[Journal of Business Chemistry]

Research Paper

Nanotechnology companies in the United States: A web-based content analysis of companies and products for poverty alleviation

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This study analyzes the goals, nanotechnology experience, corporate social responsibility and products of 50 USA-based companies working with nanotechnology to see if they are developing products that help low-income populations. Out of the top 50 R&D companies that publish and patent nanotechnology research in agri-food, energy and water sectors, 18 of them do not mention nanotechnology on their websites. The other 32 companies discuss nanotechnology in varying degrees. However, only two of the companies relate their nanotechnology R&D to poverty alleviation. Even though few companies refer to poverty alleviation, 30 firms of the sample have some type of corporate social responsibility programs. From the study, we cannot definitively conclude that nanotechnology is a technology only for wealthy consumers, but we do find that the companies analyzed do not give much attention to pro-poor nanotechnology.

1 Introduction

Since the early 2000s, scholars have hailed nanotechnology as a transformational technology that could change consumer products. Scientists predicted that nanotechnology would revolutionize healthcare, transportation, energy, and food and that nanotechnology products would form a USD 1 trillion market by 2015 (Roco, 2011). In 2000, the USA started a large nanotechnology initiative, and from 2000-2010, the government has spent more than USD 12 billion to fund nanotechnology research (Roco, 2011). The large focus on nanotechnology in rich countries did not escape the attention of emerging economies. Dozens of developing countries invested in nanotechnology as well and there was a chorus of scholars that discussed the potential of nanotechnology to decrease poverty (Maclurcan, 2010).

However, after 15 years of nanotechnology research and development (R&D), only few scholars have examined whether nanotechnology has positively impacted development and decreased poverty. Therefore, the purpose of the present study is to understand whether companies are developing nanotechnology products that could help the poor. Unlike other studies that detail government initiatives, we focus on the private sector because it is a key link in providing poverty alleviation technologies to the public (Meridian Institute, 2005). Scientists may create novel technologies that benefit the world's poor, but the private sector needs to develop, market and sell the technologies in order to decrease poverty. Therefore, it is important to understand the extent to which companies are directing their nanotechnology R&D efforts to products that will be used by industry, wealthy or poor consumers. To answer these questions, we analyze the websites of 50 top USA-based nanotechnology companies that patented or published research in the water, energy and agri-food sectors from 2000-2009. We want to find out if companies are discussing their nanotechnology initiatives and whether the types of products they develop and sell could benefit poor communities. Moreover, we assess whether poverty alleviation and other corporate social responsibility (CSR) programs are mentioned by the companies. If a company prioritizes CSR, it indicates that the company might make poverty alleviation a goal of their product development and sales. Through this research, we aim to add to the literature on the role of new technologies for poverty alleviation.

2 Literature Review

2.1 Nanotechnology for poverty alleviation

Nanotechnology uses matter from 0 to 100 nanometers as a primary component to create new products. At this scale, matter behaves differently; for example, nanoparticles have different conductivity, strength, and reactivity than larger particles, and as a result, scientists can use these properties to create novel products (Roco, 2011). The USA started the National Nanotechnology Initiative with an initial investment of USD 475 million in 2000 (Roco, 2011) and other countries quickly followed suit. By 2004, more than 64 countries had nanotechnology initiatives (Maclurcan, 2010). Since the beginning of the nanotechnology revolution, there was an emphasis on commercialization and scholars predicted that nanotechnology products could change a variety of sectors like electronics, pharmaceuticals, high performance materials, and safety products (Baker & Aston, 2005; Mazzola, 2003; Qiu Zhao, Boxman, & Chowdhry, 2003). Today, nanotechnology can be found in over 1,600 products ranging from golf balls to baby bottles (Woodrow Wilson International Center, 2012), and Shapira *et al.* (2011) estimate that there are about 5,440 nanotechnology companies in the USA and 17,600 nanotechnology companies worldwide (Shapira, Youtie, & Kay, 2011).

As nanotechnology increased in prominence, there have been discussions about its potential to help the poor (Meridian Institute, 2005). For example, many scientists believe that nanotechnology based photovoltaic solar cells might make the technology cheaper and more efficient, and consequently, it would be easier to install solar cells in low-income communities (Hassan, 2005). Similarly, nano-enhanced water filters could provide cheap and clean water and significantly improve the health of people in low-income countries (Meridian Institute, 2005). However, some scholars argue that nanotechnology could also have deleterious consequences for the poor. The new technology could displace jobs and create environmental hazards that would disproportionately hurt impoverished communities (Invernizzi, Foladori, & Maclurcan, 2007).

The dialogue about the potential of nanotechnology to reduce poverty and inequality falls in between two distinct philosophical underpinnings, i.e. instrumentalism and contextualism, that have different outlooks about technology's capability to help less developed countries (Invernizzi, Foladori, & Maclurcan, 2008). Instrumentalists believe that technology is a tool that changes society, and if scientists invent better technology and correctly implement it, then countries will experience economic growth and decrease poverty (Invernizzi *et al.*, 2008). Instrumentalists tend to have a deterministic view of technology because they believe that technology is good and unless something goes wrong, it will lead to further development (Invernizzi *et al.*, 2007). Instrumentalists feel confident about the potential benefits of nanotechnology to create better materials, cheaper devices, and new ways to approach science and technology (Hassan, 2005). They tend to suggest that low-income countries create nanotechnology centers of research excellence, and develop more South-South nanotechnology research networks in order to become world leaders in this burgeoning field (Hassan, 2005). Often national ministries of science approach nanotechnology with an instrumentalist viewpoint, and as a result, many countries implement nanotechnology strategies (Invernizzi *et al.*, 2007). Large countries like China, Brazil, and India make the biggest investments in nanotechnology, but smaller countries, like Uruguay, Bangladesh, and Tanzania, also have nanotechnology initiatives (Maclurcan, 2010).

Contextualists, on the other hand, question the assumption that technology will raise people out of poverty. Rather, they believe that technologies are not neutral artifacts, but "embody social relations, interest, political power, values, etc." (Invernizzi *et al.*, 2007). Contextualists are skeptical that the nanotechnology revolution will decrease inequality and poverty. They give examples of current nanotechnology products, like tennis balls or Wi-Fi blocking paint, as evidence that nanotechnology is used predominantly for luxury goods (Barker, Lespick *et al.* 2005). To further aggravate the disparity, contextualists point to patent laws. Patents help inventors to protect their research output, but at the same time, patents prevent companies in developing countries from using the technology as they are not able to afford the fees (Barpujari, 2010).

The debates between contextualists and instrumentalists created a space to study technology's impact on inequality, but there are fewer studies that find evidence of technology's impact on poverty. Recently, Cozzens *et al.* (2013) studied whether scientists develop pro-poor nanotechnologies in the water, energy and agri-food sectors. They conduct a bibliometric assessment of the literature and interviewed scientists and government officials about the effects of the technology. The authors find that there is very little evidence that nanotechnology products have helped low-income communities (Cozzens, Cortes, Soumonni, & Woodson, 2013). In another study, Woodson (2012) measures the R&D gap in nanomedicine and finds it to be more equal than reported. The healthcare literature often says that less than 10% of R&D is addressing diseases that impact 90% of the population. Instead, Woodson (2012) finds that over 90% of nanomedicine R&D is applicable for both poor and rich communities. This is primarily because cancer, a major disease worldwide, receives the bulk of nanomedicine R&D (Woodson, 2012). These studies give conflicting examples of nanotechnology's impact on poverty and highlight the fact that technology can have various consequences depending on the sector and how it is used.

2.2 Corporate Social Responsibility

This paper builds upon the work of Cozzens *et al.* (2013) to determine the extent to which corporations have developed nanotechnology products that help the poor (Cozzens, Cortes, Soumonni, & Woodson, 2013). Companies are controversial actors in poverty alleviation, and the literature argues whether for-profit organizations should aim to reduce poverty. One side of the debate argues that corporations, especially large ones, do not decrease poverty, but rather they can increase inequality because they undercut prices, put downward pressure on wages, crowd out local businesses and unfairly influence political systems for their benefit (Ans Kolk & Wesdijk, 2006). The other side of the debate is optimistic about the usefulness of corporations to alleviate poverty (Jenkins, 2005; Lodge, 2014). These scholars argue that companies train people in new skills, influence governments to provide better infrastructure and develop products that help individuals out of poverty (Lodge, 2014).

The efforts of companies to relieve poverty and implement social change are actively discussed in the CSR literature. A company that is socially responsible "has principles and processes in place to minimize its negative impacts and maximize its positive impacts on selected stakeholder issues" (Maignan & Ralston, 2002). Companies engage in CSR for a variety reasons ranging from a real sense of altruism to using CSR programs to achieve more profitable outcomes (Maignan & Ralston, 2002). Pedersen (2009) developed a model that outlines different corporate perspectives of CSR. On one end of the spectrum, companies can take a "do no harm" perspective and focus on minimizing accidents and complying with government regulations (Pedersen, 2009). This type of perspective approaches social responsibility with the minimum amount of effort. On the other hand, companies can be a "positive force" that contributes to social development. Companies with this mentality have a proactive approach to CSR, and they desire to contribute to the community and develop ethical products (Pedersen, 2009).

Scholars have studied CSR since the 1980s (Capriotti & Moreno, 2007), but only in the past five years teams have investigated CSR programs in nanotechnology firms. One research team studies CSR initiatives in nanomedicine, and find that there is a need for nanomedicine companies to focus on stakeholder engagement and public awareness in order to demystify the technology and allow the public to have an input into the development of the technology (Kuzma & Kuzhabekova, 2011a). In another study on corporate social performance, Kuzma and Kuzhabekova (2011) find that larger, older companies are most active in this sphere (Kuzma & Kuzhabekova, 2011b). Compared to large companies, smaller firms have less external pressure expertise and financial resources to start CSR programs (Kuzma & Kuzhabekova, 2011b). In a third study, Groves *et al.* (2011) examine online CSR documents from UK nanotechnology companies. They also find that large companies tend to have CSR programs, while smaller businesses do not have formal programs. In addition, many of the nanotechnology CSR programs in the UK promote "doing no harm" and implementing effective safeguards, as opposed to adding positive social value (Groves, Frater, Lee, & Stokes, 2011).

3 Methods

For this study, we examined the websites of the top 50 USA-based nanotechnology companies in the water, energy, and agri-food sectors who have patents and publications between 2000 and 2009. Website analysis has been used extensively to understand CSR programs of companies and it is found to be a valid method to understand CSR programs (Basil & Erlandson, 2008; Capriotti & Moreno, 2007; Snider, Hill, & Martin, 2003). Our first step was to compile a list of companies by searching for nanotechnology articles related to water, energy, and food in Web of Science and PatStat. To help this process, we used a nanotechnology database provided by the Georgia Institute of Technology Program in Science, Technology and Innovation Policy which includes a comprehensive nanotechnology publication and patent database created by using a multi-stage bootstrapping search process (Arora, Porter, Youtie, & Shapira, 2012). From this database, Cozzens *et al.* (2013) developed another keyword search to find articles and patents in the water, energy, and food sectors. Table 1 lists the keywords used and for a full discussion of the search

Table 1 Keywords used to identify nanotechnology publications related to energy, agri-food and water.

Energy keywords	Agri-food keywords	Water keywords
Biofuels, bio-diesel, bio-ethanol, biofuel cell, energy, efficiency, energy generation, energy production, energy storage, fuel cell, geothermal, solar photovoltaic, solar device, solar panel, solar cell, dye-sensitized solar cell, DSSC, solar energy, solar technology, solar electric, solar thermal energy, solar thermal, solar hot water, thermoelectric, wind energy, wind power, wind generation, wind electricity, wind turbine	Crop species and scientific names,animal production, poultry, beef, veterinary, beer, wine, milk, cattle, chesses, fertilizer, pesticide, herbicide, fungicide, insecticide, plant seed, seedling, soil, food production, and food packaging	Brackish water, desalination, drink, filtration, freshwater, freshwater pollution, groundwater, natural waters, pesticide remediation, reverse osmosis, saltwater, seawater, water pollution, water purification, water treatment

Table 2 List of codes used in the content analysis.

Code	Code description
Nanotechnology	What does the company website mention about nanotechnology?
Poverty alleviation/ CSR	What does the company website mention about poverty alleviation or helping the poor?
Date established	When was the company established?
Products/services	What products/services does this company provide?
NAICS code	What is the North American Industry Classification System (NAICS) code?
Purpose/mission	What is the purpose/mission of the company?
Foreign branches	Does the company have foreign branches? What is their global presence?
Sales/revenue	What are the sales/revenue of the company?
# of employees	How many employees work for the company?
Potential clients	Who are the clients of the company? Who buys their products? (industry, government, consumers)
Who benefits	Who benefits from the technology? (Rich consumers, poor[1] consumers, all consumers)
Other facts	Other interesting facts about the company. Was the company purchased or consolidated? Does the company do R&D to develop new patents or does the company purchase and hold patents?

1) For this study, any family that makes less than USD 23,850 per year for a family of 4 is consi-dered to be poor. This is the poverty-line as set by the US Department of Health and Human Services for 2014 (U.S. Department of Health and Human Services, 2014).

techniques see Cozzens *et al.* (2013). The refined nanotechnology database allowed us to choose the top 50 publishing and patenting USA-based nanotechnology companies that were active from 2000-2009.

We purposefully chose to analyze these companies as opposed to a random selection of nanotechnology firms because we wanted to focus the examination on nanotechnology companies that are active in water, energy and agri-food sectors. These sectors were determined to be especially relevant for decreasing poverty and inequality, and as a consequence, analyzing these sectors gives us the greatest likelihood of finding nanotechnologies that decrease poverty (Salamanca-Buentello *et al.*, 2005). Also, we limited our search to companies with nanotechnology patents and publications as opposed to companies that claim to be nanotechnology firms. Other studies found that many purported nanotechnology companies have no nanotechnology capabilities (Granqvist, 2013). To avoid analyzing these firms, we targeted nanotechnology companies with patents and publications. Third, we limited the search to USA-based nanotechnology companies. The USA has the most established nanotechnology sector; and therefore, it is important to understand how USA firms discuss nanotechnology on their websites and whether the technology will be accessible to poor populations (Shapira *et al.*, 2011). Moreover, this paper is a part of a larger project to examine nanotechnology's impact on inequality within the USA and South Africa. Unfortunately, there are few nanotechnology firms with patents and publications in South Africa, so we could not do a similar analysis for South African firms.

In each of the three sectors, we initially selected the top twenty nanotechnology patenting and publishing companies, and after removing companies that were not based in the USA, we had 50 companies to analyze. Similar studies also analyzed 50 selected companies (Gomez & Chalmeta, 2011). Table 4 in the Appendix lists the companies that we studied along with some key factors about each of them.

After compiling the list of companies, we read each company's website and collected information about their history, research, products, mission, number of employees, net sales, location and overseas branches. Next, we looked for information related to the companies' nanotechnology R&D and products. Some of the companies prominently discuss their nanotechnology efforts, but for most of the companies, we searched for references to nanotechnology using the company's website search engine. This ensured that we did not overlook references to nanotechnology.

Finally, we examined the company's social and poverty alleviation goals and if they use nanotechnology to achieve their social goals. We were particularly interested in how the CSR initiatives and products would directly benefit the poor as opposed to change larger macroeconomic conditions that could possibly improve the lives of the low-income communities. For example, if a company only provides services for large multinational companies (MNCs), then we assumed that the company would not make products that directly benefit the poor. But if a firm makes cheap, bacteria-resistant baby bottles, then the firm would manufacture products that directly benefit the poor. Again, for most of the companies the information about poverty alleviation was easily found on the company's website. However, to ensure that we found all references on poverty alleviation for each company, we also search for "poverty", "poor", and "charity" on the company's webpage search engine. In addition to companies' websites, we looked each company up in the LexisNexis database in order to find the company's North American Industry Classification System (NAICS) code, sales volume, profits and number of employees. The initial data was collected from June-August 2012 and it was updated in June 2014.

Once we have collected the data, we used standard content analysis techniques to analyze it. Content analysis is a research method that has been used since the 1950s to analyze text data. The goal of content analysis is to find patterns and relationships within texts in order to make inferences about the data (Krippendorf, 1980). Traditional content analysis has five main steps involving formulating the questions, selecting the sample, defining the categories, training the coders/checking for reliability, and coding/analyzing the data. However, these five steps are often relaxed in order to account for exploratory research and research based in grounded theory (Herring, 2002). Moreover, many of the procedures and assumptions of traditional content analysis do not work for web-based studies. For example, traditional content analysis requires that the data is drawn from a random sample of the population; however, it is impossible to ensure that a random sample of the population is selected on the internet. Consequently, scholars select another sampling frame that is not random (Herring, 2002). For this study, we select the 50 USA-based nanotechnology companies with the most publications and patents in the water, energy, and agri-food sectors as our sample.

Table 2 shows a list of the codes used in this analysis. At the beginning of the project, the coders agreed upon a common coding scheme and throughout the project any discrepancies were dis-

Figure 1 Size and sector affiliation the size of the 50 companies.

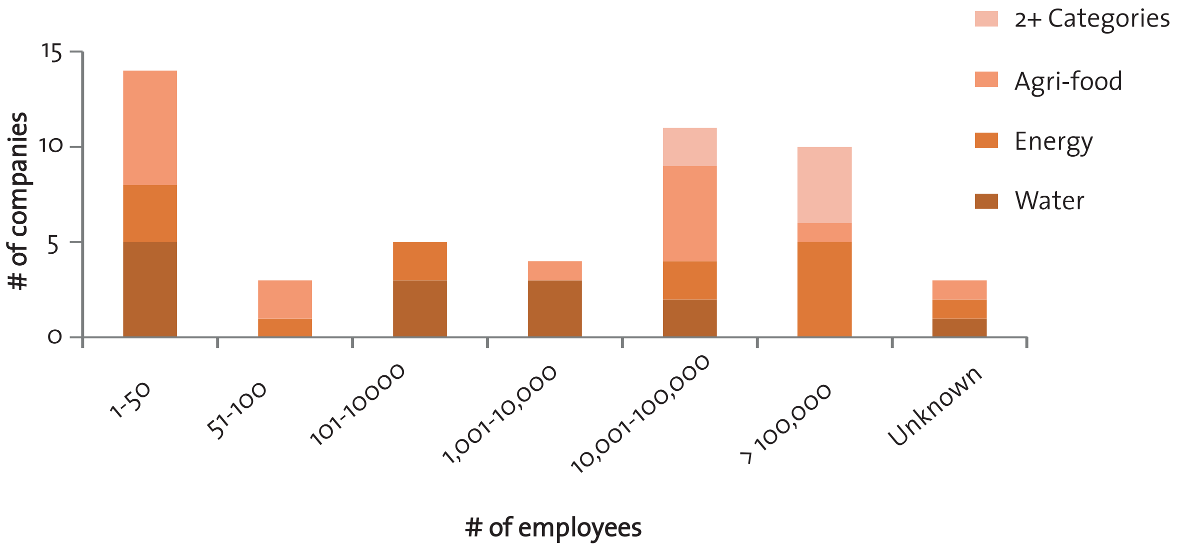

Table 3 Classification of companies by NAICS codes.

3 digit code	Description	Number of companies
111	Crop production	1
237	Heavy and civil engineering construction	1
311	Food manufacturing	1
313	Textile mills	1
314	Textile product mills	1
322	Paper manufacturing	3
325	Chemical manufacturing	9
332	Fabricated metal product manufacturing	1
333	Machinery manufacturing	7
334	Computer and electronic product manufacturing	8
336	Transportation equipment manufacturing	3
424	Merchant wholesalers, nondurable goods	4
541	Professional, scientific and technical services	9
812	Personal and laundry services	1

cussed between the coders. At the end of the project, the coding was re-verified by the principal author to ensure consistency.

Even though website content analysis has many advantages, like the accessibility and ubiquity of corporate websites, there are also issues with analyzing websites. First, a company's website does not show the effectiveness of a CSR program. Companies rarely describe the measurable impacts, the extent of the program, or the effectiveness of their efforts. Second, the companies may have developed pro-poor nanotechnologies that are not discussed on their websites. The companies may avoid discussing their pro-poor nanotechnologies because it could generate unwanted publicity or it may alert competitors of their R&D efforts. Third, websites are dynamic data sources that are constantly updated; therefore, it is possible we missed information because the website changed. We limited the impact of changing websites on the results by searching for the same information at two separate periods of time. Finally, websites are large data sources with many different papers, documents and external links. It is possible for relevant information to remain hidden. The coders spent about three hours examining each website and we extensively used search engines to ensure we collected the necessary information.

4 Results

4.1 Company Overview

The 50 nanotechnology companies in this study span a variety of industries and sectors, but the companies can be divided into two broad groups. First, there are companies that are specialized in nanotechnology. These companies are often smaller, less than 100 employees, and were founded more recently. Many of the nano-specific companies focus on solar cell technology, like Miasole, or special nanomaterials, like Nano-Tex. However, a few of the nano-specific firms do not produce nanotechnology products, but are rather environmental/technical consultants. For example, MVA provides testing services that use high powered microscopes to analyze samples. In general, the nano-specific companies focus on business-to-business sales and very few of them sell products directly to consumers. Interestingly, many of the nanotechnology-focused companies have "nano" in their company names, for example, Nanopaper, Nanosolar, Nanosys and Nano-Tex. More specific, 7 out of the 50 firms have "nano" in their titles. This was unexpected because another study found no significant relationship between a nanotechnology firm's size and their company naming strategy (Granqvist, 2013).

The other class of firms comprises large MNCs. These multinational firms span a variety of sectors such as consumer goods (Kimberly Clark and Proctor & Gamble), military and government contractors (Lockheed Martin, URS, and CH2M Hill), chemistry (Du Pont and Dow Chemical) and pharmaceutics (Pfizer and Millepore). It is not surprising that some firms like Dow and Du Pont are involved with nanotechnology since they are major chemical producers and have large R&D departments. However, the list of top USA-based nanotechnology R&D firms in the energy, water and agri-food sectors features some surprising organizations like General Motors and Phillip Morris. General Motors is one of the world's largest car manufactures and Phillip Morris is an international cigarette and tobacco manufacturer, and these firms seem not to be immediately associated with nanotechnology R&D.

Figure 1 gives a summary of the companies' sizes. Out of the 50 companies, 21 of them have more than 10,000 employees and 16 of them have less than 100 employees. The largest company in the study, IBM, has 433,400 employees, and the smallest company, Genesgues, has two employees. There are two reasons why there is a large disparity in company size among the top publishing and patenting nanotechnology companies. First, the small companies are specialized in nanotechnology, and as a result, they have many publications and patents about it. Big companies, on the other hand, have large R&D departments that can conduct R&D in a variety of fields including nanotechnology. The size of large MNCs allows them to be major players in nanotechnology even if it is only a small part of their business.

Table 3 shows the three-digit NAICS codes of the 50 companies[1] . The three biggest industries represented are "325: chemical manufacturing", "541: professional, scientific, and technical services" and "334: computer and electronic product manufacturing". Of these three industries, 541 is the broadest industrial code. Some of the companies in this category are large MNCs that provide project management, engineering design and construction services like URS Corp and CH2M Hill Corp. Other companies are small consulting firm that provide technical assistance in chemical testing. Finally, a few nano-specific companies, like Nano-Tex, are classified as scientific and technical services.

4.2 Poverty Alleviation

An important part of the study is determining whether the companies develop products that can

1) Note: The companies are classified as agri-food, energy and water companies based on their nanotechnology R&D focus. However, a company's classification to an industry via the NAICS, which depends on the overall orientation of the company, can differ.

alleviate poverty. We looked at the companies' products and determined if they would be helpful for poor, rich or all consumers. We only coded the company's products and services as benefiting the poor if they would directly help an individual below the USA poverty line of USD 23,850 per year for a family of four. Using the USA poverty line, is a sensible choice since we are examining USA companies. However, this means that many of the products and services that we code as alleviating poverty may not apply to poor people in other countries. Also, in order to make the study as objective as possible, we only coded a company as providing poverty alleviating product if there was a strong likelihood that a poor individual in the USA could afford to buy that product.

Out of the 50 companies, 21 of them sell products directly to consumers and about half of these companies, 10 companies, sell consumer products that can be purchased by low-income consumers. The other half of the companies sell consumer products that are only purchased by rich consumers.

Next, we coded the type of products produced by companies that are predominately sold to other industries and government organizations. Almost all of the companies we analyzed, i.e. 44 companies, have business to business and business to government operations. Of those 44 firms, 13 of them sell products that could help the poor even though they are not directly purchased by consumers. For example, Geosyntec Consultants specializes in water remediation, brown field development, and erosion control. The company's services are normally purchased by government agencies, but their efforts could directly benefit individuals who live in poor communities. Another firm, CH2M Hill, designs and operates large scale projects like water treatment plants, environmental remediation, and building transportation systems. Again CH2M Hill's services are normally purchased by companies and governments that are building large-scale projects. However, if these projects are implemented correctly, they can directly benefit both poor and rich communities. Note that even though the companies make products that could benefit the poor, this part of the analysis cannot determine if the company develops nanotechnology products that help low-income communities.

There are a few interesting cases that were difficult to assess the benefits of the company's products. For example, Phillip Morris produces tobacco products and their nanotechnology patents relate to technologies that produce better filters and add flavors to the cigarettes. The technology that reduces carbon monoxide inhalation could decrease health risks for smokers, but adding flavors to tobacco products to make them more desirable would increase the harmful effects of cigarettes. Similarly, the coders were unsure how to classify the product benefits of military contractors like Lockheed Martin. Some of Lockheed Martin's nanotechnology patents relate to curbing gas turbine emissions in jets and methods to build anti-ballistic structures using carbon nanotubes. These types of technologies will have both positive and negative impacts on people. In our study, we labeled 8 of the 50 companies as having an unknown benefit for rich or poor.

4.3 Nanotechnology

We found that 32 companies discuss nanotechnology on their websites. Most of the companies that explicitly mention nanotechnology are large firms, but 10 of them have less than 50 employees. The most common products that these 32 companies sell are intermediate materials like industrial chemicals. Very few companies sell the nanotechnology products directly to consumers, although some of the high-end nanotechnology products like solar panels, water filters, and fabrics could also be sold to individual consumers.

From our analysis, we find that companies portray their interactions with nanotechnology mainly in four ways. First, for some of the companies, nanotechnology is a core part of the organization's business model. Their main products and services relate to nanotechnology and the company's market advantage is that they specialize in nanotechnology research. 15 of the firms show this type of nanotechnology engagement and are thus classified as "core" nanotechnology companies.

The second set of firms mention nanotechnology on their websites and discuss their nanotechnology products; however, these companies have many other products not related to nanotechnology. Nanotechnology is a small part of their overall portfolio. We classify these firms as "periphery" nanotechnology companies. For example, 3M makes dental crowns with nano-ceramic materials, but they also make hundreds of other products not related to nanotechnology. In our sample, there are nine periphery nanotechnology companies.

The third type of firm mentions nanotechnology on their website, but they only discuss the technology as a part of R&D and as a part of future products. For example, Honeywell International discusses the potential of nano-air vehicles and nano-enhanced aerodynamic and propulsion systems (Honeywell International, 2014). Lockheed Martin says "Nanotechnology is the future of electronics, the key to creating ever more powerful and reliable devices. Our engineers and scientists are creating that future today, incorporating a wide range of advanced nanomaterials into computer chips, chemical sensors, batteries and other applications"(Lockheed Martin, 2014). These companies refer to nanotechnology as a future technology that can make a big difference, but these companies do not go into major details about current nanotechnology products.

Some companies do not have any reference to nanotechnology on their website despite having nanotechnology patents and publications. Of the 50 companies we studied, 18 do not mention nanotechnology. When we analyzed the type of nanotechnology companies that mention nanotechnology, we find that none of agri-food companies discusses the technology on their websites. This suggests that these companies are hesitant to talk about nanotechnology because the technology is not well-known by the public and might result in negative reactions.

Finally, a key question of the study is how will nanotechnology reduce poverty? It is hard to find instances where a company's nanotechnology products were key to their poverty reduction strategy. Only two companies, Konarka and Nanopaper, directly related their nanotechnology efforts to social responsibility. Both of these companies are classified as "core" nanotechnology companies. Nanopaper e.g. states that their new products will reduce the environmental impact of papermaking. Given that pollution disproportionally affects the poor (Evans & Kantrowitz, 2002), we consider their efforts as pro-poor. Konarka explicitly stated that their new nano-based solar cells could help individuals in poor and rural areas get electricity. However, Konarka declared bankruptcy in 2012 because they were unable to develop a cheap and efficient product (Kirsner, 2012).

4.4 Corporate Social Responsibilty

A main research question of this study looks beyond nanotechnology to understand whether the 50 companies are developing technologies that could alleviate poverty. Webpages are a major portal for companies to advertise themselves and espouse their values to the public. If a company prioritizes poverty alleviation, then it should appear on their webpage (Capriotti & Moreno, 2007). In our sample, 30 of the 50 companies mention something about the positive social impacts of their company or technologies. Most of the references to poverty can be found on the company's dedicated CSR page; however, a few companies discuss poverty alleviation throughout their website.

The 30 companies that mention societal impacts or poverty alleviation approach the topic very differently. In general, large companies devote significant attention to corporate social responsibility and poverty alleviation. All the companies with more than 10,000 employees say something about the societal impacts of their corporation and products. This finding matches other CSR studies that find that larger companies are more likely to have CSR programs (Maignan & Ralston, 2002). Smaller companies, on the other hand, rarely mention poverty alleviation or social responsibility. Out of the 23 firms with less than 1,000 employees, only 4 of them mention poverty alleviation or the social benefits of their technology.

The 30 companies have very different CSR initiatives. Some companies have large CSR departments focused on poverty alleviation, while other websites simply mention the possibility that their products could help the poor without any measurable deliverables. This study does not measure the size of the CSR programs, but large differences in the scope of the programs can be recorded.

A second observation is that the companies focus on a wide array of poverty alleviation and social programs. Most of the companies in our study go beyond "do no harm" CSR program and they implement proactive social strategies. Rohm and Haas states that "Corporate social responsibility encompasses all of these facets of being a good corporate citizen and more. Being responsible goes beyond just reacting to and correcting problems, and Rohm and Haas is committed to being a proactive leader in creating an environmentally and socially sustainable chemical industry" (Rohm and Haas, 2012). This company emphasizes that they have a proactive CSR program and they focus on environmental sustainability. Another company says that "Since 1963, when URS began providing technical assistance to developing countries, the company has had a continual presence in this sector. We have participated in the delivery of more than 240 development assistance programs across 47 countries. Our services include the support and implementation of infrastructure, governance, community development and institutional-strengthening activities" (URS, 2014). Again this company goes beyond "do no harm" and they are actively finding ways to reduce poverty.

Some of the CSR programs closely align with the core business model of the organization, while other CSR programs are periphery activities of the company. For example, General Motors has its own foundation and over the past 10 years, GM has spent over USD 265 million for a variety of programs ranging from scholarship funds to community development initiatives. The GM Foundation scholarship has helped poor families, but the program does not directly link to their business model of selling automobiles. In contrast, Konarka states that bringing off-grid power to developing countries was one of their main goals as an organization. Their products are thus directly linked to poverty alleviation.

5 Conclusion

This study examined the top 50 nanotechnology R&D companies in the water, energy, and agri-food sectors. We find that the firms range in size from small, nanotechnology-specific spin-off companies to large MNCs that are leaders in many technology sectors. Some companies span a variety of industries from textiles to crop production but most of the companies operate in chemical manufacturing, professional and scientific services, and computer and electronic product manufacturing.

Against the hypothesis that nanotechnology in the water, energy, and agri-food sectors could be pro-poor, we find little evidence on nanotechnology companies' websites that they are developing pro-poor products. Only 2 of the 50 companies directly associate their nanotechnology efforts with poverty alleviation and none of the companies developed nanotechnology products that only help the poor. 24 firms make products that help all consumers, including the poor, but the benefit of those products for poor communities depends on the price and distribution of the products. For example, new water filter systems could bring clean water to impoverished households, but the government has to build treatment facilities. From our results, we cannot definitively say that nanotechnology is only for the rich, but that it appears that only a few USA nanotechnology companies are actively targeting their products and R&D towards poverty alleviation. However, the public sector and non-USA-based nanotechnology firms might provide nanotechnologies that alleviate poverty. In addition, more pro-poor nanotechnologies could be developed if the technology becomes more ubiquitous. Therefore, it may take longer for nanotechnology to reach impoverished communities.

Despite the fact that few of the companies mention the potential impact of nanotechnology on poverty alleviation, 60% of the companies have statements about CSR. The CSR programs range from activities like starting a scholarship fund to giving technical assistance to developing countries. CSR statements do not automatically translate to the creation of pro-poor products, but it shows that the companies want to portray an image that they are helping society. It is desirable to see more evidence of companies using their CSR programs to develop pro-poor products by applying new technologies like nanotechnology.

6 Acknowledgments

This research was supported by the National Science Foundation under cooperative agreement #0937591 to the Center for Nanotechnology and Society at Arizona State University; the National Science Foundation Graduate Fellowship to Thomas Woodson; and the National Nanotechnology Infrastructure Network Research (NNIN) Experience for Undergraduates (REU) grant # ECS 0335765. I would also like to thank Susan Cozzens, Jennifer Kuzma and the anonymous reviewers for their advice on the paper.

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Appendix

Table 4 List of the 50 companies within this study.

Company	Bankrupt/ Out of business	Category	Year estab-lished	Nanotech-nology engagement	# of employees	NAICS 3
3M		Energy	1902	Periphery	84,000	424
AcryMed	x	Agri-food	-	Core	-	322
Albany International		Agri-food	1895	None	4,300	313
Alcon		Agri-food	1945	None	16,700	325
AstenJohnson		Agri-food	1882	None	80	314
Cargill		Water/Agri-food	1865	Future	139,000	111
Centocor (Janssen Biotech)	x	Water	1979	None	3000	325
CH2M Hil		Water/Agri-food	1946	Periphery	30.000	541
Clearant	x	Agrifood	1999	None	58	325
Dow Chemical		Water	1890	Periperhy	52,000	325
Du Pont		Water/Agri-food	1802	Periperhy	60,000	325
Eastman Kodak		Water	1888	Periperhy	8,800	333
General Electric		Water/Energy	1890	Future	287,000	333
General Motors		Energy	1908	None	219,000	336
GeneSegues		Agri-food	-	Core	2	812
Geocenter		Agri-food	1980	None	29	541
Geosyntec Consultants		Water	1983	Periphery	> 500	541
Harrison Western		Water	1968	None	20	237
Hewlett-Packard		Energy	1939	Future	324.000	334
Honeywell International		Energy	1885	Future	132.000	334
Hydranautics	x	Water	1975	Core	275	541
Inframat		Water	1995	Core	35	541
IBM		Water/Energy	1911	Future	433,362	333
Kimberly-Clark		Agri-food	1870	None	57,000	322
Koch Membrane Systems		Water	1963	Core	> 500	332
Konarka Technologies	x	Energy	2001	Core	25	334
Lifeblood Medical		Agri-food	2001	None	3	424
Lockheed Martin		Agri-food	1912	Future	113,000	336
Membrane Technology & Research		Water	1982	Core	32	333
Miasole		Energy	2001	None	315	334

Continuation of Table 4 List of the 50 companies within this study.

Company	Bankrupt/ out of business	Category	Year estab-lished	Nanotech-nology engagement	# of employees	NAICS 3
Millipore	x	Water	1954	Periphery	10,000	325
MVA		Agri-food	1990	Periphery	20	541
Nalco Chemical Company	x	Agri-food	1982	Core	38,000	424
NanoDynamics Energy	x	Energy	2002	Core	50	334
Nanopaper		Agri-food	-	Core	5	322
Nanoscale Materials Inc	x	Water	-	Core	-	325
Nanosolar	x	Energy	2002	Core	200	334
Nanosys		Energy	2001	Core	60	334
Nano-Tex		Energy	1998	Core	50	541
Nanoventions Inc		Agri-food	2002	None	20	333
Nextech Materials		Energy	1994	None	-	333
Pegasus Technical Services		Water	1996	Periphery	50	541
Pfizer		Energy	1849	Future	116,500	325
Philip Morris Products		Agri-food	1847	None	78,000	424
PPG Industries		Energy	1883	Future	42,000	325
Procter & Gamble Co		Water/Agri-food	1837	None	129,000	311
Rohm and Haas Company	x	Agri-food	1909	None	15,000	325
SolmeteX Inc		Water	1994	Core	14	333
United Technologies Corp		Energy	1958	None	212,000	336
URS Corp		Water	1904	None	47,000	541

