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Heterogeneity in the Fiscal Reaction Function: An Empirical Analysis for EU Member States

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ABSTRACT

This paper studies heterogeneity in the fiscal reaction function for European Union members by resorting to the unconditional quantile regression estimation. Based on annual observations spanning from 2005 to 2018, the results point to significant asymmetries concerning the fiscal response measured in terms of the cyclically adjusted primary balance to different covariates. First, the primary deficit has a stronger reaction to debt across the lower quantile, which becomes weaker as the balance reaches a surplus. This indicates the prevalence of fiscal discipline to ensure the public finance sustainability. Moreover, the life-expectancy negatively affects the fiscal position and the response is the highest compared to other covariates, which can diminish the debt and business stabilizing response. Governments seem to run more pronounced pro-cyclical fiscal policy when the fiscal position is already deteriorated. These empirical evidences are questioning current as well as future policy design particularly against the background of the recent pandemic situation exerting supplementary social and financial burden on the countries. In addition, the level of economic development matters for the response pattern and the reaction is stronger and positive when countries face poorer fiscal positions. Also, an increase in the long-term interest rate amplifies the deterioration of fiscal balance especially when its condition is already bad. Finally, our estimations show that the fiscal position improves as an effect of educational attainment and of external position especially when the former reaches surplus.

JEL codes: C21, E62, H63

Keywords: Fiscal response function, Heterogeneity, Fiscal sustainability, Unconditional quantile regression

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1. Introduction

The global financial crisis of 2007-2008, followed in Europe by the Sovereign Debt Crisis have shown the fragile balance between fiscal activism, fiscal space and debt sustainability. Currently, the COVID-19 pandemic has plunged the world and EU economy into a severe recession. Against this background, EU policymakers have responded with unprecedented stimulus measures, both monetary and fiscal policies supporting this stance. As a result, budgetary deficits and public debt are expected to rise sharply in the EU at least over the short term. According to the Spring 2020 Forecast of the European Commission, in the EU the budgetary deficit is expected to rise from 0.6 percent of GDP in 2019 to 8.3 percent in 2020, while the level of public debt is projected to increase from 79.4 to 95.1 percent of GDP over the same period.

Thus, debt sustainability and fiscal policy analysis are more relevant than ever. Moreover, it is crucial that the fiscal stimulus implemented amid already high levels of debt in the EU is reconciled with a sustainable debt trajectory. The central issue is to discover the factors driving the fiscal response. Therefore, it is of great interest to investigate if the fiscal behaviour might be different depending on the level of the initial fiscal position given its determinants, such as debt, interest rate or the economic situation. In short, does size of the budgetary balance matter for the amplitude of the fiscal response and, if so, how does it support public debt sustainability?

Regarding the relevant empirical literature contributions there is usually two strands of research on fiscal response analysis. The first strand is based on the linear fiscal reaction function (FRF) with seminal papers by Bohn (1995, 1998), studying the response of the primary balance to changes in the debt ratio. Usually, a positive significant response coefficient is considered as sufficient condition (weak sustainability) for stabilizing debt and sustainability of public finances. The linear model of the FRF introduced by Bohn has several implications. On one hand, the government's response to changes in public debt is constant over time and does not vary with the level of the public debt. On the other hand, the public debt can increase indefinitely and the fiscal response is a positive and strong one regardless of its size. Finally, the financial markets are willing to lend money to governments, no matter how much they owe.

These implications have been the subject of numerous debates which have shown that this approach is quite unrealistic and have suggested the possibility of a varying fiscal reaction. Among the arguments brought are difficulties in reaching a consensus on fiscal consolidation (Bertola and Drazen, 1993) which has to lead to the increase in the primary surplus. These points lead us to the other literature strand which proved the existence of non-linearities of the fiscal response (e.g., Abiad and Ostry, 2005; Legrenzi and Milas, 2013) with a seminal contribution by Gosh et al (2013) who introduced the fiscal fatigue characteristic. Approximated by a cubic function it indicates that the fiscal response varies with the size of the public debt, switching from a positive to a negative one as the debt ratio raises and it peters out.

This paper contributes to the literature by applying the novel unconditional quantile regression (UQR) on a panel comprising annual data over 2005 - 2018 for 26 EU members to

examine a possible varying fiscal reaction depending on the size of the initial fiscal position. This method overcomes the traditional conditional quantile regression (CQR) limitation given that distributions are conditioned by specific covariates. To the best of our knowledge, this is the first attempt examining the heterogeneity in the fiscal response to UQR. The latter is more useful in interpreting the results across the distribution of outcomes from a policy-making perspective, given that estimates from CQR cannot be generalizable. We also build upon the FRF model and add new explanatories to capture the challenges generated by the ageing population and the pursuit of the sustainable development goals (SDGs) to which fiscal policy has to respond through its allocative and redistributive functions. Our main finding is that the size of the initial fiscal position matters for the fiscal response that varies across the distribution, in particular the stronger reaction to debt at higher levels of budgetary deficit having significant policy implications.

2. Methodology and data

One way to assess a heterogeneous distributional effect is the usage of CQR. Mathematically, at any level τ, across the distribution of y, given a set x, the conditional quantile $Q_y(\tau|x)$ shows $inf\ \{k: T(k|x) \geq \tau\}$ where $T(*\ |x)$ represents the conditional distribution function. In a panel data framework the most common approach is the CQR with fixed effects (Koenker, 2004):

$$Q_{y_{i,t}}(\tau|x_{i,t}) = \alpha_i + x_{i,t}^T \beta^{CQR}(\tau). \quad (1)$$

In Eq. (1), $i = \overline{1,N}$ and $t = \overline{1,T}$, represent countries and years, respectively, $y_{i,t}$ is the primary balance, $x_{i,t}$ denotes the set of covariates, $\beta^{CQR}(\tau)$ is the common slope coefficient while α_i is a location shift parameter. Using this method, Schalk (2012) showed that the fiscal response in the euro area countries differs depending on the chosen quantile.

However, when it comes to assess the effectiveness of government policies, including explanatory variables in CQR renders coefficients which fail to reflect the impact of these covariates across quantiles in an absolute sense. To overcome this problem, Firpo et al. (2009) proposed the UQR by computing a recentered influence function (RIF) designed without reference to covariates which is regressed subsequently on the explanatory variables:

$$RIF\left(y_{i,t}; v(F_{y_{i,t}})\right) = v(F_{y_{i,t}}) + IF\left(y_{i,t}; v(F_{y_{i,t}})\right). \quad (2)$$

In Eq. (2), $F_{y_{i,t}}$ represents the cumulative distribution function of $y_{i,t}$ while $v(F_{y_{i,t}})$ quantifies the marginal impact on the parameter of distribution $F_{y_{i,t}}$ when removing or adding a variable. The inflluence function (IF) measures the impact of a particular variable on a distributional statistic:

$$IF\left(y_{i,t}; v(F_{y_{i,t}})\right) = \lim_{\varepsilon \to 0}\left(\frac{v\left[(1-\varepsilon)F_{y_{i,t}} + \varepsilon G_{y_{i,t}}\right] - v(F_{y_{i,t}})}{\varepsilon}\right). \quad (3)$$

In Eq. (3), $0 \leq \varepsilon \leq 1$, and $G_{y_{i,t}}$ denotes the distribution that puts mass at the value $y_{i,t}$. The expected value of the RIF is $v(F_{y_{i,t}})$, as the expected value of the $IF\left(y_{i,t}; v(F_{y_{i,t}})\right)$ is zero. This indicates that regressing a particular statistic, such as the mean, generates the same coefficients as the OLS estimates and this principles are applicable to any statistics of interest along the dependent variable distribution. In addition, if we select the τ^{th} quantile as the

statistic of interest denoted and choose to estimate the density functions for each quantile, the RIF is specified as follows:

$$RIF\left(y_{i,t}; q_\tau; F_{y_{i,t}}\right) = q_\tau + IF\left(y_{i,t}; q_\tau; F_{y_{i,t}}\right) = q_\tau + \frac{\tau - \mathbb{I}\{y_{i,t} \leq q_\tau\}}{f_{y_{i,t}}(q_\tau)}. \quad (4)$$

In Eq. (4), q_τ is the τ^{th} quantile of the unconditional distribution of $y_{i,t}$, $f_{y_{i,t}}(q_\tau)$ represents the pfd of $y_{i,t}$ evaluated at the τ^{th} quantile based on a Kernel density estimation, while $\mathbb{I}\{y_{i,t} \leq q_\tau\}$ is an indicator function showing whether $y_{i,t}$ falls below the τ^{th} quantile or otherwise. Thus, the UQR estimator is given by:

$$RIF\left(y_{i,t}; q_\tau; F_{y_{i,t}}\right) = x_{i,t}^T \beta^{UQR}(\tau). \quad (5)$$

To the best of our knowledge, we are the first examining the heterogeneity in the fiscal response using this the UQR method. The present paper fills this gap in the literature by applying the UQR technique on a panel comprising annual data ranged from 2005 to 2018 extracted from Ameco and Eurostat for 26[1] EU members. Given our data structure, it is necessary to include fixed effects in the UQR to control for all unobserved country-specific characteristics. Consequently, we followed Borgen (2016), who extended on the work of Firpo et al. (2009) and use a Gaussian Kernel for density estimation.

3. Empirical Results

Following the FRF model specifications in the literature, we use the cyclically adjusted primary balance (*CAPB*) as the dependent variable to measure the discretionary fiscal response. The debt stabilizing reaction is given by the distribution of the lagged gross debt. It is widely recognized that the highly politicized nature of the government budgeting makes it difficult to use an immediate reaction to change in the public debt (Everaert and Jansen, 2018) and, therefore, a delay is conventionally accepted. The business cycle stabilization effects are measured by the output gap (GAP). Inflation (INFL) is included as an explanatory to capture the cooperative behaviours of fiscal and monetary authorities and to show how fiscal authorities contribute to the achievement of the monetary policy objectives. The long-term interest rate (LTIR) is used to examine the distribution of the fiscal response to financial markets movements. We also use the net exports (NE) to account for the interactions between the domestic and external sectors. Besides these explanatories, we add several other variables to capture the Musgravian allocative and redistributive functions of fiscal policy which have to respond to the current challenges caused by the health crisis but that must also pursue the sustainable development goals. For this purpose, we include life expectancy at birth (LIFE) to measure the fiscal response to ageing population through spending allocation to healthcare and social protection. We use the tertiary education attainment (Education) to capture fiscal policy reaction to ensure the quality of education. The young people neither in employment nor in education or training are more likely to suffer from poverty and social exclusion and represent an unused productive capacity (Unemployment). Fiscal policy should react through active measures on labour market or through redistribution. The purchasing power adjusted GDP per capita (GDPc) is included to measure the disparities between the level of

[1] We excluded Estonia from the panel because of the data availability.

development of EU countries and how fiscal policy responds to challenges posed by the catching-up process. The greenhouse gas emissions (Emissions) is the explanatory that captures fiscal response to environmental issues.

Table 1 reports the UQR coefficients alongside the CQR and FE estimates for comparison (see also Figure 1). The UQR coefficients reveal a positive and monotonically decreasing impact of the DEBT throughout the distribution of the CAPB from 10^{th} to 50^{th} quantile, suggesting that the fiscal reaction to the dynamic of DEBT is stronger when the CAPB displays a high deficit. In comparison, the CQR coefficients are underestimating this impact, especially for the inferior quantiles, where the deficit is large. The FE shows a positive response to increasing DEBT suggesting weak sustainability but fails to capture the impact throughout the distribution. The CQR indicates a smoother heterogeneity of the fiscal reaction compared to that revealed by UQR.

Furthermore, the UQR shows that the output gap exhibits a statistical significant negative influence only at lower quantiles across the distribution of CAPB, indicating a pro-cyclical fiscal behaviour when the balance runs large deficits. These results suggest that when the GAP is decreasing and the economy is heading for a recession, EU countries facing a poor fiscal stance will decide to consolidate public finances and increase the CAPB by implementing austerity measures. On the other hand, although the coefficients are not statistically significant for the 75^{th} and 90^{th} quantiles, the results indicate a positive response, and therefore a tendency of a counter-cyclical fiscal behavior for the situations when EU countries exhibit primary surpluses. These results led us to the conclusion that the function of economic stabilization across EU countries depends on the fiscal stance and that fiscal discipline prevails. CQR shows similar results only for the lowest quantile, although the size of the response is smaller, while it indicates evidence of pro-cyclicality across the entire distribution of the CAPB that is also supported by the FE estimates.

Regarding the LTIR, the coefficients exhibit a transition from negative to positive, showing a negative impact at 25^{th} quantile, and a positive one at 90^{th} quantile and a statistically insignificant effect across the rest of distribution. This empirical fact is pointing out that higher lending costs are amplifying the deficit when the latter is reaching poor levels. In addition, when the balance has a comfortable surplus, an increase in the LTIR translates into an even larger surplus. These results suggest that when the financial market indicates an increase in the cost of long-term financing, the expectations are offset by a fiscal position that shows the stable and sustainable public finance. By comparison, CQR indicates a negative effect of the LTIR throughout the entire distribution, although the response is statistically significant only for the lower quantile. The FE also identifies a negative response but insignificant. As expected, the higher net exports, the higher CAPB, but the results are robust to UQR estimation method only for upper quantiles. This shows that the CAPB improves significantly only for large trade surpluses. The CQR suggests a positive relationship throughout the entire distribution as well as FE model that indicates a similar effect.

The UQR reveals fluctuating effects of LIFE on the CAPB, with a sharp negative impact along the superior extreme quantile. High life expectancy leads to the deterioration of the CAPB throughout the entire distribution, possibly due to ageing costs and its weight is the highest compared to other covariates. Both FE and CQR support this result, although the latter reveals a smaller and smoother effect across the distribution. An opposite pattern can be observed for

education which might suggest that when a country reaches higher attainment levels, the CAPB tends to improve, especially when the latter is already high. Similar results indicate both CQR and FE estimates, with the difference that the size is smaller than that revealed by the UQR coefficients. We also found a significant positive response to GDPc only for lower quantiles throughout the distribution of the CAPB, suggesting that the improvement of a deteriorated fiscal position is supported by a higher level of economic development and decreasing disparities between EU countries. The young employment has an inverted U-shaped impact throughout the CAPB distribution with a significant and robust effect only across the lower quantile, which implies that the increase in the level of poverty or social exclusion leads to an even stronger deterioration of the fiscal stance when the latter is already poor. The effects peter out and become insignificant when the budgetary position is sound. Furthermore, we fail to identify significant UQR estimates relating inflation or emissions with CAPB regardless the quantiles of interest.

4. Conclusions and Policy Implications

This paper examined the fiscal response to stabilization, allocative and redistributive purposes in the current context caused by the health crisis, ageing population and the pursuit of SDGs for EU members. We used the UQR to reveal the heterogeneity of the government reaction that has several implications on fiscal sustainability. The stronger fiscal response to the level of public debt at lower levels of the budgetary balance shows a concern related to the sustainability of public finances. The pro-cyclicality during bad times affects countries with deteriorated fiscal positions, which face constraints in providing fiscal stimulus, emphasizing the merits of fiscal prudence in good times. A lower level of economic development and a rise in long-term interest rates amplify the deterioration of the fiscal position for countries which are already in a difficult position. Life expectancy negatively affects the budgetary balance, probably through aging costs and might diminish the debt and economic stabilizing fiscal response.

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Table 1. Estimation results

Dep: Cycl. Adj. Primary balance	FE	UQR	CQR	UQR	CQR	UQR	CQR	UQR	CQR	UQR	CQR
		τ=10		τ =25		τ =50		τ =75		τ=90	
Lagged Gross Debt	**0.1099** **(0.0000)**	**0.1769** **(0.0010)**	**0.0748** **(0.0000)**	**0.1138** **(0.0000)**	**0.0740** **(0.0000)**	**0.0417** **(0.0060)**	**0.0704** **(0.0000)**	0.0293 (0.1060)	**0.0651** **(0.0004)**	**0.0537** **(0.0140)**	**0.0420** **(0.0067)**
Output Gap	**-0.2423** **(0.0002)**	**-0.3504** **(0.0810)**	**-0.3061** **(0.0157)**	**-0.2274** **(0.0440)**	-0.1085 (0.1975)	-0.0327 (0.6630)	-0.0108 (0.8929)	0.0201 (0.7760)	-0.1149 (0.1313)	0.0621 (0.5560)	-0.0734 (0.1963)
Inflation	0.1213 (0.2022)	-0.0562 (0.8150)	0.2636 (0.1322)	-0.0386 (0.7880)	0.0369 (0.7492)	-0.0382 (0.7140)	-0.0774 (0.4914)	0.0322 (0.7220)	0.0989 (0.3723)	-0.0470 (0.7160)	0.1024 (0.3331)
Long-term interest rate	-0.1479 (0.1202)	-0.4211 (0.1890)	**-0.6275** **(0.0087)**	**-0.4004** **(0.0700)**	-0.2871 (0.1069)	0.0571 (0.5280)	-0.0941 (0.5757)	0.1455 (0.1280)	-0.0938 (0.4375)	**0.45991** **(0.0020)**	-0.1210 (0.2834)
Net Exports	**0.1437** **(0.0039)**	0.1329 (0.2030)	**0.2361** **(0.0024)**	0.0864 (0.2730)	**0.2119** **(0.0004)**	0.0379 (0.512)	**0.1880** **(0.0148)**	**0.1810** **(0.0030)**	**0.1719** **(0.0126)**	**0.2500** **(0.0210)**	**0.1697** **(0.0030)**
Life expectancy at birth	**-1.7580** **(0.0000)**	**-1.5282** **(0.0090)**	**-0.6077** **(0.0045)**	-0.9585 (0.1140)	**-0.6552** **(0.0001)**	**-1.0425** **(0.0020)**	**-0.8045** **(0.0007)**	**-1.2718** **(0.0000)**	**-0.8652** **(0.0000)**	**-1.8869** **(0.0060)**	**-0.3957** **(0.0520)**
Tertiary education	**0.1305** **(0.0050)**	-0.0740 (0.4120)	-0.0169 (0.5917)	0.0976 (0.1530)	0.0123 (0.7042)	**0.2158** **(0.0000)**	0.0554 (0.1461)	**0.1640** **(0.0010)**	**0.0782** **(0.0261)**	**0.2443** **(0.0020)**	0.0454 (0.1363)
Young unemployment	**-0.4261** **(0.0000)**	**-0.5802** **(0.0490)**	**-0.2285** **(0.0693)**	-0.2362 (0.2280)	**-0.1487** **(0.0954)**	-0.0711 (0.4450)	-0.1377 (0.1332)	-0.1725 (0.1030)	-0.1483 (0.2158)	-0.1317 (0.3030)	-0.0568 (0.5592)
GDP per capita	**0.0552** **(0.0324)**	**0.0916** **(0.0650)**	-0.0136 (0.2008)	0.0442 (0.2720)	-0.0053 (0.6259)	0.0430 (0.1780)	0.0001 (0.9979)	-0.0307 (0.3500)	-0.0025 (0.8634)	-0.0380 (0.3130)	-0.0149 (0.2734)
Greenhouse gas emissions	-0.0055 (0.8356)	0.0311 (0.5180)	0.0105 (0.5555)	0.0381 (0.3750)	0.0175 (0.1249)	0.0070 (0.7950)	0.0243 (0.1246)	-0.0024 (0.9470)	**0.0482** **(0.0023)**	0.0107 (0.8050)	**0.0409** **(0.0004)**
Pseudo R-squared	0.5092	0.2160	0.2548	0.3240	0.2288	0.1613	0.1676	0.1464	0.1145	0.1762	0.1595

For UQR coefficients we use a Gaussian kernel while the standard errors were bootstrapped with 200 replications. CQR coefficients are estimated by setting λ=1, which is recommended given our data structure. However, imposing λ=0 or 5 or any value from this interval does not change significantly our results. P-values are reported in parentheses. Intercepts were included but not reported.

Appendix: Figure 1. UQR results