GOING HIGH-TECH IN EASTERN AND CENTRAL EUROPE: SHOULD COUNTRIES COMMIT TO A HIGH-TECH TRADING PATTERN?

by

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(Under the Direction of Darius Ornston)

ABSTRACT

This research assessed whether or not high-tech exports, a proxy variable for advanced high-tech exports, have a positive and significant effect on gross domestic product (GDP) growth in select Eastern and European countries. The study used an OLS model to test cross-country annual data for 12 European countries between the years 1998 and 2010. The hypothesis that high-tech exports have had a significant impact on GDP was rejected. The volume of trade, as a percentage of GDP, and a nation's population were the only variables found to have a significant and positive impact on GDP growth. It was concluded that high-technology exports have not had a significant and positive effect on GDP growth for the 12 countries studied. Additionally, it is argued that if nations pursue economic strategies that benefit low-to-medium technology enterprises, a more balanced growth strategy can be achieved than if the focus is in high-tech sectors.

INDEX WORDS: High-tech, Exports, Manufacturing, Structuralist barriers, GDP

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CHAPTER 1

INTRODUCTION

Advancements in technical expertise in high-income and developed countries in the realm of manufacturing over the course of the last few decades enable nations to develop their economies faster than ever before. Developments in the most economies facilitate other countries, namely those with economic output dominated by simple forms of export such as agricultural products or simple manufacturing, to jump start their economies through a process of imitation and domestic innovation. This mechanism benefits underdeveloped countries the most because it helps them leave behind economic systems dominated simple, low-tech manufacturing and allows them to substitute more advanced technologies into their exports. This rise of technological capabilities has fueled high-technology exports and a drive by nations large and small to pursue a trade agenda that maximizes manufactured productivity and exports in an effort to boost GDP growth. For small states, the drive to leave behind past economic blunders and converge on more advanced neighbors leads to this increased reliance on manufacturing and a desire to enter into higher tiered markets. The impetus for this essay is the desire to test whether this process of seeking economic gain from advanced manufacturing has paid off for Eastern and Central Europe (ECE).

But what are the qualities that make ECE countries good candidates for high-tech industries in the first place? First and foremost, to be successful traders in high-tech products, nations need to be in close geographic proximity to markets where the manufactured goods are to be consumed. All of the countries in this sample are nearby the large markets of Germany, France, the United Kingdom, and relatively near the United States. Being in close proximity to where the manufactured products will be consumed drastically lowers the cost of transportation and makes trade easier. The other reason why ECE countries are good candidates for high-tech manufacturing is that these countries have low labor costs that allow firms to operate more cheaply than in those nations with higher labor costs. Since labor costs are the biggest reoccurring cost for business, keeping wage payments low is critical for continued business development. Coupled with geographic proximity and low labor costs, ECE countries have a history of experience in industrial production. Workers with some experience are much better able to adapt to new forms of manufacturing than are countries that have little experience. On the face of things, going high-tech seems like an intelligent decision and there are many professionals who agree that countries should want to draw high-tech manufacturing to their borders because it will help improve living standards for everyone.

The literature is abuzz with economists, political scientists, and government officials all espousing the benefits higher levels of technology and modernity bring to nations (Lowrey 2012). Many believe the road to innovation and economic growth lies in the presence of a robust manufacturing sector (Manyika et al. 2012). Similarly, the U.S. President's Council of Advisors on Science and Technology, in a report published in July of 2012, spelled out the need for continued investment in high-tech manufacturing to sustain future growth and innovation in

the United States. Recent research has backed up this belief that successful high-tech manufacturing can lead to growth in other industries, if done correctly. For instance, research by Massachusetts Institute of Technology economist Michael Greenstone on the impact of high-tech manufacturing operations on existing firms found that newly-established factories in technical industries resulted in an average of 12% higher productivity and higher wages in surrounding firms (Greenstone et al. 2007). Going high-tech can repurpose existing manufacturing enterprises for the production of new goods, develop new sources of government revenue, and revitalize declining low-to –medium technology industries – all in high demand. If it can work for the United States, proponents of high-tech say, why can't it work for ECE countries?

What is not much discussed is the process of getting to that idyllic point where countries unfamiliar with advanced technology seek to enter into new markets hoping for an economic boost. This paper hypothesizes that smaller, less technologically advanced countries, like those of Eastern and Central Europe, are less prepared for becoming traders of high-tech goods and services because high-tech enterprises strip existing expertise and built up knowledge from domestic industries, force domestic issues to the background, and stifle the natural growth of domestic firms.

Specifically, this paper examines whether or not high-tech manufacturing, a proxy variable for high-tech exports, has acted as a determining factor in per capita economic growth in select Eastern and Central European countries since 1998. Cross country annual data for 12 countries between 1998 and 2010 are used for empirical analysis. An OLS regression model is employed to test the relationship between economic growth and high-tech exports (including

other variables). This research hypothesizes that advanced manufacturing as an industrial export is not a significant factor in determining per capita GDP growth for the countries studied and concludes that small states should think about maximizing existing productivity in the low-to-medium range of manufacturing before engaging in high-tech trade.

CHAPTER 2

LITERATURE REVIEW

Over the years, economists have had plenty to say regarding what really drives economic growth.[1] Although economic theories vary, the unifying theme of the literature points to the fact that technology matters when discussing ways to engender GDP growth. Some point to exogenous variables of growth, such as the popular neo-classical models (see Solow 1987) that separate improvements in productivity from capital investments and state that economic prosperity is primarily determined by external (e.g. foreign investment), rather than internal factors (e.g. domestic policy). Conversely, endogenous growth theorists believe productivity improvements are directly tied to national rates of investments in technology and human capital (see Shultz 1971). Later theorists of the 1980s and 1990s shifted their focus away from debating metatheories and looked towards the economic relationship between the developed and developing world. These theories eventually developed into a debate between why some states flourish economically while other states fail to prosper even though they might have large amounts of natural resources. The three avenues of research that directly inform this examination of high-tech manufacturing, its importance, and why small states should be wary of the consequences of moving too fast are: convergence theories, technology gap theories, and structuralist-economic theories.

[1] Economic growth is defined here as the year-to-year expansion of the productivity of the economy, measured as GDP per capita.

Nation-level research on economic growth has been greatly informed by theories of economic convergence, or how and if developing countries can reach the level of living standards of their developed neighbors. Convergence theories of economic growth, or more simply put, catching up, have significant proponents as well as opponents. However, all agree that technology matters in the race to reinvigorate slow growing economies. The first iteration of convergence theories sprung from economists' observance of poor countries and their inability to implement new technologies. This is because technology leaders have a natural lead on poor countries that is not quickly relinquished (Romer 1986). Romer believed advanced countries benefit from increased returns-to-scale more so than poorer countries.[2] Other theorists argue convergence is not likely because poor states have low long-term growth potential (i.e. low long-run per capita income levels) (see Barro 1991 and Barro and Sala-i-Martin 1991, 1992). This low potential can stem from a variety of reasons: corruption, trade restrictions, or deinvestment in human capital. Still other theorists, such as Sachs and Warner (1996), believed convergence is possible given certain institutional developments such as business-friendly economic policies like low tax and tariff rates and political willingness to open markets up to foreign competition. Before achieving convergence, though, many states must bridge something called the technology gap.

Technology gap theories describe the advantages producers of new or innovative goods and services may achieve when introducing new goods to market - something all new market

[2] Conversely, the Solow Growth Model (1987) predicted economic convergence between the rich and poor based on the assumption that countries with low capital accumulation (i.e. poorer countries) will grow faster than countries with higher capital accumulation because of the tendency for new capital to have higher returns on investment than "legacy capital" and decreasing margins dominant in rich countries.

entrants hope to achieve. These advantages create a situation where temporary monopolies may be appropriated for some period of time, giving the producer country a serious competitive advantage over their market competition. For nascent firms in emerging markets, enjoying a temporary monopoly is difficult because of their inexperience in being market leaders and their short market reach. Even for well established firms, bringing new goods to market is difficult. Most likely, small countries will seek to enter markets by imitating rather than innovating.

Convergence is often achieved through the adoption of new technologies at the cost of domestic producers and in favor of foreign companies promising investments. This leads some governments to neglect their domestic producers in favor of foreign companies that bring the promise of new investment. This process is dangerous for the host nation because it can lead to the loss of built up expertise and knowledge. A state must be ready with a variety of domestic institutions (e.g. banks, local governments, etc.) that are willing to work with the foreign business community in order to be successful. The host nation must also have a skilled labor force, strong infrastructural capacity, and a willing domestic market if it hopes benefit from the presence of foreign businesses. In sum, convergence for small states is difficult because it takes time to bring all parties on board. Specific to ECE countries, these nations do not have a long history of multinational cooperation to the degree their western neighbors enjoy. A final theoretical specification, this one based on structural principles, has also contended with whether or not convergence is achievable.

The theory of economic structuralism, a subset of world systems theory, had its roots in Latin America after WWII (see Prebisch 1951 and Furtado 1961). The theory focuses on the

structural disadvantages smaller, poorer, periphery countries face in relation to larger, richer, core countries. One version of this structuralism argues that underdeveloped countries can realize economic gains through manufacturing, but that this is a risky move because of inherent disadvantages these periphery countries face. This theory argues periphery countries are disadvantaged because they tend to export low value goods and commodities on unfavorable terms (Blackenburg, Palma and Tregenna 2008). However, if countries are somehow able to break out of raw commodity markets or other low-value industries and into manufacturing ones through the use of technology, rapid economic gains could be in reach. But like technology gap theorists before them, this version of structuralism realizes closing the gap given structural realities is not easy. This is because productivity in industrialized countries rises faster than in underdeveloped countries, meaning that the terms of trade deteriorate for the commodity exporter in relation to the manufacturer of durable goods (see Prebisch 1950 and Singer 1950). If true, underdeveloped countries will have a very difficult time transitioning into the high-skilled manufacture of more durable goods.

The second version of structuralism argues similar points. Both versions believed that even though difficult, diversifying into manufacturing sectors can lead to positive economic development for underdeveloped countries. However, the second version argues that even if countries successfully shift away from being commodity exporters and establish more complex manufacturing activities, they will still be at a disadvantage because they will place themselves on the low-end of the production chain and subject themselves to outside forces. For ECE countries the argument is whether they should continue to expand their presence in high-tech markets or if there are viable alternatives to this strategy. The next section discusses this issue.

CHAPTER 3

THE PROMISE OF HIGH-TECH MANUFACTURING

As economic structuralists have argued, nations with small, underdeveloped economies are unlikely to benefit from entering high-tech markets because they will have unfavorable terms of trade and lower productive potential than countries already well-established in high-tech markets. What ECE countries do have, however, are mature, low and medium-tech industries they can rely on for convergence. Still, many ECE countries, whether they are the Czech Republic with its auto industry or the Baltic countries with their robust telecommunications sectors, chose to enter and stay into high-tech markets because it is believed high-tech outperforms low-tech industries in the fields of GDP growth potential and spillover effects.

Success in high-tech manufacturing is thought to lead to: (1) moderate to high GDP growth; (2) the acquisition of new technologies and business practices via the spillover effect; and (3) a variety of long-term benefits ranging from a more educated workforce to a further increase in foreign interest investment.

The promise of high-tech manufacturing is that it can substantially contribute to GDP growth in a way that low-tech industry cannot because the former is considered a high-value sector whereas the latter is not.

This potential for large jumps in productivity when going from low-tech to high-tech is perhaps the most enticing benefit policy makers see when looking at establishing a foothold in the high-tech manufacturing arena. By engaging in this form new economic activity countries are able to reap direct benefits such as increased sectoral productivity or indirect benefits such as spillovers and firm competition that lower-tech domestic firms are unable to provide because they have reached their productive potential. A related component of the promise of GDP growth is the pressure put on by the populace of underdeveloped countries on their governments to make economic gains.

The countries of ECE are perhaps subject to these pressures perhaps more so than their Western neighbors, given their history of high unemployment and low living standards relative to Western Europe. Predominantly driven by domestic demand for improved economic opportunities, the Four Asian Tigers (Hong Kong, Singapore, South Korea, and Taiwan) have been through this whirlwind tour of development and have the results to show it. In the 1980s, these tigers were merely cubs compared to the vibrant Japanese economy. Three decades later, however, the cubs grew up to stand shoulder to shoulder with the Japanese economy in terms of living standards (Economist, April 2012).[3] The domestic manufacture' of advanced goods, propelled by the desire to improve overall living standards, helped buoy these countries to economic prosperity and converge on the Japanese economy. Coupled with the high profits high-tech companies enjoy compared to low-tech firms, policymakers flirting with the decision

[3] One common method of measuring and comparing living standards is taking a look at GDP per person at purchasing-power parity (PPP). Using this measurement, Singapore overtook Japan in 1993, in 1997 in Hong Kong, and Taiwan in 2010. South Korea is expected to supplant Japan soon as well. See http://www.economist.com/node/21553498

to enter or expand their presence in high-tech markets have ample examples that can be used to inform their decision-making.

The second benefit of entering into high-tech markets has to do with the technological, productivity, and other positive spillovers that domestic firms have the potential to absorb when advanced companies are operate nearby. Crespo, Martin, and Velazquez (2004) have found that international technological spillovers have had a favorable impact on GDP growth in OECD countries in the past two decades. Most importantly, the presence of high-tech industries can kick off a cycle of domestic growth and innovation, bringing in larger amounts of investments and transforming areas of the country into hubs of commerce that contribute to GDP. These spillovers are coveted because unlike traditional low or medium-tech industries, innovation at the highest level has the potential to create temporary and highly profitable monopolies. Needless to say, the phrase "success brings more success" has some merit here. When spillovers take place, broad segments of a society tend to benefit as well. Not only does the individual firm draw direct benefits of having more demand, it might hire additional employees or expand production capacity. Expansion's such as these tend to lead to more revenue for governments and more take-home pay for workers and is an attractive benefit to going high-tech.

Lastly, successes in high-tech industries have the potential to provide for investments that lead to progress in other sectors like education, healthcare, government, etc. For example, the successful growth of industrial productivity can bring more revenue for nations to invest in social programs and public works. These spillovers are not just limited to the public sector. Ishaq Nadiri (1992) has found strong evidence of sizable positive spillover effects from

investment at both the firm and industry levels. These spillovers vary from improved production processes to a changing business culture that is more open to foreign competition and the technologies they bring with them. Furthermore, these positive effects have the possibility of trickling down and lead to a higher levels of gender-equality, employment, and entrepreneurship (OECD 2012). Lastly, it has to be mentioned that these spillovers are not set in stone and improvements depend upon a host nation's level of capability and domestic competition (Blomström and Kokko 1998). However, high-tech markets are not all positive and there are dangers when hitherto low and medium-tech producing countries begin operating in new markets.

CHAPTER 4

THE DANGERS OF HIGH-TECH MARKETS AND WHY ECE COUNTRIES SHOULD BE WARY OF ENTERING THEM

Even given the many boons high-technology industries may bring to a nation, there is ample reason to question high-tech's usefulness in Eastern and Central Europe. The hypothesis of this thesis is that high-tech manufacturing has not resulted in positive GDP growth for ECE countries under study. Using the works of Soskice (1999), Edquist and Lundvall (1993), and Ziegler (1997), the following section adds onto current structuralist theory by asserting that entering into high-tech manufacturing sectors should not be an immediate priority for small states because they are in a disadvantageous position in relation to their competition and suggest an alternative theory of maximizing low-to-medium domestic technology industries first.

The alternative to promoting high-tech industries is the development of low and medium technology industries. Focusing on low-to-medium technology industries is favorable for ECE countries for a variety of reasons: (1) they allow for the natural progression from less advanced forms of manufacturing to more highly skilled ones without rapidly displacing domestic firms out of the market; (2) they allow for nations to choose their own specializations that make the most efficient use of accumulated skills and knowledge; and (3) it helps keep economies insulated from the outside influence of multinational corporations.

The merits of such a theory are convincing because it recognizes the benefits of technology, but does not believe in its preeminence. Recent research on firm behavior has proven that businesses would rather continue operating in their current market instead of expanding into new ones. Furthermore, scholarship has shown that firms circulate technologies rather than create new ones (Ziegler 1997); modernize production processes before inventing more novel ones (Edquist and Lundvall 1993), and improve existing products before beginning new development (Soskice 1999). For ECE countries, staying out of high-tech markets is beneficial because it allows this wide range of processes to continue to improve in efficiency and it creates more durable markets in the long-run. In addition to allowing ECE countries to focus on existing strategies without having to adapt to new ones, staying at the status quo gives low-to-medium technology firms time to develop into more technologically advanced businesses at their own pace. This allows ECE countries to blend existing strengths with new manufacturing processes through a process akin to survival of the fittest instead of forced specialization at the insistence of multinationals. Next, five reasons are discussed as to why staying low-tech is a more favorable option for small states rather than trying to enter into high-tech markets.

There are five key limitations small states face when entering high-tech markets through manufacturing that most low-to-medium technology enterprises do not have to contend with: (1) production fragmentation; (2) inherent market instability; (3) small domestic markets and other various structural deficiencies; (4) consequences of multinational business; and (5) unfavorable and forced specialization.

The first disadvantage countries face when entering into high-tech markets is a fragmented production chain. As a consequence, new market entrants, like many ECE countries, will be relegated menial tasks within high-tech manufacturing because they do not have the skills necessary to move higher up the production chain. This is because high-tech goods being built or assembled in ECE countries because it is cheaper, not because there is a domestic market for it. On the other hand, low-tech goods are made domestically because there is a market for them there and there would be no reason to have a these goods made abroad and shipped home. It is advantageous for ECE countries to make lower-tech goods because it keeps the manufacturing process at home and lets industry build existing competencies instead of adapting to novel ones. Also, given the domestic nature of low-tech manufacturing, it is therefore unlikely that existing low-to-medium technology operations will get pushed out of the market or outsourced like high-tech goods are prone to do.

A good example of this fragmentation is the manufacture and assembly of smartphones in China, Taiwan, and other Asian countries destined for final consumption in Europe and North America. An even more fragmented production process, the parts for Boeing's new 787 Dreamliner are manufactured by 45 separate firms operating out of countries as diverse as Japan, France, Korea, and Italy, with final assembly taking place in the United States (Boeing Corporate Website). Most high-tech industries, but few low-tech ones, follow this model of production. The danger associated with this fragmentation is that countries that are new entrants to the high-tech value chain of production are likely to fall into a middle or low value-generating category – positions that are not much better at generating profit than are many low-to-medium technology enterprises. Fragmented markets, coupled with the second danger

of high-tech markets, instability, mean that GDO growth for small states in high-tech sectors is not an assured outcome and countries are no better served in entering these markets than they would be if they stayed their course and maximized existing low-to-medium technology productivity.

Secondly, where small states need economic stability for growth, high-tech markets are inherently unstable. In low and medium technology markets, volatility is also present, but less of an issue because much of the demand is local and firms are better able to forecast changes in the economic situation than they would be if their clientele was abroad. When production is outsourced or fragmented between few or many producers, such as the manufacture of motor vehicles, market stability is ever at risk to dangers brought about by man or nature. In addition to fragmentation, the constant rate of innovation means markets constantly shift, forcing producers to often change inputs or market enabling research. Small states cannot easily afford to frequently shift economic policies to follow often changing markets – they need stability and predictability over unsure promises of growth. This instability is even more dangerous because few manufacturing is local anymore: often times, parts are manufactured in a variety of different factories all around the world and production chains are vulnerable from many different angles. For example, the March 2012 Japanese Earthquake greatly reduced the availability of parts and vehicles for many of the main Japanese auto manufacturers for many months after the disaster. Markets where Japanese vehicles are sold are still struggling with the earthquake's after-effect and parts shortages are expected to continue for some time (Economist, May 2012).

Another example of this market volatility is the auto industry in the Czech Republic. In 2007, the automotive industry accounted for 20.2% of all manufacturing output and exports in the country (CzechInvest.org). With the drop in demand from Germany and other Western European nations for Czech-made automobiles due to the financial crises, GDP contracted in the Czech Republic by 3 percentage points from 2007 to 2008, and a further 7 percentage point drop by 2009 (CIA World Factbook).[4] Ideally, small countries would like to avoid this market instability and therefore should think about going the low-tech manufacturing route because it is somewhat insulated from broader global crises because they have domestic markets to prop them up with more continuous demand.

The third disadvantage small countries face in high-tech competition is a structural one and has three facets. These include small domestic markets, inadequate political institutions, and inability to shift existing competencies to fully benefit from new markets. Here also, low-tech manufacturing is advantageous for ECE countries because these firms essentially grew up and formed in this environment and therefore operate at the intensity that the market and surrounding institutions allow. In essence, these low-tech firms are more durable than high-tech ones because they know how to gauge economic realities better than firms controlled by foreign entities, resulting in more robust longevity for low-tech firms.

Furthermore, a country with small or underdeveloped markets is at risk of not being able to reinvest the gains from manufacturing successes because profits and productivity will be controlled by multinational corporations. The size of a market will also potentially affect the

[4] From 2005 to 2007, the Czech Republic experienced a healthy real GDP growth rate in the bottom to mid 6% range. Starting with the economic crises and subsequent drop in demand from Western clients, an automotive-led manufacturing contraction resulted in a drop of the growth rate to 3% in 2008 and to a bruising -4.1% in 2009.

domestic rate of innovation due to competition, domestic demand, and potentially investment inflows because of lack of a competitive business environment. Another structural barrier is especially prevalent in Eastern Europe - it is the presence of inadequate political institutions in the sense that they are inexperienced in protecting domestic and social constituencies from foreign demands. Such inadequacies in institutional structure can lead to capital or intellectual flight, an unfortunate reality in ECE countries for the last few decades. Successful firms are often picked up by multinationals and intelligent individuals immigrate with their families out of the country for better opportunities, resulting in a serious brain drain. The last structural barrier is also related to the presence of low quality institutions. A country's inability to benefit from new markets is retarded by institutional corruption, restrictive laws, and other policies that make trade more difficult. Eastern and Central European countries are especially prone to having certain institutions with low accountability and difficulty adjusting to free market economics because of certain legacy issues stemming from the Cold War, namely, a business sector heavily influenced by government that constricts the free operation of the market. These and other realities can have serious long-term effects for small countries.

The fourth disadvantage small states face when entering into high-tech markets is that they must allow foreign multinationals to operate within their borders if they hope to develop these new industries. For the host nation, this leads to an uneven balance of bargaining power because they have to allow a certain degree of freedom to the foreign producer in an effort to continue the relationship. In the context of low-tech producers, this is a non-issue because the relationship between business and government is of more equal footing due to the fact that ownership is domestic and therefore more durable. This push by small countries to enter into

high-tech markets, and let in MNC's, is supported by the literature. Barcenilla (1999) showed that the process of convergence is more evident in the technology than in the trade field, which implies that going high-tech will bring more foreign competition if small states enter these markets. This also implies that small states will willingly lobby multinationals to operate inside their borders knowing that they will be at a disadvantage bargaining position with foreign firms. This process of letting in foreign competition is inherently risky and doubly so for small states (see Korres 1996). Blomström and Kokko (1998) have found evidence that when multinationals enter into new markets, they run the risk of displacing domestic firms and can force local firms out of business all together. The reason multinationals are eager to set up shop in ECE countries is to achieve lower labor costs, not to sow the seeds of prosperity or develop nascent domestic industries.

As mentioned before, a key selling point for foreign firms deciding to enter markets is cheap labor relative to other geographic areas and favorable economic incentives such as low tax rates or minimal red-tape. The foreign multinational, however, brings with it the sole promise that it will produce some product for some unspecified period of time. The benefits of this should not be down played; they vary from infrastructure building, to employment opportunities, to other spillovers effects discussed in the previous sections. But outside of the immediate need for these organizations to build roads, factories, or other infrastructure necessary for it to carry on its business, multinationals have minimal incentive to increase their social footprint. This is problematic for ECE because high-tech manufacturing enterprises will by necessity be concentrated in a few geographical areas to reduce costs. If the foreign firm stops or moves production facilities to another country, the host nation will be left with

deficient domestic firms that will take time to fill the gap. A good example of how MNC's affect host nations can be found in Ireland and its recent economic troubles.

Ireland in the past two decades is an unfortunate example of a small country that entered into high-tech markets and where expectations surpassed outcomes. Because of its favorable economic climate and an aggressive push led by the Irish government, foreign investments poured into high-tech industries in Ireland such as pharmaceuticals, telecommunications, and software beginning in the 1990s. This process transformed Ireland into the leading exporter of high-tech goods in the European Union in 2007. Although beating both Finland and Denmark in share of high-tech exports, Ireland found itself in the lower tiers of industrial activity of the high-end market. Ireland's economy quickly shifted to service-related sectors of the high-tech market that did not generate the same returns as upper tiers on the high-tech ladder because manufacturing was not paying off in the way Irish policymakers hoped for (Ornston 2012, 126). A partial reason for this failure to sustain economic development has been the influence of MNC's and Ireland's inability to balance social demands with economic ones. By having foreign investment as the cornerstone of their economic model, Ireland needed to maintain a low corporate tax rate to attract multinationals. Although generating impressive growth and leading some to label Ireland as the "Celtic Tiger", this policy led the government to adopt a hands-off approach to social issues which led to an increases poverty and inequality (O'Hearn 1998). Ornston (2012), in his analysis on the various forms of European corpratism, took the argument further by stating that MNC's that are attracted by low corporate tax rates will lobby for further decreases in the tax rate, making it even harder for these nations to invest in labor, research and design, and similar programs.

The final reason why small countries should be wary of entering into high-tech markets is that they will be forced to specialize in what type of goods they trade in. This outcome is difficult to overcome for small states because their productive potential is limited by various characteristics not easily overcome such as population, geography, and education. If going the low-tech route, forced specialization is not an immediate issue because it will occur naturally over a longer period of time – allowing for built up expertise to guide which industries a country chooses to specialize in. Authors like Soete (1987), Archibuig and Pianta (1992a, 1992b), Amendola et al. (1992, 1998) and Barcenilla (1999) generally agree that smaller countries display a level of specialization higher than larger countries like Germany or France. However, high-tech specialization is a double-edged sword for ECE countries. On the one hand, specialization allows ECE countries to overcome structuralist barriers by shifting away from natural resource-intensive industries to more learning-intensive industries. On the other, it opens up these countries to market volatility, a disadvantaged position in relation to foreign firms, and most likely places them lower on the production chain than they would like. Specialization is good for the ECE because they are able to establish expertise in some area of industry, but bad as well because they have a limited pool of qualified candidates from which to draw from. Low-tech is beneficial here as well because it lets labor adapt to changes in the market at a much more forgiving pace than it would if a big corporation set up operations and started to hire large amounts of workers.

Oftentimes the decision to specialize will not be made because there is a domestic need for a certain good or service, rather, entry into markets will be made based on the needs of others. These decisions often times set countries on a path of dependency where national

trading agendas will be increasingly devoted to specific industries, like the automotive sector in the Czech Republic or telecommunications in Estonia and Latvia. Instead of facing the danger of forced specialization and the others outlined above, small countries have the choice to promote existing low-to-medium technology industries.

However, this theory of promoting existing low-tech industries over high-tech ones does not imply that advanced manufacturing activities should be closed off to small states entirely. When domestic industries are well established and operate efficiently, processes of diversification and sectoral expansions can pick up speed. Ideally, this should occur after domestic firms have had time to imitate and learn from foreign multinational firms. However, if countries aggressively lobby foreign firms to come and set up manufacturing operations in their country, they will open themselves up to a host of problems associated with high-tech markets if they are not ready to make the transition. What is needed is a balanced approach that lets countries maximize their productivity without alienating certain industries in favor of others. In this process, there is room for all forms of manufacturing, but those forms must be balanced if ECE countries wish to have sustained and equal economic development. Next, the methodology is discussed and linear regression results are discussed.

CHAPTER 5

METHODOLOGY

The sample period of this study covers the years 1998 through 2010. Cross sectional data for 12 countries are used: the Czech Republic, Hungary, Poland, Estonia, Lithuania, Latvia, Slovenia, the Slovak Republic, Romania, Bulgaria, Croatia, and Macedonia. A total of 156 observations are present in the dataset. Data was collected using IMF's World Economic Outlook Database (WEO): October 2012 edition, as well as the World Bank.

The regression used to test the relationship between GDP and high-tech exports was a linear regression. To test for autocorrelation, a Wooldridge test on panel data was conducted (see Drukker (2003) and Wooldridge (2002) for further details). The corresponding F-statistic indicated the presence of first-order autocorrelation. Similarly, a Breusch-Godfrey test was also run and indicated serial correlation. To correct for autocorrelation, the lagged first-order difference of the dependent variable was used as an additional explanatory variable in the regression. Although lagging results in some loss of data, the benefits of having a correctly specified model with more accurate standard errors warranted such a measure.

To test for homoskedasticity, a graphical examination of the residuals as well as a Breusch and Pagan Lagrangian multiplier test for random effects showed that heteroskedasticity was evident in the data. To correct for this heteroskedasticity, Huber-White sandwich standard errors are used in the model. Also, the analysis was clustered by nation to further account for temporal interdependence.

The dependent variable in this equation is the percent change in gross domestic product over the previous year in constant prices (**GDP**). The independent variables in this regression analysis are a one-year lagged dependent variable to account for temporal interdependence (**LD_GDP)**, the percent of high-tech exports as a percentage of all manufactured exports (**HT_Export)**, rate of inflation (**Inflation**), total imports and exports as a percentage of GDP (**Trade**), total population (**Population)**, and the percent of workforce with a tertiary education (**Labor**).

Model 1:

$$\Delta Y_t = \Delta Y_{t-1} + (Y(t-1) - Y(t-2)) + \beta_1 X_t + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + \beta_6 X_{it} + \alpha_i + u_t$$

The dependent variable is the change in yearly per capita GDP. This variable measures the sum gross value-added by all producers of all goods and services in the economy plus any taxes and minus any subsidies divided by a nation's midyear population (World Development Indicators 2012). Using per capita GDP figures instead of yearly totals or averages allows for the interpretation of how much influence independent variables have on the change in GDP from year to year. Yet another reason using per capita GDP is advantageous over alternative

measures is that economic planners use time series data like these to plan and execute national economic strategies and trade policy that directly affect individuals' levels of income. Gross GDP figures have a hard time explaining how the average individual is affected by economic shifts.

The first independent variable is the level of high-tech exports, as a percent of total manufactured exports. The amount of relative high-tech exports is a good proxy variable for high-tech investment because it gives a sense of how much a nation has committed to that form of trade and how much changes in these exports affect GDP figures. High-tech exports are a broad category of products which include manufactured items that require specialized skills, training, equipment, and materials in order to produce. Similarly, all require high and intense levels of research and design. They include: aerospace, computers, pharmaceuticals, scientific instruments, electrical machinery, chemicals, communications equipment, and transportation equipment (World Development Indicators 2012).[5] An additional regression was run to test whether or not high-tech exports as a percentage of all manufactured exports truly capture's the variable it is thought to serve as a proxy for. A variable indicating the total number of computer, communication, and other related equipment exports as a percentage of total commercial exports was substituted in the model with very similar results. Therefore, it

[5] Similar to IMF's categories, Eurostat provides another popular measure and breaks down manufacturing technology levels in the following way: High-tech products include pharmaceuticals, computers, electronics, optical products, and air and spacecraft; medium-high-tech products include chemicals, weapons, electrical equipment, machinery, motor vehicles, and medical instruments; medium-low-tech products include petroleum, rubber, plastic, and metal products; and finally, low-tech products include textiles, food, beverage, furniture and wood products.

can be concluded that high-tech exports as a percentage of all manufactured exports serves as a good proxy variable for high-tech exports.

Inflation levels are a good measure of the health of an economy and it can inform investment decisions and export choices. Naturally, inflation is a good variable to include when studying GDP because it is a barometer for how much the national currency is valued. Level of inflation is measured here as the commonly known Consumer Price Index (CPI), specifically it is the "annual percentage change in the cost to the average consumer of acquiring a fixed basket of goods and services" (World Development Indicators 2012). Another variable in this regression analysis is a nation's total population. Population size is included to account for the relative sizes of each country because it is known that small countries tend to grow faster than larger countries under certain conditions.

To measure the level of trade occurring in a country, the total level of imports and exports as a ratio of GDP is used. This measure helps identify the relative openness of a nation's economy. High ratios of trade indicate globalization and integration into the world economy while low ratios indicate a relatively closed economy and the level of difficulty associated with conducting business. Restrictive economies are seen as riskier investments because they are more likely to engage in illegal practices like breaking contracts and reneging on promises.

Another independent variable in this regression, labor, has traditionally seen as a driver of investment worldwide (Kojima 1973). The percent of a nation's workforce with a tertiary education is used here to measure the stock of human capital in a country. High levels of tertiary education indicate whether or not a country values education and the future of its

populace. However, according to Barro and Lee (1994), educational attainment does not account for knowledge and experiences obtained outside of the classroom. Similarly, measures of educational attainment do not measure the quality of education received or specific skills acquired. Nevertheless, level of education reached is a good indicator to measure the quality of available labor in a nation. For Eastern and Central Europe, labor costs are generally very low when compared to Western Europe or North America. Labor costs are what drive investment because they are recurring and unavoidable. In the countries under study, all have relatively low labor costs and high educational attainment (10-25%) – creating a favorable climate for investment. Next, a discussion of the regression results will be presented.

CHAPTER 6

RESULTS AND CONCLUSIONS

The regression results for the model are presented on page 36 of the appendix (Table 3). Page 35 of the appendix presents summary statistics (Table 1) and a correlation matrix (Table 2) for the data. Pages 37 through 38 present various figures describing the data.

Overall, the statistical regression output has an R^2 value of 0.175. Substantively, 17.5% of the total variance in the dependent variable can be explained by this model. As theorized, high-tech exports, a proxy variable for high-tech manufacturing, was not significant in this research. For the model the coefficient for high-tech exports is negative. Specifically, for a percentage point increase in high-tech exports, we expect to see a .044% decrease in a nation's GDP in that year, on average and holding all other predictors constant. However, this statistic was not significant at any of the commonly used significance levels. Based on the results, it is concluded that high-tech exports have not been a positive influence on per capita GDP growth for the 12 ECE countries under study between 1998 and 2012. However, three significant variables are present in this research: trade, population, and labor. Both trade and population, as theory suggests, should have a positive influence on GDP growth. We see that here in the results. Specifically, for every one percentage point increase in a nation's trade as a percentage of total GDP, we expect to see GDP grow by .066% in that year, on average and holding all other predictors constant. For every million increase in a nation's populace, we expect to see a change in GDP of .004%, on average and holding all other predictors constant. The result for

the labor variable was both negative and significant. For every 1 percentage point increase in a nation's population with a tertiary education, we expect to see a .1% decrease in the GDP growth rate for that year, on average and holding all other predictors constant.

Further evidence against the theory that high-tech manufacturing has led to large gains in productivity is presented on page 37 of the appendix. Figure 1 of the appendix compares the differences between per capita GDP growth rates and high-tech exports among all 12 countries. With the exception of Macedonia, Slovenia, and Slovakia, and arguably Poland, all countries were experiencing an upward trend of high-tech exports from 1998 onwards. Over the corresponding time period the change per capita GDP growth rate for the remaining eight countries was not greatly affected by that countries level of high-tech exports. Figure 2 graphs each country's change in GDP growth rate against the change of high-tech exports, as a percentage of total manufactured exports, for a given year. With the exception of Estonia and Hungary, most countries in the study did not experience large accompanying jumps in their GDP growth rate when high-tech exports as a share of total manufactured exports rose.

The results in this paper are interesting because they do not verify the theory that advanced manufacturing leads to sustained economic growth. A glance at figure 1 in the appendix shows that high-tech manufacturing operations are largely not immune from macroeconomic shocks and subject to the same volatility triggers as other economic sectors. Perhaps what countries should view high-tech manufacturing as quick fixes for past economic setbacks or used as a crutch in hopes of boosting GDP growth rates, rather, they should focus on maximizing the spillover effects high-tech industries provide by maximizing institutional potential. Education, infrastructure, living standards, and government are all able to reap

benefits from increasing market exposure and advanced manufacturing enterprises, but nations must be prepared for the transition from low or medium technology-intensive industries to higher tiered ones with adequate institutions to overcome structuralist barriers and to make the most out of the foreign-domestic firm dynamic.

Small countries should aim for the successful utilization of high-tech manufacturing through institutions that can adequately transfer the gains from increased productivity. Countries with well-developed institutions are also potentially more able to challenge MNC's more effectively – negotiating more equal labor contracts and the like. This institutional response to new markets in Eastern Europe is another potentially fruitful avenue of future research because the acquisition of advanced technologies is unlikely to lose relevance. Taken together, this research shows that countries should be wary before entering into high-tech markets until they are ready with quality institutions, a mature domestic market, and a stable and productive position on the value-production chain.

REFERENCES

After the Quake. May, 2011. The Economist. London 2011.

Amendola, G., P. Guerrieri and P. Padoan. 1992. International Patterns of Technological Accumulation and Trade. Journal of International and Comparative Economic*s*, Vol. 1, pp.173-197.

Amendola, G., P. Guerrieri and P. Padoan. 1998. International Patterns of Technological Accumulation and Trade", in D. Archibugi and Michie, J. (eds), Trade, Growth and Technological Change, 141-167.

Archibuigi, D. and M. Pianta. 1992a. Specialization and Size of Technological Activities in Industrial Countries: The analysis of patent data", Research Policy, Vol. 21, 1, pp.79-93.

Archibuigi, D. and M. Pianta. 1992b. The Technological Specialization of Advanced Countries: A Report to the EEC on International Science and Technology Activities, Kluwer Academic Publishers: Dodrecht.

Automotive Industry in the Czech Republic. 2012. <http://www.eepcindia.org/indiashow/czech2012/Czech_auto_sector.pdf>

Barcenilla, S. 1999. Especializacion tecnologica y especializacion commercial. Evedencia empirica para los paises de la Union Europea. Informacion Comercial Espanola, Vol. 781, pp. 85-102.

Barro, R., 1991. Economic Growth in a Cross Section of Countries. Quarterly Journal of Economics 106, 407-444.

Barro, Robert J. and Jong-Wha Lee. 1994. Sources of Economic Growth. Carnegie-Rochester Conference Series on Public Policy, 40:1-46.

Barro, R. and X. Sala-i-Martin. Convergence Across States and Regions. Brookings Papers on Economic Activity, 1991:1

Barro, R. and X. Sala-i-Martin. 1992. Regional Growth and Migration: A Japan-United States Comparison," Journal of Japanese and International Economics, 6, pp. 312-346

Blomström, M. and Kokko, A. 1998.Multinational Corporations and Spillovers. Journal of Economic Surveys, 12: 247–277. doi: 10.1111/1467-6419.00056

Crespo, J., Carmela Martín and Francisco J. Velázquez, 2004. The Role of International Technology Spillovers in the Economic Growth of the OECD Countries. Global Economy Journal, Berkeley Electronic Press, vol. 4(2), pages 3.

Crespo, J., Carmela Martín and Francisco J. Velázquez. 2004. International Technology Spillovers from Trade: the Importance of the Technological Gap. Investigaciones Economicas, Fundación SEPI, vol. 28(3), pages 515-533, September.

Drukker, D. M. 2003. Testing for serial correlation in linear panel-data models. Stata Journal (3)2: 168-177.

Edquist, C., and Bengt-Ake Lundvall. 1993. Comparing Danish and Swedish Innovation Systems of Innovation. In *National Innovation Systems: A Comparative Analysis,* edited by Richard R. Nelson. 265-98. New York: Oxford University Press.

Jaegers, T., Lipp-Lingua, C., and Digna Amil.2013.High-Tech and Medium-Technology Industries Main Drivers of EU-27's Industrial Growth. Eurostat Statistics in Focus Series. January 08, 2013. Issue Number 1/2013. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-13-001/EN/KS-SF-13-001-EN.PDF

Fageberg, J. 1987. A Technology Gap Approach to why Growth Rates Differ. Research Policy, vol. 16. pp. 87-99.

Furtado, C. 1961. Desenvolvimento e subdesenvolvimento. Rio de Janiero, Editoria Fundo de Cultua.

Greenstone, Hornbeck, Moretti 2007.Idnetifying Agglomeration Spillovers: Evidence from Million Dollar Plants. MIT Department of Economics Working Paper No. 07-31.

Kojima, K. 1973. A Macroeconomic Approach to Foreign Direct Investment. Hitotsubashi Journal of Economics.Vol.14, no. 1.Hitotsubashi University.

Korres, George M. 1996.Technical Change and Economic Growth: An Empirical Analysis of the EEC. Aldershot, England.

Lowrey, A. 2012. Companies See High-Tech as Fonts of Ideas. *New York Times*. http://www.nytimes.com/2012/12/14/business/companies-see-high-tech-factories-as-fonts-of-ideas.html?_r=0

Manyika, J., M. Chui, B. Brown, J. Bughin, R. Dobbs, C. Roxburgh and Angela Hunf Byers. 2011. Big data: The next frontier for innovation, competition, and productivity. May 2011. MacKinsey Global Institute.

Nadiri, M. Ishaq.1992. Innovations and Technological Spillovers", National Bureau of Economic Research, Cambridge, Mass., No. w4423.

National Science Foundation. 2012. Science and Engineering Indicators http://www.nsf.gov/statistics/seind12/pdf/overview.pdf

OECD (Organization for Economic Cooperation and Development). 2012. *Closing the Gender Gap: Act Now.*
http://www.keepeek.com/Digital-Asset-Management/oecd/social-issues-migration-health/close-the-gender-gap-now_9789264179370-en

Ornston, D. 2012. When Small States Make Big Leaps: Institutional Innovation and High-Tech Competition in Western Europe. Cornell University Press: Ithaca

Prebisch, Raúl. 1950. *The Economic Development of Latin America and Its Principal Problems*. New York: United Nations.

Prebisch, R. 1951a. Growth, Disequilibrium and Disparaties: Interpretation of the Process of Economic Development, Economic Survey of Latin America 1949. E/CN.12/164/Rev.1, Santiago, Chile. ECLAC. Also published as "Interpretacion del proceso de desarrollolatinoamericano en 1949.

Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing. July 2012. President's Council of Advisors on Science and Technology. http://www.whitehouse.gov/ostp/pcast

Romer, Paul M. 1986. Increasing Returns and Long Run Growth. *Journal* of Political Economy, 94, 1002-37.

Singer, Hans. 1950. "The Distribution of Gains between Investing and Borrowing Countries." *American Economic Review* 40: 473–485.

Soete, L. 1987.The Impact of Technological Innovation on International Trade Patterns: The Evidence Reconsidered. Research Policy,16: 101-30.

Soskice, D. 1999. Divergent Production Regimes: Coordinated and Uncoordinated Market Economies of the 1980s and 1990s. In *Continuity and Change in Contemporary Capitalism*. Edited by Herbert Kischelt, Peter Lange, Gary Marks, and John D. Stephens. 101-34. New York: Cambridge University Press.

Wooldridge, J. M. 2002. Econometric Analysis of Cross Section and Panel Data. Cambridge, MA: MIT Press.

World Bank. 2012. *World Development Indicators*. <http://data.worldbank.org/data-catalog/world-development-indicators>

Ziegler, J. Nicholas 1997. Governing Ideas: Strategies for Innovation in France and Germany. Ithaca: Cornell University Press.

APPENDIX A

METHODOLOGY

Table 1: Descriptive Statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
GDP	0.035	0.046	-0.18	0.122	156
HT_Export	0.082	0.065	0.008	0.299	154
Inflation	0.059	0.077	-0.013	0.591	156
Trade	0.533	0.156	0.226	0.869	156
Labor	0.201	0.075	0.082	0.432	144
Population (In millions)	9.114	1.04e+07	1.34	38.7	156

Table 2: Correlation Matrix

.	**GDP**	**HT Export**	**Inflation**	**Trade**	**Labor**	**Pop.**
GDP	1.000					
HT_Export	-0.082	1.000				
Inflation	0.054	-0.058	1.000			
Trade	0.034	0.487	-0.183	1.000		
Labor	-0.116	0.098	-0.290	0.249	1.000	
Population	0.009	-0.147	0.178	-0.501	-0.365	1.000

Table 3: Lagged Differences Model

	Coefficient	Standard Error	t-value
LD_GDP	-0.448***	0.110	0.000
HT_Export	-0.0438	0.0822	0.594
Inflation	0.0203	0.126	0.872
Trade	0.0661**	0.0255	0.009
Labor	-0.109**	0.0392	0.006
Population	0.000409**	0.000156	0.009
_cons	-0.0206	0.0151	0.173
R^2	0.175		
N	123		

Standard errors in second column

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

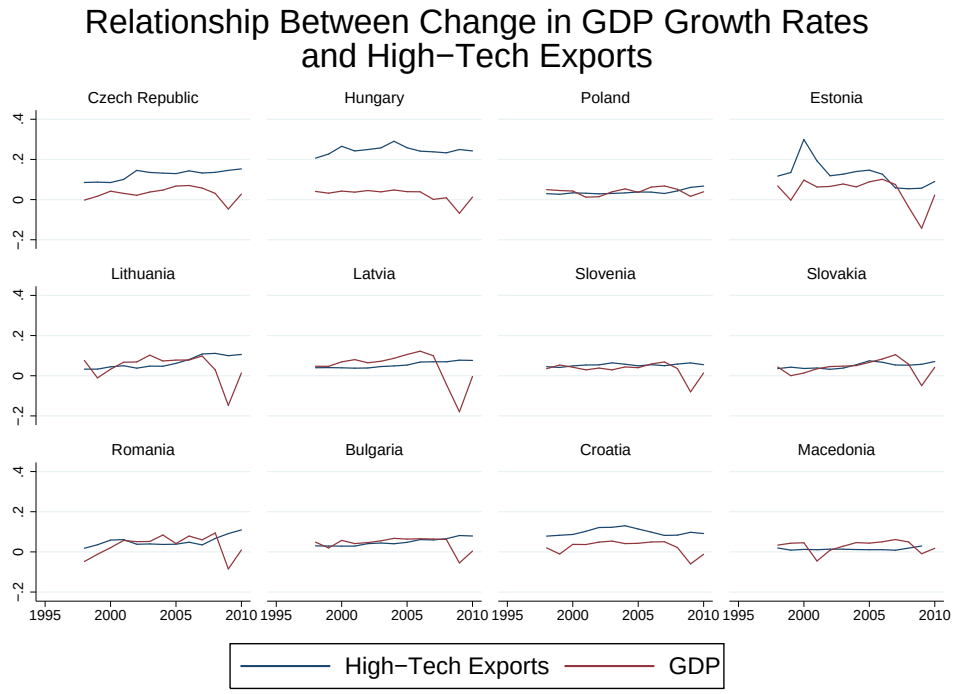

Figure 1

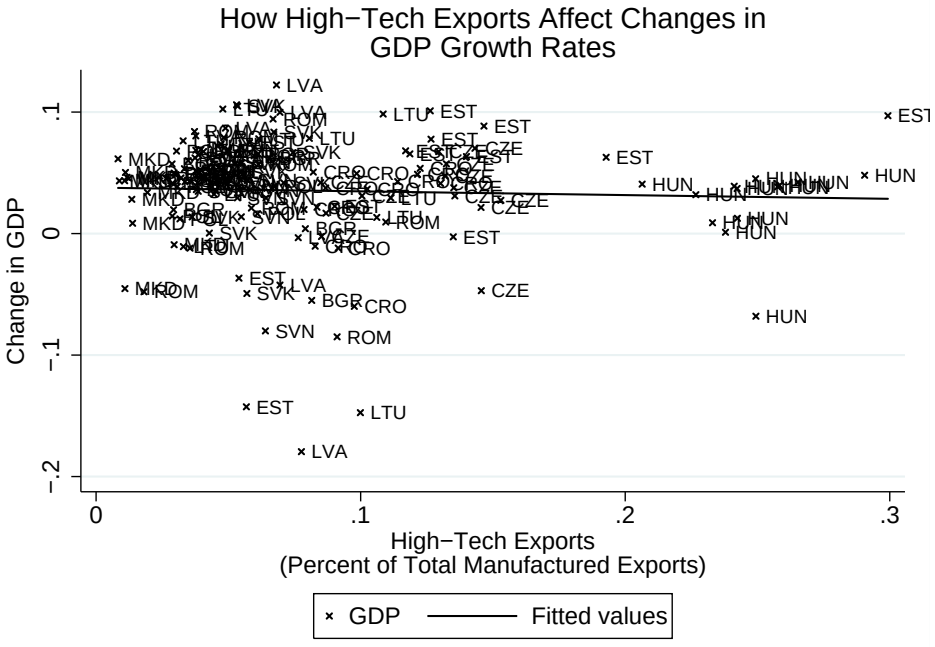

Figure 2

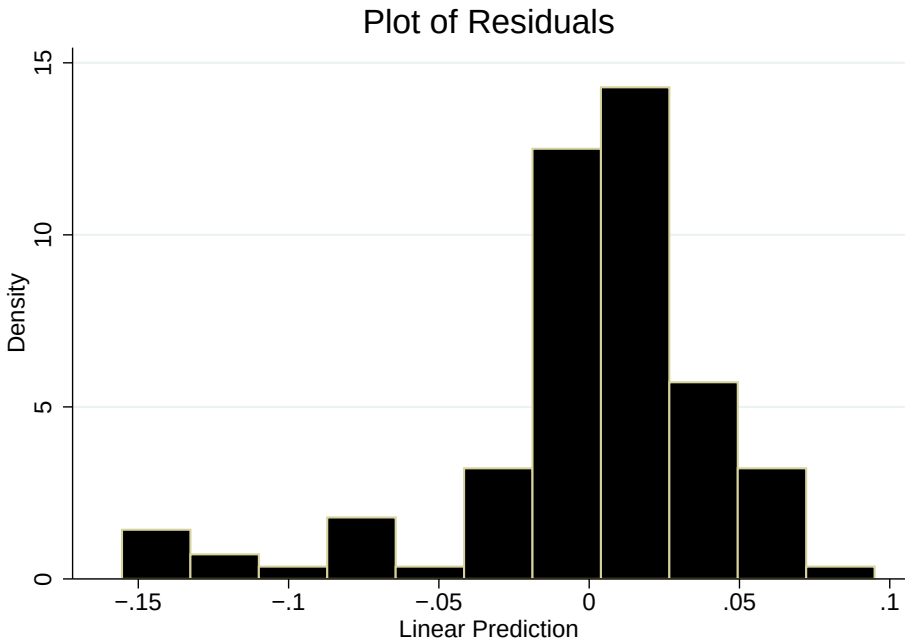

Figure 3

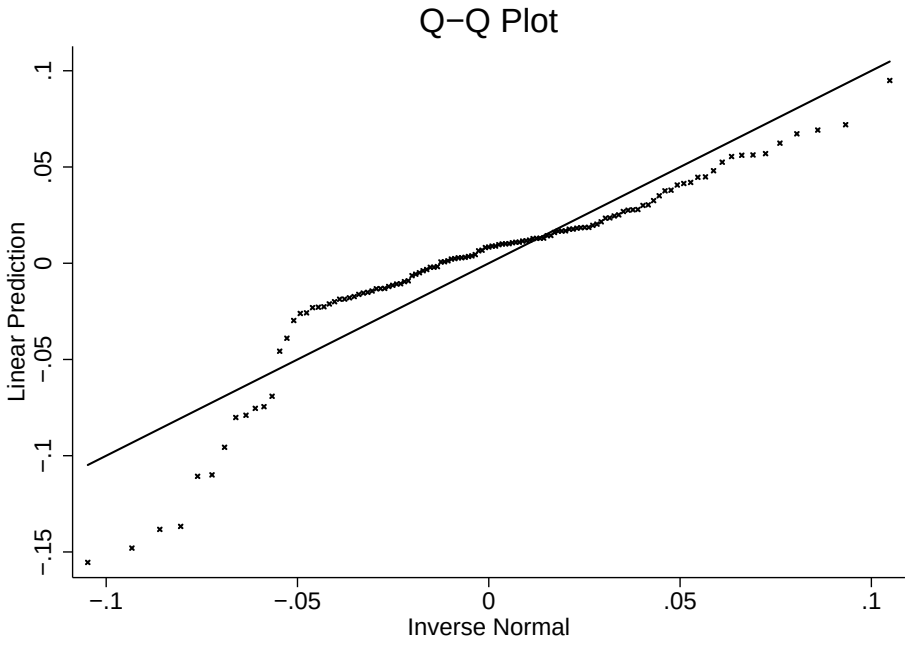

Figure 4