilde{\beta}_p(Y - Y^n) + \beta_\epsilon\,(1-\eta)\Big)\,p, \tag{6.14}$$

what turns to

$$\hat{p} = \left(\tilde{\beta}_p(Y - Y^n)\right) p, \tag{6.15}$$

if the nominal exchange rate as well as the foreign price level are believed to remain constant by the economic agents. More generally, one may simply assume for this case that inflationary expectations are still ignored by this model type in order to save one law of motion and to leave the discussion of destabilizing Mundell type effects for later extensions of the model, see our discussion of kinked Phillips curves below.

The implied $\dot{p}$=0−isocline turns out to consist of two parts: for $p > 0$ the $\dot{p}$=0−isocline is the straight vertical line $Y = Y^n$. Along the horizontal axis ($p = 0$), additionally, $\dot{p}$=0 also holds: As discussed in the next section, a further — though economically not meaningful — steady state exists at the intersection of the $\dot{Y}$=0−isocline and the horizontal axis.

6.4.1 Local Stability Analysis

The extended currency crisis model (under a fixed exchange rate regime) is fully described by the following differential equations:

$$\begin{aligned}
\dot{Y} &= \beta_y \left[C(Y - \delta\bar{K} - \bar{T}) + I((1-\upsilon)r, \upsilon\mu_F) + \delta\bar{K} + \bar{G} + NX(Y^*, 1/p, Y) - Y\right] \\
\dot{p} &= \left[\tilde{\beta}_p(Y - Y^n)\right] p.
\end{aligned}$$

with the nominal exchange rate depreciation expectations still ignored.

The Jacobian of this system at the steady state is given by:

$$J = \begin{bmatrix} \beta_y\left(C'(Y) + \partial_Y NX(\,\cdot\,) - 1\right) & \beta_y\left(\partial_\eta I(\,\cdot\,)((1-\upsilon)i' + \upsilon\mu'_F) + \partial_\eta NX(\,\cdot\,)\right) \\ \tilde{\beta}_p p_0 & 0 \end{bmatrix}.$$

Because of the nonlinear shape of the $\dot{Y}$=0−isocline there exist three possible economically meaningful steady states,[4] whose local stability properties can easily be calculated:

$$J_{E1} = \begin{bmatrix} - & - \\ + & 0 \end{bmatrix} \Longrightarrow tr(J_{E1}) < 0, \quad det(J_{E1}) > 0 \Longrightarrow \text{a stable steady state}$$

[4] Due to the nonlinearity of the second law of motion there exists a fourth steady state at the point where the $\dot{Y}$=0−isocline cuts the horizontal axis. This fourth steady state is not relevant however, since it cannot be approached by the trajectories in the presently considered dynamics.

$$J_{E2} = \begin{bmatrix} - & + \\ & \\ + & 0 \end{bmatrix} \Longrightarrow tr(J_{E2}) < 0, \quad det(J_{E2}) < 0 \Longrightarrow \text{a saddle point}$$

$$J_{E3} = \begin{bmatrix} - & - \\ & \\ + & 0 \end{bmatrix} \Longrightarrow tr(J_{E3}) < 0, \quad det(J_{E3}) > 0 \Longrightarrow \text{a stable steady state.}$$

The resulting dynamics of our extended currency crisis model (still a fixed exchange rate) are described in Figure 6.5.

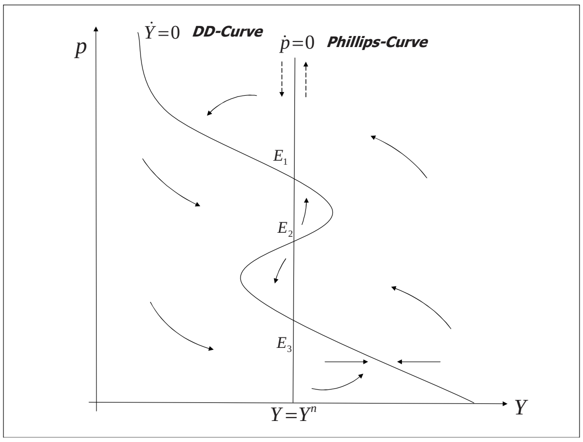


Fig. 6.5: Phase Space Representation of the DD-PC Dynamics with a Normal and a Bad Equilibrium, E_1 and E_3, respectively.

Steady state $E1$ represents the "normal" situation, where the domestic price level is high and therefore (under the assumption of a fixed exchange rate) η is low. In this steady state the economy's output is at its full employment level, the investment activity is high (due to the low $\tilde{q}_{\upsilon}$) and the exports are low due to a strong currency — relative to the high domestic price level — and thus low competitiveness.[5] In this steady state the standard situation $\partial_{\eta} I(\,\cdot\,)((1-\upsilon)i' + \upsilon\mu'_F) < |\partial_p NX(\,\cdot\,)|$ holds.

Steady State $E2$ represents the fragile case where $\partial_{\eta} I(\,\cdot\,)((1-\upsilon)i' + \upsilon\mu'_F) > |\partial_{\eta} NX(\,\cdot\,)|$ holds: A slight deviation of the output level from this steady state level can lead the economy to a short-run investment boom (and to an over-employment situation) or to

[5] Such a situation could be observed in the years preceding the East Asian Crisis, see Corsetti, Pesenti and Roubini (1999).

an economic slowdown or a recession, since this equilibrium point is unstable up to the two stable arms that are shown as dotted lines.

Steady State $E3$ constitutes the "crisis equilibrium". At this equilibrium point the investment activity is severely depressed due to the high value of η ($\tilde{q}_v$). The economy, though, is situated at its full-employment level because of the strong export of goods production induced by the very low level of domestic prices, and thus by the implied competitiveness of the economy.[6]

6.4.2 Dynamics with a Standard Phillips-Curve

Next, by employing a standard Phillips-Curve we discuss a situation where, after a one-time devaluation of the domestic currency as a result of a speculative attack, the economy experiences a financial crisis and can, eventually, shift from a "normal" equilibrium with high investment and low exports to a "crisis" equilibrium with depressed investment activity and high exports due to the included domestic price level adjustments. Assuming again a constant exchange rate after the devaluation, the model dynamics will be sketched in the $(p - Y)$ space instead of the $(e - Y)$ space as in the Flaschel and Semmler (2006) model.

Assume the economy is initially situated at its upper full employment level E_1 in Figure 6.6. A significant flight into foreign currency can take place in the model through an increase of the κ parameter in the foreign currency bond demand. As long as the monetary authorities can defend the old currency peg, the flight into foreign currency does not have any effects besides the reduction of the foreign exchange reserves of the central bank (because a constant money supply is assumed, a full sterilization of money base changes by the central bank is also implicitly assumed). Now suppose that the central bank gives in to the foreign market pressure after a while, because of the dangerous lowering of foreign reserves. In order to release the pressure from the foreign exchange market, see eq.(6.11), it carries out a one-time devaluation (for simplicity we assume in this section that the new exchange rate is then considered by the economic agents as "sustainable"). The effect of the currency devaluation on the $\dot{Y}{=}0-$isocline, i.e. the direction of the shift of the $\dot{Y}{=}0-$isocline depends on the strength of the balance-sheet and the competitiveness effects. To understand this point, consider the original model of section 6.3 where prices were held constant: There too the output

[6] For proofs for the global stability of the system, see Proaño et al. (2005).

reaction to the exchange rate change depended on the strength of the exchange rate effect on investment and exports.

The direction of the shift of the $\dot{Y}$=0−isocline in the extended 2D model (in the $(p-Y)$ space) is analogous to the exchange rate effect on output in the original model (in the $(e-Y)$ space): If $\partial_\eta I(\cdot)\upsilon\mu_F > |\partial_\eta NX(\cdot)|$ holds, the nominal devaluation of the domestic currency will shift the $\dot{Y}$=0−isocline to the left and vice-versa.

The resulting system dynamics after a severe nominal devaluation of the currency under the first situation are sketched in Figure 6.6.

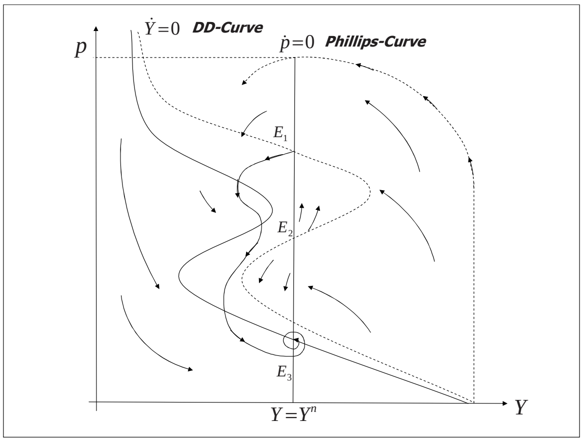


Fig. 6.6: The Macroeconomic Effects of a Currency and Financial Crisis under Gradually Adjusting Domestic Goods Prices

Directly after the currency crash, the banks take into account the sharp deterioration of the balance sheets of the business sector due to the strong devaluation of the domestic currency. As a means of hedging themselves against "bad creditors", they implement credit constraints and cut the volume of the granted loans. The industrial sector, put now in a dramatic financial situation, must cancel the majority of the investment projects either voluntarily or due to the credit constraints, leading to a reduction of aggregate demand, employment and, due to the Phillips-curve, also of the domestic price level.

We consider now as an example the case where the DD-curve – with the exception of the zero price level situation – unambiguously shifts to the left as a result of the currency devaluation. The steady state E_3 is assumed, due the size of the shift of the DD-curve, to be the only economically meaningful steady state. Falling prices are then at first accompanied by falling output levels. They lead to a further real depreciation, in addition to the initially caused nominal exchange rate shock. Thus in turn leads to further gains in competitiveness on the international goods market. Sooner or later, the increased foreign demand for domestic goods leads to such an increase in exports and that aggregate demand starts rising again, when the DD-curve is crossed from above by the initiated temporary deflationary process. The deflationary spiral, since output cannot rise by so much that the NAIRU level is reached again. Instead output will start falling once again – when the DD-curve is crossed again on the way down to the bad equilibrium – which still further down leads again to increasing output and then either to monotonic adjustment to the steady state E_3 or to damped cycles around it (shown in Figure 6.6). We thus in sum observe a deflationary process with fluctuating economic activity below the NAIRU output level until the economy is back to normal output levels and smaller cycles around them.

Falling prices have negative effects as well as positive effects on aggregate demand. The latter because of an export increase and the former because they reduce the nominal value of the firms' capital, deteriorating even more their financial situation. We thus have both counteracting forces operating simultaneously, with a stronger investment effect initially (implying decreasing output levels), and an over time increasingly stronger competitiveness effect, which will lead to improvements in the trade balance and therefore to higher economic activity, which however will still be lower than at its normal level and thus will still be accompanied by further deflationary pressures. The graphical analysis here shows that the economy will fluctuate around a somewhat persistent underemployment situation (with still falling prices) until the competitiveness effect finally dominates (maybe because the investment level has come close to its "floor" level) and the economy returns to its "full"-employment level. This must happen by assumption since it was assumed that the intersection of the DD-curve with the horizontal axis lies to the left of the NAIRU output level. Deflation therefore must come to an end and – maybe also with temporarily increasing price levels – approach the steady state price level at E_3 finally.

Note that the crucial mechanism in this dynamics that allows the economy to return to the full-employment situation is the variation of the domestic price level. Because in basic model sketched in section 6.3.2 there are assumed prices to be constant, one cannot consider the (medium-run) possibility for the economy to return to a "full"-employment situation. In the basic model the country which suffered from a currency and financial crisis is "thrown back" to a lower steady state output level where it remained because the model did not produce any endogenous mechanism that would allow the economy to recover from the twin crisis. In this extended version where we allow prices to be sufficiently flexible the economic performance of the economy can sufficiently improve through a real depreciation of the domestic goods, leading it back to the full-employment level if the ceilings and floors in the investment and the export function are chosen appropriately.

However, in contrast to our basic model discussed in section 6.3, where we could have large output loss in the crisis equilibrium, this extended model may raise the question to what extent the lower equilibrium represents a bad equilibrium. We have full employment in the sense of the NAIRU theory, coupled with high exports, but very low investment activity. The growth rate of the capital stock is thus very depressed or even negative. This, of course, is bad for the future evolution of the economy with respect to income growth and employment growth. Furthermore, if economic activity is moving towards the lower equilibrium, the evolution may be subject to long periods of deflation, in particular if there are downward rigidities in money wage adjustments (a nonlinear PC) as we will consider them briefly below. In the present model, the dangers of deflation are not fully included, and thus do not call for particular attention by the monetary authority – with the exception that monetary policy may be used to speed up the process of convergence to the good equilibrium and to avoid the bad equilibrium. This will be discussed in the next section.

6.4.3 Dynamics with a "Kinked" Phillips Curve

Yet, already Keynes (1936, ch.2) had recognized that an economy-wide wage deflation with a simultaneous deflation in money wages is rare to be observed. Taking downward money wage rigidity into account the wage-price Phillips-Curve can be modified as follows:

$$\hat{p} = \max\left\{\tilde{\beta}_p(Y - Y^n), 0\right\}. \tag{6.16}$$

This modified Phillips-Curve implies that in under-employment situations prices do not fall but instead remain constant. Price changes can only take place in over-employment situations, where the price level is assumed to rise as before. Adding such a kink in money wage behavior modifies the considered dynamics as follows:

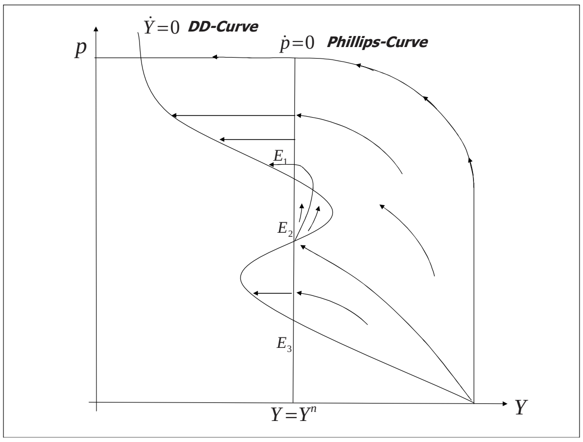


Fig. 6.7: The Consequences of Downward Money Wage Rigidity

The empirical observation of downwardly rigid wages has important consequences for the dynamics of the extended model. Assume the country finds itself in the same situation as discussed above: After a run on the foreign currency the monetary authorities are forced to devaluate, so that – under the assumption that $\partial_\eta I(\cdot)\upsilon\mu_F' > |\partial_\eta NX(\cdot)|$ holds – aggregate demand declines and the $\dot{Y}$=0−isocline shifts again to the left. Because in the entire economic domain to the left of the $\dot{p}$=0−isocline we have that $\hat{p}$=0 holds true, the $\dot{Y}$=0−isocline is in this domain an attracting curve representing stable depressions. All points on the $\dot{Y}$=0−isocline to the left of the $\dot{p}$=0−isocline are thus now equilibrium points. For each of these steady states, there is no longer a mechanism that allows the economy to return to its "full"-employment level. The "crisis" equilibrium in the basic model of sections 6.3.2, derived from Flaschel and Semmler (2006), is now just one of these under-employment equilibria.

One may argue therefore that the assumed wage rigidity is bad for the working of the economy. However, at present deflation is still a too tranquil process in order to allow for any other conclusion. Advocates of downward wage flexibility should therefore not yet interpret the present framework as an developed argument that supports their view. Adding real rate of interest effects (Mundell-effects) to the formulation of aggregate demand, or adding a Fisher debt effect to investment behavior, can easily remove the lower turning point in deflation dynamics from the model. This would therefore imply an economic breakdown, in case the kink in the money wage PC was not there. The kinked wage Phillips Curve prevents or at least delays deflationary processes from working their way. Though stable depressions may be considered a big problem, the remedy to allow for a significant degree of wage flexibility would in such situations not revive the economy, but make things only worse, in particular in situations where a liquidity trap has become established.

In the present form of the model the kink in wage behavior however implies that a stable depression becomes established to the left of the good equilibrium E_1 with no effect on the price level, as it was already considered in Flaschel and Semmler (2006).

6.5 Dynamics under Gradually Adjusting Prices and Nominal Exchange Rates

After having investigated the role of nominal exchange rate and domestic price level adjustments for the medium run dynamics of our model separately, we analyze in this section the dynamics of the model when both the nominal exchange rate and the domestic price level are allowed to adjust to disequilibrium situations in both the goods and the financial markets. Note that the strength of the balance-sheet effect on the aggregate demand depends on the degree of dollarization of liabilities in the economy υ: For $\upsilon = 1$, the balance-sheet effect operates with full strength, while for $0 < \upsilon < 1$ this effect operates only partially.

In the flexible exchange rate regime the model consists of the following differential equations:

$$\begin{aligned}
\dot{Y} &= \beta_y \left[C_1(Y - \bar{T}) + I((1-\upsilon)r, \upsilon\mu_F) + \delta\bar{K} + \bar{G} + X(\bar{Y}^*, \eta, Y) - Y\right] \\
\dot{\eta} &= \frac{\beta_e}{p}\left[f\left(i(Y, \bar{M}/p) - \bar{i}^* - \beta_\varepsilon(1-\eta), W_h, \kappa\right) - \eta F_h\right] \\
&\quad - \left(\tilde{\beta}_p(Y - Y^n) + \beta_\epsilon(1-\eta)\right)\eta
\end{aligned}$$

The first differential equation is the standard goods markets adjustment mechanism described by eq.(6.4) in section 6.2. The second equation gathers eq.(6.12) and eq.(6.14) and represents the adjustment of the real exchange rate to changes in Y. As it can easily be observed, for $Y > Y^n$ the real exchange rate appreciates, i.e. $\dot{\eta} < 0$. This development results from two effects: on the one hand, a rise in Y above Y^n leads to a nominal interest rate increase due to the Taylor rule and therefore to a nominal exchange rate appreciation , i.e. $\dot{e} < 0$. On the other hand, for $Y > Y^n$ follows that

$\dot{p} > 0$. The additional term of exchange rate expectations only strengthens this effect (but it is not its main determinant). For $Y < Y^n$, the opposite holds.

The Jacobian of this system is

$$J = \begin{bmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{bmatrix}$$

with

$$\begin{aligned} J_{11} &= \beta_y \left[C'(Y) + \partial_r I(\,\cdot\,)(1-\upsilon)\partial_Y i(\,\cdot\,) + \partial_Y NX(\,\cdot\,) - 1\right] \\ J_{12} &= \beta_y \left[\partial_\eta I(\,\cdot\,)\upsilon\mu_F' + \partial_\eta NX(\,\cdot\,)\right] \\ J_{21} &= \frac{\beta_e}{p}\partial_\xi f(\,\cdot\,)\partial_Y i(\,\cdot\,) - \tilde{\beta}_p \eta \\ J_{22} &= \frac{\beta_e}{p}(\partial_{W_p} f(\,\cdot\,) - 1)F_{po}). \end{aligned}$$

Because of the nonlinearity of the $\dot{Y}$=0−isocline there exist three economically meaningful steady states in the considered situation, whose local stability properties can be calculated easily:

$$J_{E1,\,E3} = \begin{bmatrix} - & + \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E1}) < 0, \quad det(J_{E1}) > 0 \Longrightarrow \text{stable steady state}$$

$$J_{E2} = \begin{bmatrix} - & - \\ - & - \end{bmatrix} \Longrightarrow tr(J_{E2}) < 0, \quad det(J_{E2}) < 0 \Longrightarrow \text{saddle point}$$

under the assumption of a stable interaction between goods markets, price dynamics and monetary policy, implying that

$$C'(Y) < |\partial_r I(\cdot)(1-\upsilon)\partial_Y i(\cdot) + \partial_Y NX(\cdot) - 1|$$

holds for J_{11}. The resulting phase diagram of this currency crisis model is sketched in Figure 6.8.

Steady state $E1$ represents the "normal" steady state, where the economy's output is high as well as the domestic investment activity. In this steady state, the standard

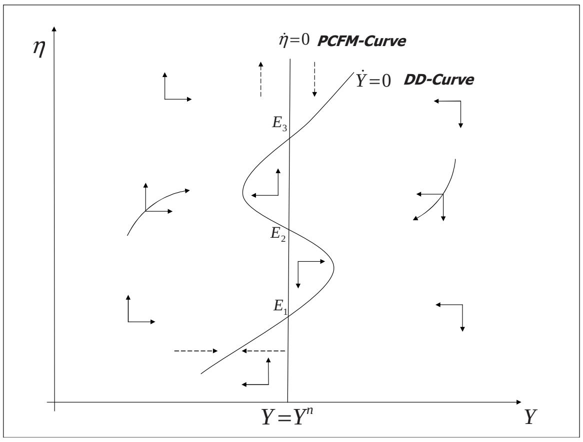


Fig. 6.8: The DD-PCFM Model

case $|\partial_\eta I(\cdot)\upsilon\mu_F'| < \partial_\eta NX(\cdot)$ holds. Steady State $E2$ represents the fragile case with $|\partial_\eta I(\cdot)\upsilon\mu_F'| > \partial_\eta NX(\cdot)$: Because a slight deviation of the output level from this steady state level can lead the economy to a short-run investment boom or to a decline in the economic activity, this equilibrium point is unstable. Steady State $E3$ constitutes the "crisis equilibrium". At this equilibrium point the investment activity is highly depressed due to the high value of e. Nevertheless, the slope of the $\dot{Y} = 0-$isocline is again positive because of $|\partial_\eta I(\cdot)\upsilon\mu_F'| < \partial_\eta NX(\cdot)$ describing the dominance of exports over (the remaining) investment demand in the considered situation.

6.5.1 The Case of Total Liability Dollarization $\upsilon = 1$

In order to highlight the implications of the incorporation of the domestic interest rate in the aggregate investment function of our model, we discuss first the resulting dynamics for the complete liability dollarization case ($\upsilon = 1$), as it was the case in Flaschel and Semmler (2006) and Proaño et al. (2005). Assume the economy is initially situated at its NAIRU employment level in steady state E_1. A speculative attack on the domestic currency can be represented in our model by an increase of the parameter κ in the foreign currency bond demand. In such a situation, the domestic monetary authorities can choose between two strategies: Increasing the nominal interest rates or serve the excess demand by the reduction of their foreign exchange reserves. In both cases, the flight into foreign currency does not have any real effects as long as the monetary authorities can defend the old currency peg besides the reduction in the money supply – resulting from the operations in the foreign exchange market – and the reduction of the foreign exchange reserves of the central bank. Since domestic investment is solely financed through foreign currency credit, as long as the nominal exchange rate remains unchanged, the speculative attack on the domestic currency does not affect the creditworthiness of - and therefore the credit awarding to domestic firms. Now suppose that the central bank gives in to the foreign market pressure due to, say, a dangerous approaching of the international reserves to a critical level. As a result of a speculative attack on the domestic currency, the nominal exchange rate devaluates sharply, triggering the activation of credit constraints by the financial sector and depressing the level of aggregate investment and therefore of the entire economic activity. Now, while in the model discussed in the previous section the new exchange rate level after the one-time devaluation was assumed for simplicity to be considered by the economic agents as "sustainable", here, on the contrary, this must not necessarily be the case, as we will discuss below.

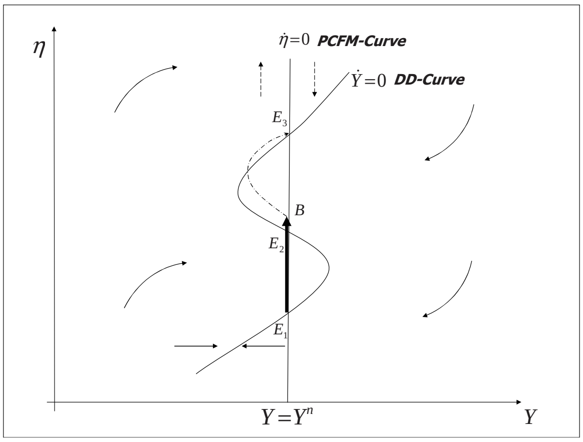


Fig. 6.9: The Consequences of a Breakdown of the Currency Peg in the Case of Total Liability Dollarization

In the (η, Y) - space, the short run sharp nominal exchange rate devaluation is represented by a "jump" of the value of η along the $\dot{\eta} = 0-$isocline up to point B.[7] Now, due to the dynamic adjustment mechanism in the goods markets, Y declines so that $Y < Y^n$. This development has two effects, as already discussed in the previous sec-

[7] We assume that the nominal depreciation is of such magnitude that B lies above the unstable steady state $E2$. We will discuss the case where B lies below $E2$ below.

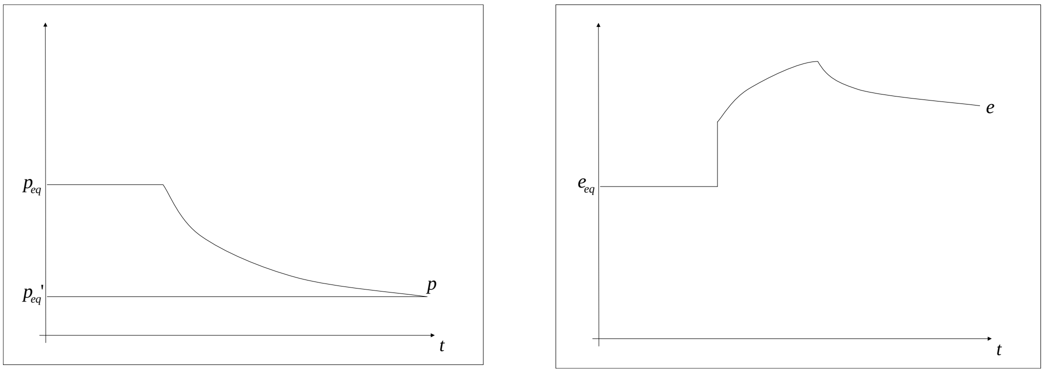


Fig. 6.10: Price Level and Exchange Rate Adjustments after a Breakdown of the Currency Peg in the DD-PF Model

tion. On the one hand (assuming now a post-crisis flexible exchange rate regime), a decrease in Y leads to a fall in the domestic interest rates and to a higher demand for foreign bonds and to a further rise in e. On the other hand, the underemployment situation leads to a fall in the domestic price level, i.e. $\dot{p} < 0$. Both effects lead to a strong depreciation of real exchange rate, helping the economy to return to its NAIRU employment level through the expansion of the domestic exports. Obviously, in a post-crisis fixed exchange rate regime, a much more severe deflationary process than in a flexible exchange rate regime is required for the domestic economy to return to its pre-crisis NAIRU level of employment, as discussed in Proaño et al. (2005). These dynamics are sketched in Figure 6.9.

Since now the nominal exchange rate is allowed to float after the occurrence of the currency crisis, there is no necessity for a severe deflationary process in order to reach the NAIRU consistent output again. Further nominal exchange rate adjustments (in this case depreciations) can also contribute to further real exchange rate devaluations.

As stated before, in the case of total liability dollarization, a defense of the prevailing exchange rate level by the domestic monetary authorities would not have (at least in the short run) a direct effect on the aggregate demand because the domestic firms finance their investment projects completely through foreign currency credit. Theoretically, the monetary authorities could thus indefinitely increase the domestic interest rates in order to reduce the pressure on the exchange rate without directly affecting the real sector of the economy. Such a measure could reduce the magnitude of an eventual nominal depreciation and might even generate a short run expansion due to the expansion of the net exports, if the real exchange rate jumps in the short run only to a point B' below the steady state E_2.

Downward rigidity as discussed by the "kinked" Phillips Curve in section 6.4.3 does not "condemn" here, in contrast, the economy to remain in such under-employment equilibria due to the absence of a way to re-gain competitiveness and therefore to increase the level of exports again. In the presence of downward rigidity the nominal exchange rate assumes the whole weight of the recovery process so that further nominal (and also real) exchange rate depreciations are needed to enhance the competitiveness of the domestic products in the international goods markets and so to return to the NAIRU-production level.

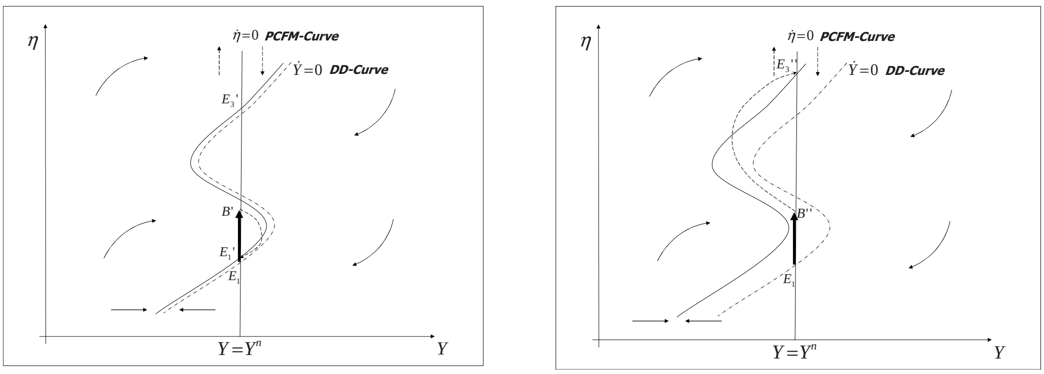
6.5.2 The Case of Partial Liability Dollarization 0< υ <1

We now analyze the dynamics of the model for the case where a fraction of the domestic firms does not issue foreign-currency debt but instead finances its investment projects by domestic currency denominated credit. Despite the fact that the $\dot{Y} = 0-$isocline has basically the same shape as in the previous section, the magnitude of the balance-sheet effect on the aggregate investment and therefore on the aggregate demand depends on the degree of dollarization of liabilities in the economy.

In an economy with liabilities denominated only partially in foreign currency, during a speculative attack on the domestic currency the monetary authorities are confronted with a lose-lose situation. Exactly this situation is represented when $0 < \upsilon < 1$. In this case an increase of the domestic interest rate has a direct effect on the aggregate investment due to a subsequent decrease of the investments undertaken by the fraction $(1 - \upsilon)$ of domestic firms. In our model, such a response to a speculative attack on the domestic currency does not only influence the dynamics of $\dot{\eta}$, but it also shifts the $\dot{Y} = 0-$isocline to the left reducing the aggregate investment and demand, as sketched in Figures 6.11 and 6.12. In the next sections we show that this potential counterproductiveness of an increase in the domestic interest rate by the monetary authorities depends on the elasticity of the aggregate demand with respect to interest rate changes.

Dynamics after a Successful Defense of the Currency Peg

Under the assumption that the increase of the domestic nominal interest rate by monetary authorities succeeds in lowering the pressure in the foreign exchange market so that the prevailing exchange rate (or currency peg in case of a fixed exchange rate regime) remains at its former level (or just slightly deviates from it), two scenarios are possible. If the elasticity of the aggregate investment with respect to domestic interest rate changes is low (and/or the degree of liability dollarization in the economy is particularly high), the $\dot{Y} = 0-$isocline will not significantly shift to the left and the economy will return to an equilibrium point very similar to the pre-crisis equilibrium situation after a short term period of slight over-production and -employment and a moderate domestic inflation, as sketched in Figure 6.11a. If, on the contrary, the elasticity of the aggregate demand to interest rate changes is high (and/or the degree of liability dollarization is low), the DD-Curve will significantly shift to the left and the $E1$ equilibrium point might be missed, as sketched in Figure 6.11b.



a) b)

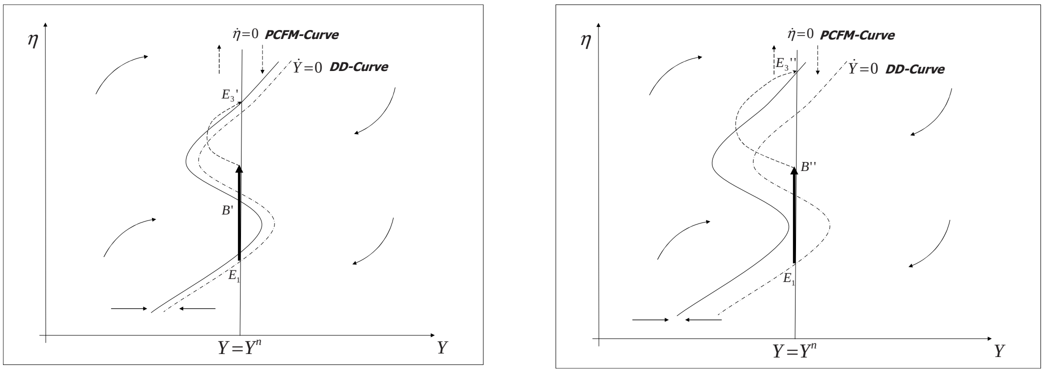
Fig. 6.11: Real Exchange Rate and Output Dynamics resulting from a Successful Defense of the Exchange Rate Level under a) Low and b) High Interest Rate Elasticity of the Aggregate Investment

In this second case an increase in the domestic interest rate will thus lead to a severe economic slowdown in the short run due to the fall in the aggregate demand, despite of the successful defense of the nominal exchange rate. In the medium run, the equilibrium point E_3 is the only steady state to which the economy can converge to. Since $Y < Y^n$, the domestic price level will fall and $\dot{\eta} > 0$, even though the nominal exchange rate might remain fixed. This decrease in the domestic price level will enhance the competitiveness of the domestic products in the international markets, expanding the export volume and leading the economy in the medium run to the full-employment level E_3, with a different composition though, namely high exports and depressed investments. Note nevertheless that this recovery process might only take place if the domestic wages and prices fall sufficiently to enhance in a significant way the competitiveness of the domestic goods. If the domestic nominal wages and prices are downwardly rigid as empirically is the case in the majority of modern economies, then the economy might stay in an unemployment situation where the nominal exchange rate is constantly under pressure for a longer period of time. In this case, two alternatives to return to Y^n exist: either the government pursues an expansionary fiscal policy (shifting the DD-Curve back to the right) or the monetary authorities give in to the foreign exchange market pressure and devaluate the domestic currency, accelerating so the recovery process to E_3.

Dynamics after a Failed Defense of the Currency Peg

The two possible scenarios discussed in the previous section were based on the assumption that an interest rate increase by the domestic monetary authorities is successful in the defense of the prevailing exchange rate (or currency peg in case of a fixed exchange rate regime). Nevertheless, as the majority of currency crises in the last decades have demonstrated, the foreign exchange market pressure can be of such a magnitude that the monetary authorities might be forced to devalue or let the nominal exchange rate float. In such a case the currency mismatch between the assets and liabilities of the fraction of domestic firms which finance their investment projects through foreign currency credit takes place all in all, leading to the activation of credit constraints by the financial sector and to a decrease in the investment of the group of domestic firms indebted in foreign currency. The investment of the remaining firms, which actually does not depend on the level of the nominal exchange rate, is also affected by the domestic interest rate increases undertaken by the monetary authorities in their effort to defend the currency peg. The aggregate consequences for the economy are then catastrophic, since not a fraction, but the complete investment by the entrepreneurial sector is depressed. The extent of the investment decrease depends, of course, on the interest rate elasticity of the aggregate demand, as shown in Figure 6.12.

Figures 6.12a and 6.12b show an important insight: the higher the interest rate elasticity



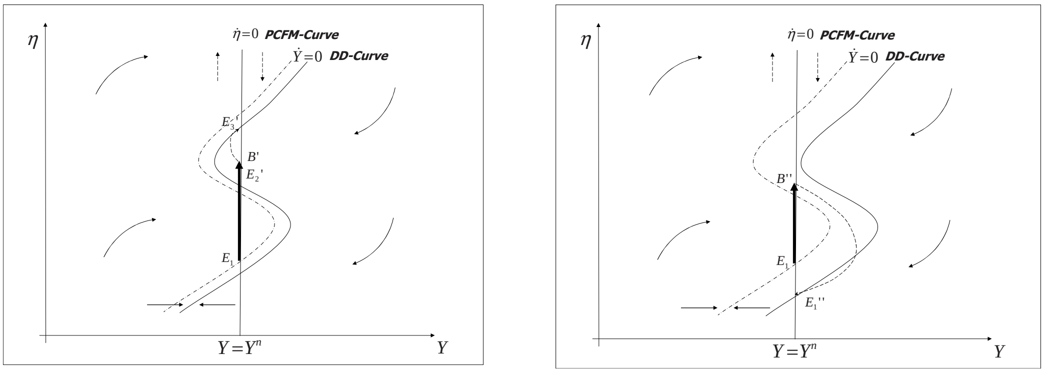
a) b)

Fig. 6.12: Real Exchange Rate and Output Dynamics resulting from a Failed Defense of the Exchange Rate Level under a) Low and b) High Interest Rate Elasticity of the Aggregate Investment

of the aggregate demand is, the longer will be the recession period the economy will experience after the currency breakdown and the higher will be the equilibrium real exchange rate to which the economy converges in the medium run, as shown in Figure 6.12b. These results are intuitive: the higher the interest rate elasticity of the aggregate demand, the greater is the investment decrease and therefore the real exchange rate increase which is needed for the economy to return to its NAIRU level of employment and production. We see thus that a failed defense of the prevailing exchange rate by the monetary authorities can have disastrous implications for the short- and medium run performance of the economy.

6.5.3 Short Term Policy Responses and Medium Term Consequences: The Rules vs. Discretion Debate

Due to the potential occurrence of the scenarios discussed above, Furman and Stiglitz (1998), Radelet and Sachs (1998) and Krugman (2000b) have pledged that in certain situations not an *increase*, but a *decrease* in the domestic interest rate might be the right measure during a speculative attack on the domestic currency. Indeed, since the exchange rate does not have *per se* a real meaning for the economic activity, the monetary authorities might decide to bring the foreign exchange market turmoil behind them once and for all and to stabilise or even to enhance the economic activity by lowering the interest rates, irrespective of the exchange rate level. Such a measure will induce an even greater nominal exchange rate depreciation, i.e. a jump from E_1 to B' as sketched in Figure 6.13. As shown there, the resulting dynamics depend on whether the new nominal (and real in the short run) exchange rate lies beneath or above the unstable new steady state E_2''.



a) b)

Fig. 6.13: Two Possible Consequences of an Interest Rate Decrease as a Response to a Speculative Attack a in Economy with Dollarized Liabilities

In Figure 6.13a, where the interest rate elasticity of the aggregate demand is low, the $DD-$Curve does not significantly shift to the right after the interest rate decrease, so that B' lies above E_2'' in the short run. In this case the economy will experience a period of underemployment, depressed investment of the fraction of domestic firms indebted in foreign currency (due to the increase of the domestic currency value of the foreign currency liabilities of that group) and falling prices (since $Y < Y^n$) until E_3' is reached. Again, the enhancement of the net exports via real depreciation is the mechanism which enables the economy to return to its NAIRU level of employment. Nevertheless, the output loss in this case will probably be lower and the duration of the economic slowdown shorter than in the previous cases where the exchange rate was successfully defended but the aggregate investment was severely damaged, as sketched in Figure 6.12.

In Figure 6.13b, where the interest rate elasticity of the aggregate demand is high, the aggregate investment rises due to the decrease of the domestic interest rate, shifting the $DD-$Curve significantly to the right (perhaps even so much that E_3 disappears as sketched above), so that B' lies below E_2'' in the short run (if E_2 still exists). In this case the positive effect of the domestic interest rate decrease overcomes the negative balance sheet effect resulting form the nominal depreciation of the domestic currency. In this scenario, thus, the final outcome is a period of over-production and -employment of the economy caused by higher aggregate investment and net exports, despite of the decline in investment of the fraction of firms indebted in foreign currency. Nevertheless, due to the resulting increase in the domestic price level (since $Y > Y^n$), over time the domestic products will loose competitiveness and the net exports will decrease again, leading the economy to its NAIRU production level at E_1'.

In the previous section we showed that while the defense of the currency peg through interest rate increases is likely to have devastating effects on the real side of economy, even if it is successful, in determinate situations the alternative strategy of interest rate decreases, as proposed by Furman and Stiglitz (1998) and Krugman (2000b), among others, might be a better strategy to follow from a medium-run output-stabilization point of view.

From the intertemporal point of view and more specifically, in the context of the rules-vs.-discretion debate, the choice of the "adequate" strategy to follow depends on additional factors. Indeed, if as for example in Burnside, Eichenbaum and Rebelo (2001) the mere existence of a currency peg regime is considered as dependent on the credibility of the monetary authorities as "peg defenders", the only available, and from an intertemporal point of view, sustainable strategy to be implemented would be the defense of the currency peg by means of domestic interest rate increases. Indeed, if the domestic monetary authorities would not follow such a strategy, the resulting lack of credibility in the financial markets would enhance and even encourage further attacks on the domestic currency, due to the (justified) expected capital gains from such a handling. This would make it impossible for the attacked economies to remain in a fixed exchange rate regime, even if the domestic monetary authorities peg the exchange rate at a new (higher) level after a successful speculative attack.

On the contrary, if the monetary authorities decide during a speculative attack in a discretionary manner to abandon the system of currency pegs and let the nominal exchange rate float indefinitely and therefore to fulfill a radical macroeconomic regime change, then considerations about their credibility as "peg defenders" will not be of much importance anymore. In the new flexible exchange rate regime, the domestic monetary authorities would not be directly accountable for nominal exchange rate fluctuations. Their commitment to price stability and therefore to a stable purchasing power of the domestic currency is what would be of much more importance for the determination of the nominal exchange rate in such a floating regime.

The decision concerning the response to a speculative attack, and more generally, concerning the old rules-vs.-discretion debate, depends thus not only on the relative impact of currency mismatches and domestic interest rates effects, but also on the intertemporal pros and cons of the abandonment of a fixed exchange rate system for a floating regime for the domestic economy.

6.6 Econometric Analysis

As stated before, the East Asian as well as the Mexican (1994-95) currency and financial crises are quite particular episodes in financial history due to the abruptness and extent to which the real side of the economy was affected by the sharp devaluations of the domestic currency. As previously discussed, the fact that in the majority of countries the domestic monetary authorities tried to defend – though unsuccessfully – the prevailing nominal exchange rate by raising the domestic short term interest rates (a measure which was backed up by the IMF) raises the question whether that strategy was not in part responsible for the subsequent sharp decline in the aggregate demand, and especially in the aggregate investment, as discussed in the model scenario sketched in Figure 6.12.

In Figure 6.14 we show time series data of Mexico and selected East Asian countries for the 1990s, the decade when currency and financial crises took place in those countries. In all cases a sharp nominal exchange rate depreciation, caused by a successful speculative attack, preceded an abrupt and severe decline in the aggregate investment activity in the following quarters.

While the collapse of the aggregate investment in nearly all attacked East Asian countries has been explained by the majority of researchers by means of an open-economy version of the financial accelerator concept introduced by Bernanke et al. (1996), whereafter the domestic currency value of the foreign currency liabilities soared due to the sharp nominal depreciation of the domestic currencies, leading to a credit crunch by the financial intermediaries, the sharp increase in the nominal domestic interest rates might also have been an important source of the breakdown of investment, as discussed in the theoretical model in the previous sections. In order to address the relative importance of these two effects for the behavior of aggregate investment after the currency crisis,

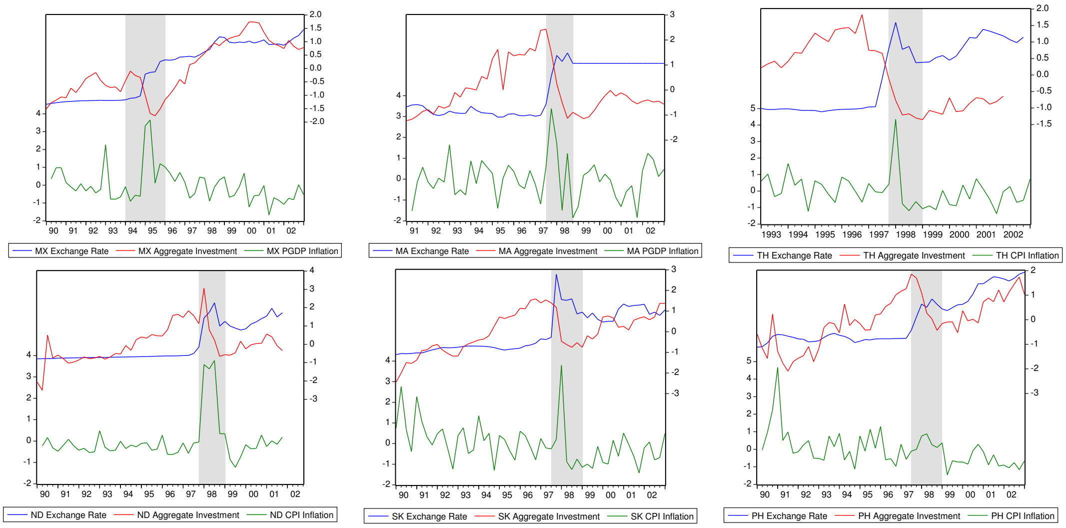


Fig. 6.14: Real Aggregate Investment, Nominal Exchange Rates and Price Inflation (normalized data)

in this section we investigate the dynamic interaction of the nominal exchange rate, the domestic nominal interest rate and the aggregate investment in a sample of East Asian countries by means of an unrestricted VARX (vector autoregressive model with exogenous terms) estimation.

For our analysis we use time series data of aggregate investment (in constant 1995 prices, seasonally adjusted), the respective nominal bilateral US-Dollar exchange and domestic interest rates of Mexico (MX), Malaysia (MA), Thailand (TH), Indonesia (ND), South Korea (SK) and the Philippines (PH) and the CPI/PGDP (depending on their availability) inflation stemming from the International Statistical Yearbook 2003. As endogenous variables in the VARX model we use the logs of these variables, with the exception of the respective price indices, of which we use the growth rates.

The question whether the analyzed time series were integrated and eventually cointegrated was not pursued in the following econometric analysis because of two reasons: First, no economic interpretation or theory is available (as for as we know) about a "steady state" relationship between the *level* of dollarized debt of a country and its aggregate investment: A possible cointegrating relationship between these variables would face difficulties to be interpreted in form of economic theory. Second, because of the small size of the time series samples, the results of unit root and cointegration tests would not be reliable enough to make a definitive assertion about their order of

Tab. 6.2: Descriptive Statistics

Country	Variable	Sample	Obs	Mean	Min	Max	Std.Dev	JB-Prob.
MX	exchrate_lg	1990Q1-2003Q1	53	1.764	0.989	2.022	0.518	0.023
	tbillrate_lg	1990Q1-2003Q1	53	2.917	1.880	4.100	0.523	0.917
	investment_lg	1990Q1-2003Q1	53	5.971	5.613	6.274	0.175	0.269
MA	exchrate_lg	1991Q1-2003Q1	49	1.123	0.901	1.400	0.197	0.024
	lendrate_lg	1991Q1-2003Q1	49	2.080	1.854	2.502	0.167	0.367
	investment_lg	1991Q1-2003Q1	49	9.828	9.498	10.32	0.231	0.135
TH	exchrate_lg	1993Q1-2002Q1	37	3.471	3.203	3.852	0.247	0.084
	lendrate_lg	1993Q1-2002Q1	37	2.375	1.945	2.724	0.256	0.180
	investment_lg	1993Q1-2002Q1	37	5.729	5.286	6.186	0.289	0.158
ND	exchrate_lg	1990Q1-2001Q4	48	7.742	7.502	9.413	0.695	0.023
	moneyrate_lg	1990Q1-2001Q4	48	2.566	1.900	4.306	0.577	0.000
	investment_lg	1990Q1-2001Q4	48	10.282	9.586	10.77	0.208	0.009
SK	exchrate_lg	1990Q1-2003Q1	53	6.861	6.554	7.435	0.248	0.064
	tbillrate_lg	1990Q1-2003Q1	53	2.259	1.386	3.173	0.524	0.064
	investment_lg	1990Q1-2003Q1	53	10.35	10.00	10.54	0.126	0.342
PH	exchrate_lg	1990Q1-2003Q1	53	3.489	3.118	3.990	0.284	0.041
	lendrate_lg	1990Q1-2003Q1	53	2.505	1.531	2.541	0.396	0.630
	investment_lg	1990Q1-2003Q1	53	4.676	4.379	4.676	0.128	0.306

integration and cointegration. Because of these reasons we perform our VARX analysis in level form.

The restricted data availability does not allow us, unfortunately, to check for a highly probable nonlinear relationship between investment and sharp nominal exchange increases by means of econometric methods, forcing us to assume a log-linear relationship in our estimations. Concerning the lag order of the VARX models, it was chosen according to the Schwarz information criterion.

Tab. 6.3: Schwarz Bayesian VAR Lag Length Selection Criteria

Lags	MX	MA	TH	ND	SK	PH
0	1.474	-1.591	-0.848	2.999	-0.700	-0.917
1	-7.739	-7.510*	-7.175*	-3.373*	-7.659	-6.671*
2	-7.905*	-7.215	-6.872	-3.240	-8.117*	-6.314
3	-7.577	-6.971	-6.905	-3.142	-8.094	-5.896
4	-7.434	-6.921	-6.567	-3.039	-7.583	-5.354
5	-6.856	-6.370	-5.967	-2.836	-7.044	-4.899
6	-6.370	-5.762	-5.725	-2.528	-6.690	-4.544

We analyze the dynamic response of aggregate investment to nominal exchange rate and interest rate shocks by calculating impulse-response functions based on the estimated

Tab. 6.4: Residual Serial Correlation LM-Tests
H0: No Serial Correlation at Lag Order h. Probs from Chi-Square with 9 DFs

Lags	MX	MA	TH	ND	SK	PH
1	0.1479	0.0049	0.1349	0.0034	0.0002	0.1346
2	0.8761	0.0070	0.1832	0.3669	0.2340	0.0595
3	0.6915	0.3359	0.0195	0.3207	0.8823	0.8778
4	0.7882	0.2362	0.9898	0.3292	0.8882	0.1344
5	0.7046	0.6483	0.0031	0.0173	0.2753	0.2362
6	0.0283	0.3015	0.0288	0.8298	0.6693	0.0910
7	0.4765	0.5400	0.2478	0.9164	0.8256	0.0066
8	0.2146	0.8300	0.8809	0.6179	0.2686	0.4955
9	0.9168	0.7342	0.5277	0.7469	0.8055	0.1958
10	0.9653	0.3624	0.4262	0.9871	0.6591	0.6801

parameters of the corresponding VARX models. As discussed in Bernanke, Gertler and Watson (1997), VARs are used to analyze the systematic responses of an economic system, for example, to unanticipated shocks (like exchange rate shocks). Now, since large and abrupt nominal exchange and interest rate increases as the ones observed during the Mexican and East Asian crises are likely to have been unexpected by the economic agents, we interpret both exchange rate and interest rate impulses as representing unanticipated shocks, even though the interest rate increases are probably in line with the reaction function or at least with the preferences of the domestic monetary authorities.

Figure 6.15 shows the estimated dynamic responses of the real aggregate investment and price inflation in the analyzed countries to a generalized one standard deviation shock in the respective nominal exchange rates calculated according to Pesaran and Shin (1998): As discussed there, the principal advantage of this calculation procedure is that the resulting impulse response functions (generated by an orthogonal set of innovations) are independent of the ordering of the endogenous variables in the VARX model, in contrast to the standard Cholesky orthogonalization procedure. As it can be observed there, in all economies an important and statistically significant negative reaction of aggregate investment to a positive shock in the log nominal exchange rate. Concerning the reaction of price inflation, in nearly all countries an initially positive reaction (caused probably by a pass-through effect) is followed by a later negative reaction, which nevertheless is almost insignificant from the statistical point of view,

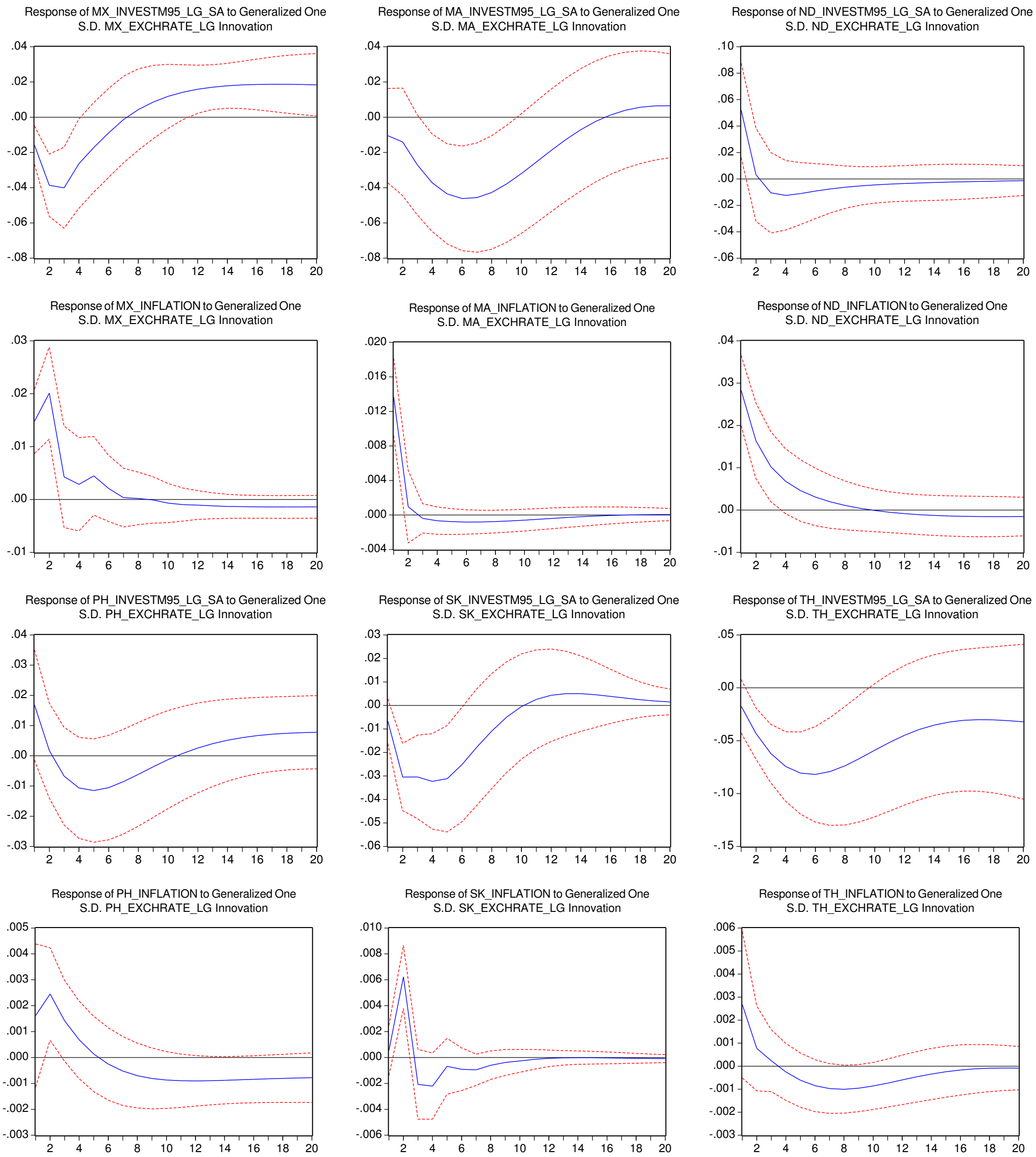


Fig. 6.15: Response of the Log of Aggregate Investment and of Price Inflation to a Generalized One Std. Dev. Innovation in the Logs Nominal Exchange

leading to the presumption that the deflationary pressures discussed previously, though theoretically possible, probably did not play an important role in the medium run dynamics in the analyzed economies.

In the following we analyze the dynamic response of aggregate investment to an unexpected one standard deviation shock in the log nominal exchange rate and alternatively, in the domestic nominal interest rate.

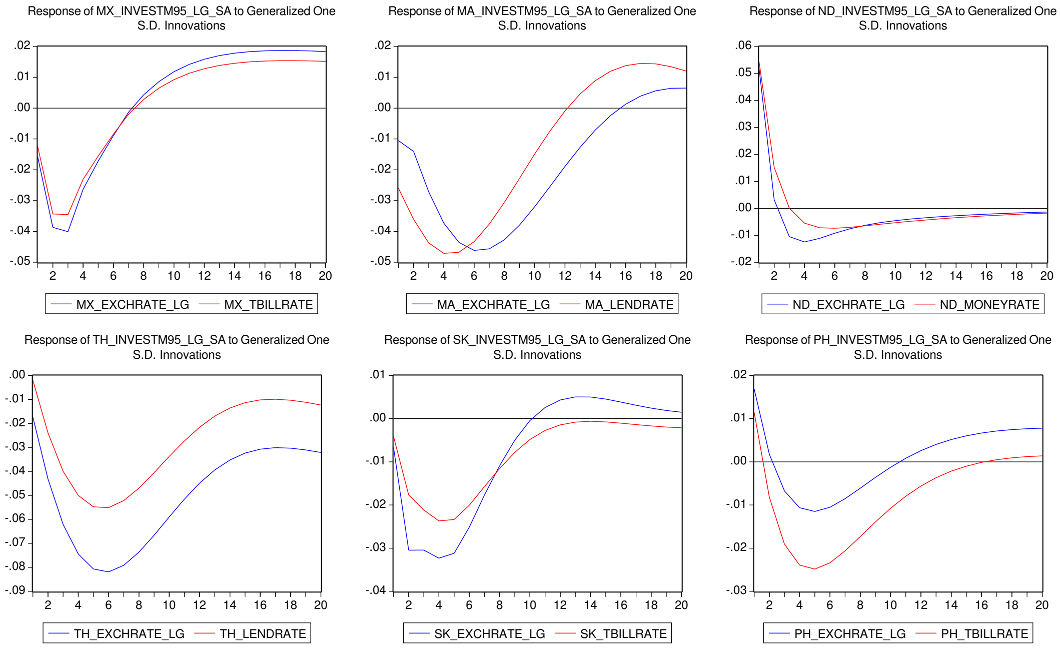


Fig. 6.16: Response of the Log of Aggregate Investment to a Generalized One Std. Dev. Innovation in the Log Nominal Exchange and the Nominal Interest Rate

As Figure 6.16 shows, the reaction of aggregate investment to a shock in the nominal exchange rate and interest rate varies significantly across countries. While in Mexico the extent and duration of both responses is relatively low (what would explain the fast recovery of the Mexican economy after the 1994-1995 Tequila crisis), in the other countries the recovery of aggregate investment has a much longer duration. An additional and probably more interesting finding is the heterogeneous relative strength of the nominal exchange and interest rates across countries. While in Thailand and South Korea the exchange rate shock affects the respective aggregate investment levels in a more significant manner, in Indonesia and the Philippines the interest rate effect seems to have predominated during the estimation period. Now, even if these empirical findings are not definitive in their implications with respect to the main determinant (if there was only one) of the investment decline in the East Asian countries, they nevertheless open up the question whether, at least in some countries, the defense of the currency pegs through interest rate increases might perhaps not have been the most adequate response to the speculative attacks on the domestic currencies. This differentiated effect of nominal exchange and interest rate shocks in Mexico and the analyzed East Asian countries can also be observed by means of the variance decomposition of aggregate investment, as depicted in Figure 6.17.

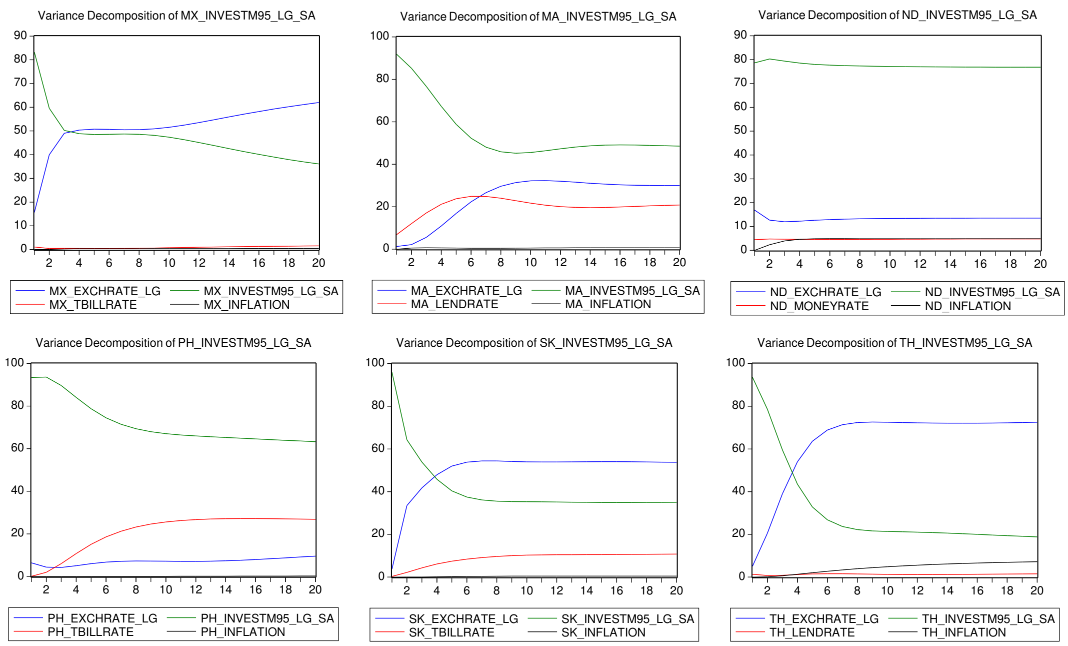


Fig. 6.17: Variance Decomposition of Aggregate Investment

6.7 Concluding Remarks

This chapter builds on our previous work on the short run dynamics which are triggered by a sharp depreciation of the domestic currency and the resulting credit rationing in economies with dollarized liabilities. Going beyond the scope of the Flaschel and Semmler (2006) framework, where a rather short run perspective disregarding wage and price dynamics was presumed, we developed and discussed here two variants of the Mundell-Fleming-Tobin currency crisis model which focused on the medium run recovery processes after the occurrence of such a currency and financial crisis. These two model variants, which consisted of the incorporation of domestic price level adjustments and the general formulation of the real exchange rate dynamics, allowed us to highlight the importance of nominal exchange rate and domestic price level adjustments for the medium run recovery process in economies which have suffered from a sharp depreciation of their domestic currency and the subsequent breakdown of aggregate investment caused by the activation of credit constraints.

Besides highlighting the fact the net short run effect of a sharp nominal exchange rate depreciation and the resulting medium run dynamics depend on the relative strength of the real interest rate and the credit rationing by the financial institutions on aggregate investment, we showed that in the short run either the defense of the currency peg or the more unorthodox decrease of the nominal interest rate as proposed by Radelet and Sachs (1998), Furman and Stiglitz (1998) and Krugman (2000b) can turn out either successful or unsuccessful, depending on the different macroeconomic characteristics of the concerned countries. In this line, the empirical evidence on the diversity of the currency crises transmission mechanisms across the Mexican and East Asian economies provided by the econometric VARX analysis of section 6.6 supported the differentiated scenario analysis of section 6.5.

We conclude this chapter by pointing out that models where currency shocks trigger a financial crisis and a severe economic slowdown need to take into account some specification of the wage- and price inflation dynamics in order to also study medium run scenarios where inflation or deflationary pressures may arise and where the effects of monetary policy are to be considered. The wage and price dynamics have not been made an issue in the work of the third generation currency crisis models. The research there has mainly focused on the mechanisms that transmit large currency shocks to the financial sector and to real economic activity.

Summary and Outlook

This dissertation handled of the role of wage and price inflation dynamics and of monetary policy for the stability of monetary economies from the theoretical and empirical perspective. On the one hand, it analyzed the case of small open economies within a monetary union where, by definition, the country-specific nominal exchange rate channel does not exist anymore and where therefore the degree of macroeconomic flexibility relies to a much larger extent on the dynamics of domestic wage and price inflation. On the other hand, the interplay between the nominal exchange rate dynamics and the behavior of wage and price inflation in open economies was investigated.

In Chapter 1 the dynamic behavior of the inflation rate differentials in the main euro area countries prior and after the introduction of the euro was analyzed. The convergence and stationarity tests performed there showed that, while there was a process of *relative* inflation convergence across the euro area countries which could be observed during Stage Two of EMU, the dynamic behavior of the national inflation rate differentials among the EMU members has featured significant and persistent deviations from the EMU average ever since. Given the cumulative effect that persistently biased inflation rates that are not supported by accordant labor productivity growth rates have for the relative competitiveness of the concerned economies, these results support the concerns of a wide variety of researchers concerning the long-run sustainability of EMU. Furthermore, the single-equation GMM estimations of the inflation rates and inflation rate differentials for Germany, France, Italy, Spain and the Netherlands showed in the first place the importance of the relative business cycle position of the economy for both variables in all these countries (with the exception of Germany, where this only holds for the inflation rate), and in the second place, that the degree of persistence, measured by the coefficients of the lagged values of inflation, is significant and of similar extent in all analyzed countries for both inflation and inflation differentials estimations.

As discussed in Chapter 2, the various estimations of the semi-structural (Disequilibrium) AS-AD model with aggregate data of the U.S., the euro area, the U.K., Germany and France confirmed the theoretical sign restrictions of the dynamical system. Furthermore, they delivered a variety of interesting insights into the similarities and differences of both economies with respect to the analyzed macroeconomic variables. In the first place, a remarkable similarity in nearly all of the estimated coefficients in the structural equations was found. For the euro area, this result is rather surprising if we keep in mind that it became a factual currency union with a unique and centrally determined monetary policy only eight years ago, on January 1999. For a long interval within the estimated sample, the estimated coefficients reflect only the theoretical values of an artificial economy. Nonetheless, all other analyzed economies seem to share many characteristics concerning the dynamics not only of wage and price inflation, but also of the capacity utilization rate and the role of monetary policy.

Taken together, the results of Chapter 2 delivered an alternative perspective on the role of interacting price – wage determination. The nowadays popular DSGE approach is based on the assumption that primarily future expected values are the determinants of wage and price inflation. However, the estimation results of Chapter 2 delivered empirical support for the alternative specification of the wage-price inflation dynamics discussed in Chiarella and Flaschel (1996), where cross over inflation expectation formation (that is, current price (wage) inflation influencing current wage (price) inflation), as well as lagged price inflation (the inflationary climate) cannot be rejected as significant explanatory variables in the wage and price Phillips Curves.

Based on the notion that asymmetries in the labor markets are likely to explain to a quite significant extent differences in the transmission of monetary policy and exogenous shocks in member economies of a currency union (due to the absence of the country-specific nominal exchange rate adjustment mechanism), in Chapter 3 the role of labor market rigidities was explicitly modeled into a simple theoretical model in the line of Chen, Chiarella, Flaschel and Semmler (2006). This straightforward modification of the baseline (D)AS-AD framework delivered some interesting results concerning the dynamic responses of the economy to various exogenous shocks. It was demonstrated that the degree of rigidity in labor markets has an important effect on the dynamics of output and inflation. The more rigid the labor markets are, the smaller is the response of employment, output and inflation to exogenous shocks. Since nowadays the predominant view is that real marginal costs (the labor share) are the main force driving price inflation, this approach represents an interesting alternative to the DSGE framework, which considers the real marginal costs as being determined primarily by intertemporal profit maximization under imperfect competition. Concerning the role of monetary policy, the dynamic simulations of this chapter showed that a flexible inflation targeting rule in the line of Taylor (1993) (where price inflation as well as output are targeted), and/or a flexible inflation targeting rule with an additional weight on wage inflation, have a better performance than flexible inflation targeting rules where the employment rate or the wage share are also targeted, or a strict inflation targeting strategy.

On more real-world related grounds, if the significant differences in the characteristics of the labor markets across the EMU countries are seriously taken into account, the findings of Chapter 3 might have delivered some interesting insights on the recent inflation developments in those economies, with countries such as Germany or Austria with persistently low inflation rates compared to other countries such as Spain and Ireland, as discussed for example in Honohan and Lane (2003), Fritsche et al. (2005) and Angeloni and Ehrmann (2007).

In Chapter 4 the implementation as well as the effectiveness of monetary policy in a monetary union with asymmetric national labor market characteristics such as the EMU were analyzed within a simplified two-country version of the model introduced in Chapter 3. Using the strict inflation targeting approach of Svensson (1997), it was possible to derive an analytical solution for the optimal instrument interest rate which would stabilize the price inflation dynamics under two different specifications of the loss function of the MUCB. In the first specification the MUCB focused on the simple, country-size weighted average of the two member economies (and indeed it was simply the average inflation rate which was entered in the loss function of the MUCB). In the second specification the MUCB acted in accordance with the individual developments of the member economies, which inflation rates entering explicitly in its loss function.

The dynamic simulations performed in Chapter 4 deliver two important findings. First, that due to the explicit endogenization of the instrument interest rate as a function of the country-weight λ^a, under country-specific inflation targeting, the MUCB is capable to address country-specific developments by the adequate choice of the country weight in a more efficient manner than in the simple average case. And second, that this strategy is able to attain a lower welfare loss than the average inflation targeting strategy precisely due to the explicit accounting of the individual country developments and specially of the relative competitiveness between the union member countries.

Even though the exact results of the undertaken simulations are valid only in the calibrated theoretical model discussed in this chapter, the implications of this analysis are in fact quite relevant for actual policy-making. Indeed, they open up the question whether an alternative, time-varying accounting of the individual member countries of a currency union such as the EMU would indeed be more welfare enhancing that the usual simple average practice as long as not only the national labor markets as it was the case here but also other macroeconomic characteristics in the member economies significantly differ from each other, as it is still the case in the EMU.

The main focus of the analysis in Chapter 5 was the role of the nominal exchange rate dynamics determined in a chartists-fundamentalists framework and its interaction with the adjustment of wage and price inflation within the (D)AS-AD approach. For this a two-country version of the baseline DAS-AD model of Chapter 2 was formulated, where two large open economies interacted with each other and influenced each other through trade, price and financial channels. As discussed in Chapter 5, despite its relative basic structure, this theoretical framework was nevertheless able to deliver dynamic responses in line with other empirical studies on the dynamics of open economies such as Eichenbaum and Evans (1995), Kim (1999) and Kim and Roubini (2000). Furthermore, through the calculation of the eigen-values of the 11D system, the effects of variations in the parameter values were investigated. Particularly with regard to the modeling of the nominal exchange rate dynamics, this eigen-value analysis delivered three main results which are indeed of significant importance. First, it corroborated the standard notion concerning the chartists' destabilizing influence not only for the FX dynamics, but also for the international economy. Second, it confirmed the findings of previous studies such as Chen, Chiarella, Flaschel and Semmler (2006) (as well as Chapter 2 of this dissertation) concerning the role of wage and price flexibility for the stability of the economy. And third, the maximum-eigenvalue-diagram concerning the inflation gap coefficient ϕ_π in the monetary policy rule showed that in an open economy the threshold value for the effectiveness of monetary policy is not one as discussed for example in Woodford (2003) for the case of closed economies, but rather less than one, due to the functioning of other stabilizing macroeconomic channels such as the real exchange rate channel in an open economy.

Chapter 6 developed and discussed two variants of the Mundell-Fleming-Tobin currency crisis model. These variants focused on the medium run recovery processes after the occurrence of such a currency and financial crisis. These two model extensions, which consisted of the incorporation of domestic price level adjustments and the general formulation of the real exchange rate dynamics, showed the importance of nominal exchange rate and domestic price level adjustments for the medium run recovery process in economies which have suffered from a sharp depreciation of their domestic currency and the subsequent breakdown of aggregate investment caused by the activation of credit constraints. In addition, they highlighted the fact that the net short run effect of a sharp nominal exchange rate depreciation and the resulting medium run dynamics depend on the relative strength of the real interest rate reaction and the extent of credit rationing by the financial institutions on aggregate investment. Furthermore, these modifications of the baseline model by Flaschel and Semmler (2006) demonstrated that in the short run either the defense of the currency peg or the more unorthodox decrease of the nominal interest rate as proposed by Radelet and Sachs (1998), Furman and Stiglitz (1998) and Krugman (2000b) can turn out to be either successful or unsuccessful, depending on the different macroeconomic characteristics of the concerned countries. In this line, the empirical evidence on the diversity of the currency crises transmission mechanisms across the Mexican and East Asian economies provided by the econometric VARX analysis of section 6.6 supported the differentiated scenario analysis of section 6.5. Since the theoretical and empirical literature on currency crises has primarily focused on the preceding trends that foreshadow financial crisis episodes (such as deterioration of balance sheets, deterioration of current accounts, decreasing external debt to reserve ratio) and the mechanisms of the crisis scenario, the model variants presented in Chapter 6 provided a useful perspective to trace out the possible medium run macrodynamics of a country which has suffered from a currency and a financial crisis. As it was shown in this chapter, multiple equilibria models appear to be a useful device to study various scenarios of the medium-run after a financial crisis has been triggered by large exchange rate shocks. Yet, we want to note here that a study of the effectiveness of monetary policy would have to be undertaken in a more elaborated framework which would incorporate the effects of monetary policy on the stock of foreign currency debt and on capital accumulation.

In summary, the empirical and theoretical analysis undertaken in this dissertation showed the importance of wage and price inflation adjustments for the macroeconomic stability not only of economies within a monetary union, but also for small and large open economies where the nominal exchange rate channel is fully operable. This was undertaken on the basis of a theoretical framework based on gradual adjustments to disequilibrium situations in the goods, labor and financial markets based on Chiarella and Flaschel (2000) and Chiarella et al. (2005).

As pointed out in the introductory chapter of this dissertation, the new alternative research approaches on *behavioral economics* and *learning* support, at least partially, the modeling approach which was pursued here. Furthermore, they seem indeed to represent promising research directions which might indeed deliver, as partly done here, a different, and more realistic understanding of the dynamics of modern economies than the actual DSGE approach based on the “dogmas” of intertemporal utility maximization and more importantly, of rational expectations.

References

Aghion, P., Bacchetta, P. and Banerjee, A. (2001). Currency crises and monetary policy in an economy with credit constraints, *European Economic Review* **45**: 1121–1150.

Aghion, P., Bacchetta, P. and Banerjee, A. (2004). A corporate balance sheet approach to currency crises, *Journal of Economic Theory* **119**: 6–30.

Akerlof, G. A. (1970). The Market for “Lemons”: Quality Uncertainty and the Market Mechanism, *The Quarterly Journal of Economics* **84**(3): 488–500.

Alberola, E. (2000). Interpreting inflation differentials in the euro area, *Economic Bulletin*, Banco de España, pp. 61–70.

Alberola, E. and Tyrväinen, T. (1998). Is there scope for inflation differentials in EMU?, *Technical report*, Bank of Finland.

Amable, B. and Ernst, E. (2006). Financial and labor market interactions, *Working Paper 93*, Center for Empirical Macroeconomics, Bielefeld University.

Angeloni, I. and Ehrmann, M. (2007). Euro area inflation differentials, *The B.E. Journal of Macroconomics* **7**(Iss. 1 (Topics)): Article 24.

Angeloni, I., Kashyap, K., Mojon, B. and Terlizzese, D. (2003). Monetary policy transmission in the euro area: Where do we stand?, *in* I. Angeloni, K. Kashyap and B. Mojon (eds), *Monetary Policy Transmission in the Euro Area*, Cambridge University Press, Cambridge, U.K.

Asada, T., Chen, P., Chiarella, C. and Flaschel, P. (2006). Keynesian dynamics and the wage-price spiral. A baseline disequilibrium model, *Journal of Macroeconomics* **28**: 90–130.

Asada, T., Chiarella, C., Flaschel, P. and Franke, R. (2006). Interacting two-country business fluctuations. A two-country model, *Singapore Economic Review* **51**: 365–394. forthcoming.

Baele, L., Ferrando, A., Hördahl, P., Krylova, E. and Monnet, C. (2004). Measuring financial integration in the euro area, *Occasional Paper 14*, European Central Bank.

Balassa, B. (1964). The Purchasing Power Parity doctrine: A reappraisal, *Journal of Political Economy* **72**: 584–86.

Barran, F., Coudert, V. and Mojon, B. (1997). The transmission of monetary policy in the European countries, *in* S. Collignon (ed.), *European Monetary Policy*, Pinter Press, London and Washington.

Barro, R. (1994). The aggregate supply / aggregate demand model, *Eastern Economic Journal* **20**: 1–6.

Barro, R. J. and Sala-i Martin, X. (1991). Convergence across states and regions, *Brookings Papers on Economic Activity* **1991**(1): 107–182.

Barro, R. J. and Sala-i Martin, X. (1992). Convergence, *The Journal of Political Economy* **100**(2): 223–251.

Beck, G. and Weber, A. A. (2005). Inflation rate dispersion and convergence in monetary and economic unions: Lessons for the ECB, *Working Paper 2005/31*, Center for Financial Studies.

Beetsma, R. M. and Jensen, H. (2005). Monetary and fiscal policy interactions in a microfounded model of a monetary union, *Journal of International Economics* **67**: 320–352.

Beningno, P. (2004). Optimal monetary policy in a currency area, *Journal of International Economics* **63**: 293–320.

Berben, R.-P., Locarno, A., Morgan, J. and Vallés (2005). Cross-country differences in monetary policy transmission, *Documento de Trabajo 0502*, Banco de España.

Bernanke, B. and Mihov, I. (1998). Measuring monetary policy, *The Quarterly Journal of Economics* **113**(3): 869–902.

Bernanke, B. S. and Blinder, A. S. (1992). The federal funds rate and the channels of monetary transmission, *The American Economic Review* **82**(4): 901–921.

Bernanke, B. S., Gertler, M. and Gilchrist, S. (1996). The financial accelerator and the fight to quality, *The Review of Economics and Statistics* **78**(1): 1 – 15.

Bernanke, B. S., Gertler, M. and Watson, M. (1997). Systematic monetary policy and the effects of oil price shocks, *Brookings Papers on Economic Activity* **1997**(1): 91–157.

Bertola, G. (2000). Labor markets in the European Union, Vol. 46(1), of *Ifo-Studien*, pp. 99–122.

Blanchard, O. and Galí, J. (2005). Real wage rigidities and the New Keynesian model, *Working Paper 05-14*, Federal Reserve Bank of Boston.

Blanchard, O. J. and Fischer, S. (1989). *Lectures on Macroeconomics*, The MIT Press.

Blanchard, O. J. and Katz, L. (1999). Wage dynamics: Reconciling theory and evidence, *The American Economic Review* **89**: 69–74. Papers and Proceedings of the One Hundred Eleventh Annual Meeting of the American Economic Association (May, 1999).

Blanchard, O. J. and Summers, L. H. (1991). Hysteresis and unemployment, *in* G. N. Mankiw and D. Romer (eds), *New Keynesian Economics. Coordination Failures and Real Rigidities*, Vol. 2, MIT Press, London, pp. 235–243.

Blanchard, O. J. and Wolfers, J. (2000). The role of shocks and institutions in the rise of European unemployment: the aggregate evidence, *The Economic Journal* **110**(462): 1–33.

Blanchard, O. and Kiyotaki, N. (1987). Monopolistic competition and the effects of aggregate demand, *American Economic Review* **77**(4): 647–66.

Bluedorn, J. C. and Bowdler, C. (2006). The open economy consequences of U.S. monetary policy. unpublished manuscript, Nuffield College.

Braunerhjelm, P., Faini, R., Norman, V., Ruane, F. and Seabright, P. (2000). Integration and the regions of Europe: How the right policies can prevent polarization, Monitoring European Integration 10, CEPR.

Breitung, J. (2000). The Local Power of Some Unit Root Tests for Panel Data, *in* B. Batalgi (ed.), *Nonstationary Panels, Panel Cointegration, and Dynamic Panels*, Vol. 15 of *Advances in Econometrics*, JAI Press, pp. 161–178.

Breitung, J. and Pesaran, M. H. (2005). Unit roots and cointegration in panels, *Discussion Paper 42/2005*, Deutsche Bundesbank.

Burnside, C., Eichenbaum, M. and Rebelo, S. (2001). Hedging and financial fragility in fixed exchange rate regimes, *European Economic Review* **45**(7): 1151–1193.

Busetti, F., Forni, L., Harvey, A. and Venditti, F. (2006). Inflation convergence and divergence within the European Monetary Union, *Working Paper 574*, European Central Bank.

Calvo, G. A. (1983). Staggered prices in a utility maximizing framework, *Journal of Monetary Economics* **12**: 383–398.

Campolmi, A. and Faia, E. (2006). Cyclical inflation divergence and different labor market institutions in the EMU, *Working Paper 619*, European Central Bank.

Céspedes, L. F., Chang, R. and Velasco, A. (2003). IS-LM-BP in the Pampas, *IMF Staff Papers* **50**(9337): 142–156.

Chari, V., Kehoe, P. and McGrattan, E. (2000). Sticky price models of the business cycle: Can the contract multiplier solve the persistence problem?, *Econometrica* **68**: 1151–79.

Chen, P., Chiarella, C., Flaschel, P. and Hung, H. (2006). Keynesian disequilibrium dynamics. Estimated convergence, roads to instability and the emergence of complex business fluctuations, *in* H. Galler and C. Dreger (eds), *Advances in Macroeconometric Modeling. Papers and Proceedings of the 5th IWH Workshop in Macroeconometrics*, Nomos Verlagsgesellschaft, Baden-Baden. forthcoming.

Chen, P., Chiarella, C., Flaschel, P. and Semmler, W. (2006). Keynesian macrodynamics and the Phillips Curve. An estimated baseline macromodel for the U.S. economy, *in* C. Chiarella, P. Flaschel, R. Franke and W. Semmler (eds), *Quantitative and Empirical Analysis of Nonlinear Dynamic Macromodels*, Contributions to Economic Analysis, Elsevier, Amsterdam.

Chen, P. and Flaschel, P. (2006). Measuring the interaction of wage and price Phillips Curves for the U.S. economy, *Studies in Nonlinear Dynamics and Econometrics* **10**: 1–35.

Chiarella, C. and Flaschel, P. (1996). Real and monetary cycles in models of Keynes-Wicksell type, *Journal of Economic Behavior and Organization* **30**: 327–351.

Chiarella, C. and Flaschel, P. (2000). *The Dynamics of Keynesian Monetary Growth: Macro Foundations*, Cambridge University Press, Cambridge, U.K.

Chiarella, C., Flaschel, P. and Franke, R. (2005). *Foundations for a Disequilibrium Theory of the Business Cycle. Qualitative Analysis and Quantitative Assesment*, Cambridge University Press, Cambridge, U.K.

Chiarella, C., Flaschel, P., Khomin, A. and Zhu, P. (2002). *The SND Package. Applications to Keynesian Monetary Growth Dynamics*, Vol. 22 of *Dynamic Economic Theory*, Peter Lang, Frankfurt am Main.

Choi, I. (2001). Unit root tests for panel data, *Journal of International Money and Finance* **20**: 249–272.

Christiano, L., Eichenbaum, M. and Evans, C. (1999). Monetary policy shocks: What have we learned and to what end?, *in* J. B. Taylor and M. Woodford (eds), *Handbook of Macroeconomics*, Vol. 1A, Elsevier, Amsterdam, pp. 65–148.

Christiano, L., Eichenbaum, M. and Evans, C. (2005). Nominal rigidities and the dynamic effects of a shock to monetary policy, *Journal of Political Economy* **113**: 1–45.

Christiano, L. J. and Fitzgerald, T. J. (2003). The band pass filter, *International Economic Review* **44**(2): 435–465.

Christoffel, K., Kuester, K. and Linzert, T. (2006). Identifying the role of labor markets for monetary policy in an estimated DSGE model, *Working Paper 635*, European Central Bank.

Christoffel, K. and Linzert, T. (2006). The role of real wage rigidity and labor market frictions for unemployment and inflation dynamics, *Discussion Paper 11/2006*, Deutsche Bundesbank.

Clarida, R. and Gertler, M. (1997). How the Bundesbank conducts monetary policy, *in* C. D. Romer and D. H. Romer (eds), *Reducing Inflation: Motivation and Strategy*, Chicago University Press, Chicago, pp. 363–406.

Corsetti, G., Pesenti, P. and Roubini, N. (1999). What caused the Asian currency and financial crisis?, *Japan and the World Economy* **11**(3): 305–373.

De Grauwe, P. (1996). Inflation convergence during the transition to EMU, *in* P. De Grauwe, S. Micossi and G. Tullio (eds), *Inflation and Wage Behavior in Europe*, Oxford University Press, Oxford, UK, chapter 7, pp. 193–208.

De Grauwe, P. and Grimaldi, M. (2005). Heterogeneity of agents and the exchange rate: A nonlinear approach, *in* P. De Grauwe (ed.), *Exchange Rate Economics: Where Do We Stand?*, CESifo Seminar Series, MIT Press, Cambridge, pp. 125–168.

De Grauwe, P. and Grimaldi, M. (2006). *The Exchange Rate in a Behavioral Finance Framework*, Princeton University Press.

De Grauwe, P. and Skudelny, F. (2000). Inflation and productivity differentials in EMU, *Working paper*, Centre of Economic Studies, University of Leuven.

De Grauwe, P. and Vanhaverbeke, W. (1993). Is Europe an optimum currency area?: Evidence from regional data, *in* P. R. Masson and M. P. Taylor (eds), *Policy Issues in the Operation of Currency Unions*, Cambridge University Press, Cambridge, UK, pp. 111–29. as reprinted in De Grauwe (2001), *The Political Economy of Monetary Union*, Cheltenham, UK: Edward Publishing Limited.

Deroose, S., Langedijk, S. and Roeger, W. (2004). Reviewing adjustment mechanisms in the EMU: from overheating to overcooling, *European Economy, Economic Papers 198*, European Commision - Directorate General for Economic and Financial Affairs.

Dornbusch, R. (1976). Expectations and exchange rate dynamics, *The Journal of Political Economy* **84**(6): 1161–1176.

ECB (2003). Inflation differentials in the euro area: potential causes and policy implications, Frankfurt a.M.

ECB (2005). Monetary policy and inflation differentials in a heterogeneous currency area, *ECB Monthly Bulletin*, May, pp. 61–78.

Ehrmann, M. and Fratzscher, M. (2005). Exchange rates and fundamentals: New evidence from real-time data, *Journal of International Money and Finance* **24**(2): 317–341.

Eichenbaum, M. and Evans, C. L. (1995). Some empirical evidence on the effects of shocks to monetary policy on exchange rates, *The Quarterly Journal of Economics* **110**(4): 975–1009.

Eichengreen, B. (1990). One money for Europe? Lessons from the U.S. currency union, *Economic Policy* **5**(5): 118–187.

Eickmeier, S. (2007). Business cycle transmission from the US to Germany - a structural factor model, *European Economic Review* . forthcoming.

Eller, J. W. and Gordon, R. J. (2003). Nesting the New Keynesian Phillips Curve within the mainstream model of U.S. inflation dynamics. Presented at the CEPR Conference *The Phillips Curved Revised*, Berlin, Germany, June 5-6 2003.

Erceg, C. J., Henderson, D. W. and Levin, A. T. (2000). Optimal monetary policy with staggered wages and prices, *Journal of Monetary Economics* **46**: 281–313.

Estrella, A. and Fuhrer, J. C. (2002). Dynamic inconsistencies: Counterfactual implications of a class of rational expectations models, *The American Economic Review* **92**: 1013–1028.

European Commision (2004). Cyclical convergence in the euro area: recent developments and policy implications, *Quarterly Report on the euro area*, Vol. 3(2),, Directorate General of Economic and Financial Affairs, pp. 27–38. July.

Eviews 5 (2004). *User's Guide*, Quantitative Micro Software, LLC.

Faia, E. (2006). Optimal monetary policy rules with labor market frictions, *Working Paper 698*, ECB, Frankfurt a.M.

Fair, R. (2000). Testing the NAIRU model for the United States, *The Review of Economics and Statistics* **82**: 64–71.

Flaschel, P., Groh, G., Proaño, C. and Semmler, W. (2008). *Topics in Applied Macrodynamics Theory*, Springer, Berlin. forthcoming.

Flaschel, P., Kauermann, G. and Semmler, W. (2007). Testing wage and price Phillips Curves for the United States, *Metroeconomica* **58**: 550–581.

Flaschel, P. and Krolzig, H.-M. (2006). Wage-price Phillips Curves and macroeconomic stability. Basic structural form, estimation and analysis, *in* C. Chiarella, P. Flaschel, R. Franke and W. Semmler (eds), *Quantitative and Empirical Analysis of Nonlinear Dynamic Macromodels*, Contributions to Economic Analysis, Elsevier, Amsterdam.

Flaschel, P. and Semmler, W. (2006). Currency crisis, financial crisis and large output loss, *in* C. Chiarella, P. Flaschel, R. Franke and W. Semmler (eds), *Quantitative and Empirical Analysis of Nonlinear Dynamic Macromodels*, Contributions to Economic Analysis (Series Editors: B. Batalgi, E. Sadka and D. Wildasin), Elsevier, Amsterdam.

Franke, R., Flaschel, P. and Proaño, C. R. (2006). Wage-price dynamics and income distribution in a semi-structural Keynes-Goodwin model, *Structural Change and Macroeconomic Dynamics* **17**(4): 452–465.

Frankel, J. A. and Froot, K. A. (1990). Chartists, fundamentalists, and trading in the foreign exchange market, *The American Economic Review* **80**(2): 181–185. Papers and Proceedings of the Hundred and Second Annual Meeting of the American Economic Asociation.

Frankel, J. A. and Rose, A. K. (1998). The endogeneity of the optimum currency area criteria, *The Economic Journal* **108**(449): 1009–1025.

Fritsche, U., Logeay, C., Lommatzsch, K., Rietzler, K., Stephan, S. and Zwiener, R. (2005). Auswirkungen von länderspezifischen Differenzen in der Lohn-Preisniveau- und Produktivitätsentwicklung auf Wachstum und Beschäftigung in Deutschland, *DIW Berlin: Politikberatung Kompakt 8*, DIW Berlin.

Fuhrer, J. C. and Moore, G. (1995). Inflation persistence, *Quarterly Journal of Economics* **110**(1): 127–59.

Furman, J. and Stiglitz, J. (1998). Economic crises: Evidence and insights from east asia, *Brookings Papers on Economic Activity* **2**: 1–136.

Galí, J. (2008). *Monetary Policy, Inflation and the Business Cycle*, Princeton University Press.

Galí, J. and Gertler, M. (1999). Inflation dynamics: A structural econometric analysis, *Journal of Monetary Economics* **44**: 195–222.

Galí, J., Gertler, M. and López-Salido, J. D. (2001). European inflation dynamics, *European Economic Review* **45**: 1237–1270.

Gertler, M. and Trigari, A. (2006). Unemployment fluctuations with staggered nash wage bargaining. unpublished manuscript, New York University.

Goodfriend, M. and King, R. G. (1997). The new Neoclassical Synthesis and the role of monetary policy, *in* B. S. Bernanke and J. J. Rotemberg (eds), *NBER Macroeconomics Annual*.

Goodhart, C. and Hofmann, B. (2005). The Phillips Curve, the IS curve and monetary transmission: Evidence for the US and the euro area, *CESifo Economic Studies* **51**(4): 757–775.

Groth, C. (1992). Some unfamiliar dynamics in a familiar macromodel, *Journal of Economics* **58**: 293–305.

Hall, R. E. (1995). Lost jobs, *Brookings Papers on Economic Activity* **1**: 221–56.

Hall, R. E. (2005). Employment fluctuations with equilibrium wage stickiness, *American Economic Review* **95**(1): 50–65.

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators, *Econometrica* **50**(4): 1029–1054.

Harvey, A. C. and Carvalho, V. M. (2002). Models for converging economies, *Working Paper 0216*, Faculty of Economics (DAE), University of Cambridge.

Hayashi, F. (2000). *Econometrics*, Princeton University Press.

Hofmann, B. and Remsperger, H. (2005). Inflation differentials among the euro area countries: Potential causes and consequences, *Journal of Asian Economics* **16**(3): 403–419.

Honohan, P. and Lane, P. (2003). Divergent inflation rates in EMU, *Economic Policy* **37**: 357–394.

Issing, O., Gaspar, V., Angeloni, I. and Tristani, O. (2001). *Monetary Policy in the Euro Area. Strategy and Decision-Making at the European Central Bank*, Cambridge University Press, Cambridge, U.K.

Juillard, M., Karam, P., Laxton, D. and Pesenti, P. (2006). Welfare-based monetary policy rules in an estimated DSGE model of the US economy, *Working Paper 613*, European Central Bank.

Kalyvitis, S. and Michaelides, A. (2001). New evidence on the effects of US monetary policy on exchange rates, *Economic Letters* **71**: 255–263.

Kenen, P. B. (1969). The theory of optimum currency areas: An eclectic view, *in* R. M. Mundell and A. K. Swoboda (eds), *Monetary Problems of the International Economy*, University of Chicago Press, Chicago, pp. 41–60. as reprinted in De Grauwe (2001), *The Political Economy of Monetary Union*, Cheltenham, UK: Edward Publishing Limited.

Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*, MacMillan, New York.

Kim, S. (1999). Do monetary policy shocks matter in the G-7 countries? Using common identifying assumptions about monetary policy across countries, *Journal of International Economics* **48**: 367–412.

Kim, S. (2001). International transmission mechanism of U.S. monetary policy shocks: Evidence from VAR's, *Journal of Monetary Economics* **48**: 339–372.

Kim, S. and Roubini, N. (2000). Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach, *Journal of Monetary Economics* **45**: 561–586.

Kirman, A. (1993). Ants, rationality, and recruitment, *The Quarterly Journal of Economics* **108**(1): 137–156.

Krugman, P. (1993). Lessons of Massachusetts for EMU, *in* F. Torres and F. Giavazzi (eds), *Adjustment and Growth in the European Monetary Union*, Cambridge University Press, Cambridge, UK, pp. 241–61. as reprinted in De Grauwe (2001), *The Political Economy of Monetary Union*, Cheltenham, UK: Edward Publishing Limited.

Krugman, P. (2000a). Crises: The price of globalization?, *Global Economic Integration: Opportunities and Challenges*, Federal Reserve Bank of Kansas City, pp. 75–105.

Krugman, P. (2000b). *The Return of Depression Economics*, Penguin Books Ltd.

Krugman, P. and Venables, A. J. (1996). Integration, specialization, and adjustment, *European Economic Review* **40**: 959–967.

Kwiatkowsky, D., Phillips, P. C., Schmidt, P. and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: how sure are we that economic time series have a unit root?, *Journal of Econometrics* **54**: 159–178.

Layard, R., Nickell, S. and Jackman, R. (1991). *Unemployment: Macroeconomic Performance and the Labor Market*, Oxford University Press, Oxford.

Ljungqvist, L. and Sargent, T. J. (1998). The European unemployment dilemma, *Journal of Political Economy* **106**(3): 514–550.

Llaudes, R. (2005). The Phillips Curve and long-term unemployment, *Working Paper 441*, European Central Bank.

Lombardo, G. (2006). Inflation targeting rules and welfare in an asymmetric currency area, *Journal of International Economics* **68**(2): 424–442.

Lommatzsch, K. and Tober, S. (2004). The inflation target of the ECB: Does the Balassa-Samuelson effect matter?, *EUI Working Paper 2004-19*, European University Institute, Robert Schuman Centre for Advanced Studies.

Lucas, R. E. J. (1976). Econometric policy evaluation: A critique, *Carnegie-Rochester Conference Series on Public Policy* **1**: 19–46.

Lux, T. (1995). Herd behavior, bubbles and crashes, *The Economic Journal* **105**(431): 881–896.

MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests, *Journal of Applied Econometrics* **11**: 601–618.

Maddala, G. S. and Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test, *Oxford Bulletin of Economics and Statistics* **61**: 631–652.

Mankiw, G. (2001). The inexorable and mysterious tradeoff between inflation and unemployment, *Economic Journal* **111**: 45–61.

Manzan, S. and Westerhoff, F. (2007). Heterogenous expectations, exchange rate dynamics and predictability, *Journal of Economic Behavior and Organization* . in press.

McKinnon, R. (1963). Optimum currency areas, *The American Economic Review* **53**: 717–725.

Mehra, Y. P. (2004). The output gap, expected future inflation and inflation dynamics: Another look, *Topics in Macroeconomics* **4**(1). Article 17.

Meltzer, A. H. (1986). Size, persistence, and interrelation of nominal and real shocks, *Journal of Monetary Economics* **17**: 161–94.

Mentz, M. and Sebastian, S. P. (2003). Inflation convergence after the introduction of the euro, *Working Paper 2003/30*, Center for Financial Studies, Frankfurt am Main, Germany.

Mojon, B. and Peersman, G. (2003). A VAR description of the effects of monetary policy in the individual countries of the euro area, *in* I. Angeloni, A. Kashyap and B. Mojon (eds), *Monetary Policy Transmission in the Euro Area*, Cambridge University Press, Cambridge, U.K., chapter 3, pp. 56–75.

Mortensen, D. and Pissarides, C. (1994). Job creation and job destruction in the theory of unemployment, *Review of Economic Studies* **61**: 397–415.

Mundell, R. A. (1961). A theory of optimum currency areas, *The American Economic Review* **51**: 657–664.

Obstfeld, M. and Rogoff, K. (1995). Exchange rate dynamics redux, *The Journal of Political Economy* **103**(3): 624–660.

OECD (2002). The ins and outs of long-term unemployment, *OECD Employment Outlook*, OECD, pp. 189–239.

Okun, A. M. (1970). *The Political Economy of Prosperity*, The Brookings Institution.

Ortega, E. (2003). Persistent inflation differentials in Europe, *Documentos de Trabajo 0305*, Banco de España, Madrid.

Peersman, G. and Smets, F. (1999). The taylor rule, a useful monetary policy benchmark for the euro area?, *International Finance* **1**: 85–116.

Peersman, G. and Smets, F. (2003). The monetary transmission mechanism in the euro area: Evidence from VAR analysis, *in* I. Angeloni, A. Kashyap and B. Mojon (eds), *Monetary Policy Transmission in the Euro Area*, Cambridge University Press, Cambridge, U.K., pp. 36–56.

Pesaran, H. H. and Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models, *Economic Letters* **58**: 17–29.

Petrongolo, B. and Pissarides, C. A. (2001). Looking into the black box: A survey of the matching function, *Journal of Economic Perspectives* **39**: 390–431.

Pissarides, C. (1992). Loss of skill during unemployment and the persistence of unemployment shocks, *Quarterly Journal of Economics* **107**(4): 1371–1391.

Pissarides, C. A. (2000). *Equilibrium Unemployment Theory*, 2nd edn, MIT Press.

Proaño, C. R., Flaschel, P., Ernst, E. and Semmler, W. (2006). Disequilibrium macroeconomic dynamics, income distribution and wage-price Phillips Curves: Evidence from the U.S. and the Euro Area, *Working Paper 04/2006*, Macroeconomic Policy Institute (IMK), Düsseldorf, Germany.

Proaño, C. R., Flaschel, P. and Semmler, W. (2005). Currency and financial crises in emerging market economies in the medium run, *The Journal of Economic Asymmetries* **2**(1): 105–130.

Proaño, C. R., Flaschel, P. and Semmler, W. (2006). Currency crises and monetary policy in economies with partial dollarization of liabilities, *Working Paper 5/2006*, Macroeconomic Policy Institute (IMK), Düsseldorf.

Rabanal, P. and Tuesta, V. (2006). Euro-dollar real exchange rate dynamics in an estimated two-country model: What is important and what is not, *Working Paper 06/177*, IMF.

Radelet, S. and Sachs, J. (1998). The onset of the East Asian financial crisis, *Working Paper 6680*, NBER.

Roberts, J. M. (1995). New Keynesian economics and the Phillips Curve, *Journal of Money, Credit and Banking* **27**(4): 975–984.

Rødseth, A. (2000). *Open Economy Macroeconomics*, Cambridge University Press, Cambridge, U.K.

Romer, D. (2000). Keynesian macroeconomics without the LM curve, *The Journal of Economic Perspectives* **14**(2): 149–169.

Rose, A. K. and Engel, C. (2002). Currency unions and economic integration, *Journal of Money, Credit and Banking* **34**(4): 1067–1089.

Rose, H. (1967). On the non-linear theory of employment, *Review of Economic Studies* **34**: 153–173.

Rotemberg, J. (1982). Monopolistic price adjustment and aggregate output, *Review of Economic Studies* (4): 517–531.

Rotemberg, J. J. and Woodford, M. (1997). An optimization-based econometric framework for the evaluation of monetary policy, *in* B. S. Bernanke and J. J. Rotemberg (eds), *NBER macroeconomics annual 1997*, MIT Press, Cambridge, MA, pp. 297–346.

Röthig, A., Flaschel, P. and Semmler, W. (2007). Hedging, speculation and investment in balance-sheet triggered currency crises, *Australian Economic Papers* **46**(3): 224 – 233.

Rudd, J. and Whelan, K. (2005). New tests of the new-Keynesian Phillips curve, *Journal of Monetary Economics* **52**: 1167–1181.

Rudebusch, G. D. (2002). Term structure evidence on interest rate smoothing and monetary policy inertia, *Journal of Monetary Economics* **49**: 1161–87.

Rudebusch, G. D. (2006). Monetary policy inertia: Fact or fiction?, *Working paper*, Federal Reserve Bank of San Francisco.

Rudebusch, G. D. and Svensson, L. E. (1999). Policy rules for inflation targeting, *in* J. B. Taylor (ed.), *Monetary Policy Rules*, The University of Chicago Press, Chicago, chapter 15.

Rudebusch, G. D. and Wu, T. (2003). A macro-finance model of the term structure, monetary policy, and the economy. Federal Reserve Bank of San Francisco, mimeo.

Samanidou, E., Zschischang, E., Stauffer, D. and Lux, T. (2007). Agent-based models of financial markets, *Reports on Progress in Physics* **70**: 409 – 450.

Samuelson, P. A. (1964). Theoretical notes on trade problems, *Review of Economics and Statistics* **23**: 1–60.

Sbordone, A. M. (2004). A limited information approach to simultaneous estimation of wage and price dynamics. Rutgers University, mimeo.

Shimer, R. (2005). The cyclical behavior of equilibrium unemployment, vacancies and wages: Evidence and theory, *American Economic Review* **95**(1): 25–49.

Sims, C. (1987). Discussion of Olivier J. Blanchard, aggregate and individual price adjustment, *BPEA* **1**: 117–20.

Sims, C. (1992). Interpreting the macroeconomic time series facts: The effects of monetary policy, *European Economic Review* **36**: 975–1011.

Sims, C. A. (1980). Macroeconomics and reality, *Econometrica* **48**(1): 1 – 48.

Sinn, H.-W. and Reutter, M. (2000). The minimum inflation rate for euroland, *Working Paper 377*, CESifo.

Smets, F. and Wouters, R. (2003). An estimated dynamic stochastic general equilibrium model for the euro area, *Journal of the European Economic Association* **1**(5): 1123–1175.

Solow, R. (2004). Introduction: The Tobin approach to monetary economics, *Journal of Money, Credit and Banking* **36**: 657–663.

Sorensen, C. K. and Werner, T. (2006). Bank interest rate pass-through in the euro area, *Working Paper 580*, European Central Bank.

Stevens, M. (2004). New microfoundations for the aggregate matching function. University of Oxford, mimeo.

Stiglitz, J. E. and Weiss, A. (1981). Credit rationing in markets with imperfect information, *The American Economic Review* **71**(3): 393–410.

Svensson, L. E. (1997). Inflation forecast targeting: Implementing and monitoring inflation targets, *European Economic Review* **41**: 1111–1146.

Svensson, L. E. (1999). Inflation targeting as a monetary policy rule, *Journal of Monetary Economics* **43**(6790): 607–654.

Svensson, L. E. (2000). Open-economy inflation targeting, *Journal of International Economics* **50**(6545): 155–183.

Taylor, J. B. (1980). Aggregate dynamics and staggered contracts, *Journal of Political Economy* **88**: 1–23.

Taylor, J. B. (1993). Discretion versus policy rules in practice, *Carnegie-Rochester Conference Series on Public policy* **39**: 195–214.

Taylor, J. B. (ed.) (1999). *Monetary Policy Rules*, Vol. 31 of *Business Cycles Series*, National Bureau of Economic Research, The University of Chicago Press, Chicago.

Tobin, J. (1975). Keynesian models of recession and depression, *American Economic Review* **45**: 195–202.

Trigari, A. (2004). Equilibrium unemployment, job flows and inflation dynamics, *Working Paper 304*, European Central Bank.

von Hagen, J. and Hofmann, B. (2004). Macroeconomic implications of low inflation in the euro area, *North American Journal of Economics and Finance* **15**: 5–23.

Walsh, C. E. (2003a). Labor market search and monetary shocks, *in* S. Altug, J. Chadha and C. Nolan (eds), *Elements of Dynamic Macroeconomic Analysis*, Cambridge University Press, Cambridge, U.K., pp. 451–86.

Walsh, C. E. (2003b). *Monetary Theory and Policy*, MIT Press, Cambridge, MA.

Walsh, C. E. (2005). Labor market search, sticky prices, and interest rate policies, *Review of Economic Dynamics* **8**(4): 829–49.

Woodford, M. (2003). *Interest and Prices. Foundations of a Theory of Monetary Policy*, Princeton University Press, Princeton.

Wooldridge, J. M. (2001). Applications of generalized method of moments estimation, *Journal of Economic Perspectives* **15**(4): 87–100.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*, MIT Press, Cambridge, MA.

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