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Sakari Lähdemäki

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ABSTRACT

This dissertation consists of a preamble and three separate articles. All articles in the dissertation examine economic productivity. Two articles examine productivity at the macro-level and one at the micro-level. One of the macro-level analyzes examines whether the productivity levels of countries converge. In contrast, the other examines whether or not geographical factors can explain the persistent differences in countries' productivity levels. The third article examines the impact of privatization on productivity with plant-level data.

The first paper, using the Penn World Table 9.1 dataset, studies cross-country convergence of labor productivity. The study utilizes several different convergence tests, both standard and new. The tests support unconditional convergence in the country groups of OECD, EU, APEC, Europe, and Asia. Contrary to the current belief that the income gap between rich and poor countries is not closing, the paper provides evidence of convergence in a group that excludes only African countries. More so, even the group of all countries seems to converge from on the year 2000.

The second paper studies the relationship between fixed environmental factors - natural resources and geography - and labor productivity. The paper combines a novel data set covering 42 developed countries for the years 1995-2011. An econometric model is estimated to predict how productivity might change if there is a change in one of the fixed environmental variables. The results provide supportive evidence that mineral reserves boost productivity, whereas on average, forest area and gas and oil reserves, if anything, only slightly decrease productivity. Moreover, it seems that education and R&D intensity seem to counteract the disadvantages of a sparse population and remote location.

The third paper studies the effects of privatization on establishment/plants that operate in Finland's manufacturing sector. The sample consists of 84 establishments that went through privatization during 1988-2012. Also, the sample consists of the exact share of state ownership for 60 establishments. The paper uses this information to study the effects of any reduction in state ownership with the generalized event study design. Furthermore, a control group is formed with coarsened exact matching from private establishments to strengthen the analysis. The results suggest that privatization increases productivity (sales/employment).

KEYWORDS: Labor productivity, Convergence, Geography, Natural Resources, Privatization

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TIIVISTELMÄ

Tämä väitöskirja koostuu johdanto-osasta ja kolmesta erillisestä artikkelista. Väitöskirjan kaikki artikkelit tutkivat taloudellista tuottavuutta. Kaksi artikkelia tutkii tuottavuutta makrotasolla ja yksi mikrotasolla. Toinen makrotason tarkasteluista tarkastelee sitä lähentyvätkö maiden tuottavuustasot toisiaan, toinen taas tutkii sitä voivatko maantieteelliset seikat selittää tuottavuustasojen pysyviä eroja maiden välillä. Kolmas artikkeli tutkii yksityistämisen vaikutusta tuottavuuteen toimipaikka-aineistolla.

Ensimmäisessä artikkelissa tutkitaan maiden välistä työn tuottavuuden konvergoitumista Penn World Table 9.1 aineistolla. Tutkimuksessa käytetään sekä standardeja että uusia konvergoitumistestejä. Testit tukevat kovergoitumista OECD:n, EU:n, APEC:n, Euroopan ja Aasian maaryhmissä. Vastoin nykyistä käsitystä siitä, että tuloero rikkaiden ja köyhien maiden välillä ei ole poistumassa, artikkeli tarjoaa todisteita kovergoitumisesta maaryhmässä, jossa on mukana kaikki muut paitsi Afrikan maat. Edelleen jopa ryhmä joka sisältää kaikki maailman maat näyttää konvergoituvan vuodesta 2000 alkaen.

Toisessa artikkelissa tutkitaan kiinteiden ympäristötekijöiden - luonnonvarojen ja maantieteen - ja työn tuottavuuden suhdetta. Artikkelissa kootaan uusi aineisto, joka kattaa 42 kehittynyttä maata vuosina 1995-2011. Ekonometrisen mallin avulla ennustetaan, miten tuottavuus muuttuisi, jos kiinteä ympäristömuuttuja muuttuisi. Tulokset tarjoavat tukeva sille, että mineraalivarannot lisäävät tuottavuutta, kun taas metsä sekä kaasu- ja öljyvarat, jos jotakin, heikentävät tuottavuutta hieman. Lisäksi näyttää siltä, että koulutus ja T&K-intensiteetti näyttävät tasapainottavan harvaanasutun ja syrjäisen sijainnin haittoja.

Kolmas artikkeli tutkii yksityistämisen vaikutuksia Suomen tehdasteollisuudessa toimivissa laitoksissa. Otokseen kuuluu 84 toimipaikkaa, jotka yksityistettiin vuosina 1988-2012. Aineisto sisältää tiedon valtion tarkasta omistusosuudesta 60 toimipaikalle. Paperissa käytetään tätä tietoa, kun tutkitaan vaikuttaako yksityistämisen lisäksi myös se, kun valtio luopuu vain tietystä omistusosuudesta. Tutkimuksessa muodostetaan kontrolliryhmä samanlaisista yksityisistä toimipaikoista analyysin vahvistamiseksi. Tulokset viittaavat siihen, että yksityistäminen lisäsi tuottavuutta (liikevaihto/työntekijät).

ASIASANAT: Työn tuottavuus, Konvergenssi, Maantiede, Luonnonvarat, Yksityistäminen

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After the obligatory doctoral-level core studies in autumn 2014, I was assigned to Helsinki to Labour Institute of Economic Research, where I have been working since. I want to thank all the institute's colleagues and personnel I have enjoyed working with. I would especially like to address my gratitude towards Eero Lehto, from whom I learned much about practical economists' work and conducting research. I am also grateful to Tuomas Kosonen for his comments and guidance. I would also like to thank Ilkka Kiema for his support and especially for affording me the time to finish this project. Furthermore, I also want to thank Eero Mäkynen for his research assistance and Henri Keränen for all the refreshing discussions in recent years. Yet, I would also like to address my gratitude to Palkansaajasäätiö for largely funding this thesis.

Roughly seven and a half years have passed since I started my journey in autumn 2013. To be honest, I did not assume that this would take so long. In the beginning, I spent roughly one year in the Economics department in Turku, concentrating mostly on the core studies. At that time, I started under Professor Matti Viren's supervision, to whom I am thankful. Also, I enjoyed forming a friendship with fellow PhD-students, Kim, Erik, and Joonas, to name a few. Overall, I would like to state my gratitude to the Department of Economics at Turku University and its personnel.

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February 2021
Sakari Lähdemäki

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List of Original Research Articles

This dissertation is based on the following original research articles, which are referred to in the text by their Roman numerals:

I Cross-country convergence: To be or not to be, that is the question, Sakari Lähdemäki.

II Productivity in Developed Countries - The Role of Natural Resources and Geography, Eero Lehto & Sakari Lähdemäki.

III Privatization in Competitive Environment: Evidence from Finland's Manufacturing Sector, Sakari Lähdemäki.

1 Introduction

If one is after for answers to such simple questions as; why we are wealthier than before and why do we have more leisure time than, say 50 years ago, one finds answers by studying productivity. That is, how much goods and services can we produce with a given amount of effort.

Productivity relates to many economic questions. For example, productivity is an important factor when we think of such questions as; how much a nation can take dept. If we assume that our productivity keeps growing in the future, our total income is larger even if the effort we put into production does not increase. Currently, it seems that the amount of employment will decrease in the future since the demographic forecasts show that the number of work-aged people is starting to decline in western Europe and many parts of Asia, for example, Japan and China. Indeed, it seems crucial that productivity keeps growing.

Productivity is one of the most important factors, which explains the aggregate income differences between countries. There are apparent differences between countries in how the aggregate income divides among the residents. However, the big picture is, except for some special cases, that residents of high productivity countries are on average better off (at least economically) than people in countries that lack productivity.

Much of the high levels of productivity can be explained by capitalization. From the beginning of the industrial era, machines have been producing more and more of the products made before by human hands. Indeed, the use of capital in production has increased in the last centuries. However, it is more so that the technological advances that have made it possible to build these factories and production lines are the real force behind productivity growth.

Technological development is an ongoing process. For example, right now, much effort is put into the development of robots. At the same time, more robots are utilized in production.[1] Robotization is, of course, only an example of possible future sources of productivity. All possible developments in the way we organize our production might lead to increases in productivity.

[1] See, for example, Cséfalvay (2020) for more on the topic.

Productivity is a crucial factor that determines human life. Due to the science of economics, we know a lot about productivity and how it has developed. Yet, there are still many questions and aspects that relate to productivity, for which we do not know the final answers and which we cannot explain thoroughly. As productivity is as crucial as it is, any research that increases our knowledge of productivity topics is essential.

To give some background for the studies in this thesis, I next present some concepts used in economics that relate to productivity and the studies of this thesis. I start by discussing how productivity is measured in economics. I then aim to give a general background for the papers in this thesis by discussing the economic history of productivity growth shortly. Therefore, I provide an overview of popular growth theories and factors that are seen to explain the productivity differences between rich and poor countries. Additionally, I also discuss why different environmental factors might relate to the developed countries' persistent productivity differences. Finally, I discuss how micro-level productivity is related to macro-level productivity and preview some topics studied at the micro-level.

1.1 Measures of productivity

Firstly, there is not a single right way how to measure productivity. Naturally, there are typical choices for such a measure. Here I first give a general definition as a start:

$$Productivity = \frac{Output}{Effort}$$

This simple equation tells us that we can measure some process's productivity if we know the total amount produced and the effort that was put to make these products. While maybe easier to understand, effort as a word might not reflect all possible inputs that we desire to account for. Often a similar equation is used instead where inputs replace effort. This equation then better reflects all possible inputs that were involved in the production.

At the aggregate-level in economics, output in the above equation is mostly measured with value added or GDP. Productivity then reflects the capability to produce products or income with a given effort (inputs). Sometimes GDP is taken to reflect welfare even while GDP does not measure welfare. If output in the above equation is changed to a social welfare measure, one could calculate the economy's capability to produce welfare, say per worked hour. While it is compelling to calculate GDP accurately, it is even trickier to measure welfare. For example, Jones and Klenow (2016) calculate welfare measures that are comparable between countries. They find that GDP per capita and aggregate welfare seem to correlate

strongly. However, they also find that, for example, the welfare differences between the USA and western Europe are not as large as the differences in GDP per capita indicates. The United Nations Human Development Index (HDI) is another type of country-level measure that aims to better account for social welfare.

A firm- or plant-level output could also be measured as the unit's total amount of produced products. But it can also be measured as value added or sales of the unit. The choice over which measure to use to represent output and effort (or inputs) is not meaningless, and if different measures are used, comparability is often lost. For example, a productivity measure calculated with value added as output tells a somewhat different story than productivity calculated from sales.

This is since value added, used in national accounting, is calculated as sales minus intermediate products. In other words, value added is the sum of wages, profits, and depreciation. Which measure to use is often a question of data availability. In a sense, value added is a more appropriate measure than total sales since it tells how much actual value the unit produces. That is, how much it adds value to intermediate products. Sometimes, if total sales are used as a measure of output, intermediate products are accounted for as inputs.

Furthermore, it is questionable, are sales or value added based measures of different firms comparable. This is since even in a specific industry, different firms probably produce several different products, and total sales then reflect different product baskets. The actual quantities (both output and input) of a particular product would quarantine the best comparability. However, these figures are often not available. See, Valmari (2016) for more on these issues.

One standard measure of productivity used at the country-level is *labor productivity*. That is, value added or GDP of a country divided by total employment or total work hours in that country, for example, within a year. Note that this measure is very similar to GDP per capita. Overall, this measure is simple, easy to calculate, available, and quite comparable between countries. However, it does not tell about the possible differences in production structure between countries. This measure tells how much an average worker in a country produces. But in some cases, while in a sense telling the truth, this figure might give a somewhat distorted or at least one-sided picture of a particular type of country. For example, this figure is typically high for some Middle East large oil producers, while in other activities than oil production, their productivity is often low.

Another central productivity measure in economics is *total factor productivity* (TFP). To calculate TFP, one must define a production function and inputs (see next section). Usually, labor and capital are considered as inputs, but also other inputs such as intermediate products could be accounted for. Traditionally, TFP is calculated as output divided by a function of inputs. This type of TFP measure can also be derived from an estimated production function as its residual series. TFP

reflects the technological level. For example, different firms might have the same technological level but still differ in *labor productivity*. This could be since one of the firms uses capital more intensively. The measure of TFP is, in a sense, indifferent to the intensity of inputs. That is, a firm with higher TFP will produce more given the same amount of inputs.

While TFP is designed to better capture a unit's actual productivity, its calculation is much more complicated. This means that many assumptions are to be made before this measure can be calculated. Also, the data availability is more of a problem since data from other inputs than labor is also needed. Especially, capital inputs are related to many measurement issues. See Syverson (2011) for more on how to calculate TFP and related issues. Feenstra, Inklaar, and Timmer (2015) describe comprehensively how cross-country-comparable output and input series can be formed.

One more related issue is how to deal with prices. Typically, one is interested in real values and not nominal values. Feenstra, Inklaar, and Timmer (2015) provide a comprehensive overview of these issues at the country-level. Syverson (2011) points out that prices could also reflect some units' pricing power in some industries. This might be a problem at the firm-level if industry-level deflators are used together with revenue-based productivity measures because the price differences among firms are then not accounted for. However, the use of industry-level deflators is often a necessity since firm- or product-level price information is rarely available.

The thesis' articles concentrate on studying *labor productivity*. Mostly this is because of data availability. For example, at the country-level, this productivity measure guarantees the most extensive country coverage, and the components it is formed from, GDP and employment, are reliably measured. Therefore, this measure is relatively comparable between countries. Contrary to achieve somewhat similar data coverage for the TFP measure, the construing of the data components involves estimation, which might reduce reliability. Moreover, recently more attention has been drawn to how the inputs and TFP should be measured. See, for example, Brynjolfsson, Rock, and Syverson (2021) and Comin, Gonzalez, Schmitz, and Trigari (2020). Furthermore, at the plant-level, only sales and employment data are readily available. Therefore, when later referring to the results of these studies, they reflect *labor productivity*.

1.2 Aggregate-level productivity and economic growth

At the country-level, aggregate output is measured mostly with value added or GDP from national accounts data. These measures are also primarily used in studies related to the growth of country-level aggregate output. The development of labor

productivity shows whether productivity grows or not, but it does not directly reflect the factors which determine productivity growth. A traditional aggregate production function can be used to describe which factors or inputs form the aggregate production:

$$Y = AL^{1-\alpha} K^{\alpha}$$

This equation tells that production Y is an outcome of technological level or total factor productivity A, labor L, and capital K. This production function is in the form of the famous Cobb Douglas (CD) production function. It is simple and has some appealing features. This is one reason why most growth models use this production function, at least in their basic representations. Growth accounting is also often based on this function. Then capital K can be thought of in a broad sense. It represents both capital and human capital; see Mankiw, Romer, and Weil (1992). As often is done, other inputs are also added to this function.

The classical Solow-Swan (1956) growth model assumes a constant growth rate for A and L, whereas an economy adopts through K if the economy is apart from the model's steady state. This model implies that in the long-run, labor productivity grows because the level of technology grows. In this model, the growth rate of technology is exogenous.

Barro (2015) notes that modern growth models have developed mainly in a direction where the technological process has been endogenized. For example, the growth model by Romer (1990) and the Schumpeterian growth model by Aghion and Howitt (1992) are both called endogenous growth models because of this development. The endogenization of the technological process in Schumpeterian growth models can be seen to mimic the idea of creative destruction, see Schumpeter (1943). Put freely, over time, old and less productive production is overcome by new, more productive production.

As productivity correlates strongly with national wealth and prosperity, it is natural to ask how productivity growth could be delivered from one country to another. As time has shown, it is not a simple question, and there is no single answer. One argument is that in countries with open and free-market-oriented economies, the economic growth process will lead to economic convergence. The idea of economic convergence is old, and especially after 1990, it has been studied intensively. In its basic form, economically behind countries will develop faster and catch up with the developed countries. Several reasons have been proposed why this might happen, for example, technological diffusion and or capital accumulation.

The existence of economic convergence is something which many agree on when considering some clear cases, for example, Asian tigers, Japan, China, and Finland. On the other hand, many world countries have not converged as rapidly, if at all.

Therefore, we are in a situation where there is some quite clear evidence of economic convergence. Nevertheless, on the other hand, it has remained puzzling why certain countries have gone through the process with pace while others have not. This situation has inspired the development of several theories and concepts that explain the economic growth process and thereby convergence more comprehensively.

Gerschenkron's (1962) observation that countries behind in development can implement from frontier technology by implementation has lead to the development of a class of Schumpeterian growth models. The idea in these models is that such countries that participate in the innovation process share the same growth rate of technology in the long run. This is since countries on the frontier invest more in R&D than other countries. Countries behind the frontier invest less in R&D, and thus the probability of successful innovation is smaller, but the size of the innovations is larger. The intuitive explanation for this is that if a country falls behind from the world technology frontier, it eventually can catch up by implementation. It is burdensome to stay at the frontier since it is harder to develop innovations than implement them. This mechanism guarantees that countries that participate in the innovation process will converge to the long run's frontier growth rate. The textbook by Aghion and Howitt (2009) explains these models in more detail.

Howitt and Mayer-Foulkes (2005) study this type of model that allows for differences between countries' productivity levels. This is since country-specific parameters, which can be seen to describe, for example, the quality of a country's financial institutions and education system, determine the proximity to the frontier in the long run. That is, what is the distance between frontier productivity and an individual country's productivity in the long run. The model also implies that countries that do not participate in the innovation process will stagnate and stay poor. This model divides countries into three groups; countries that innovate, countries that implement, and countries that stagnate. This model fits well with the observation that some countries have grown fast while some are stuck behind. In this model, the source of differences in productivity levels between different countries is explained through the innovation process. The model also accounts for the idea that some institutional factors affect productivity. Furthermore, if these institutional backgrounds are poor, this leads to a lack of R&D investments.

One essential background factor that might affect the growth mechanism is the quality of financial institutions. The investments in research (or capital) are often financed by external money. If the financial institutions are low in quality, they might restrict the growth process because even promising investment projects might not find a funding source. Aghion, Howitt, and Mayer-Foulkes (2005) provide a Schumpeterian growth model with financial constraints and show evidence that financial development can be one of the most critical factors that explain why some countries fail to converge to the growth rate of the global technological frontier.

Furthermore, the examination based on Schumpetering growth theory by Aghion and Howitt (2006) suggests that optimal policy might depend on the development stage of a country. For example, if financial institutions' quality is low, the stabilization policy in a recession might be more effective than in a country with high-quality credit markets. This is since the low-quality financial environment might discourage R&D investments in a recession as firms' earnings decrease, altering their possibilities to fund their long-term innovation activities. Similarly, Aghion and Howitt (2006) suggest that the required educational investments might depend on the nation's development level. For example, they consider that before, as the growth process in Europe relied on the implementation of existing technologies, it was sufficient to maintain high levels of primary and secondary schooling. However, it has become essential to invest more in tertiary education because, during recent decades, Europe has moved closer to the technological frontier and now relies more on the innovation process.[2]

In multi-equilibrium models, a situation where some countries stay behind while other countries grow is modeled in another way than in the Schumpeterian models, see Azariadis and Drazen (1990). These models share similar features as the traditional Solow-Shaw (1956) model. However, the distinctive central part is that they incorporate nonconvexities. Certain threshold initial values determine the steady state a country converges into. For example, countries with high human capital and or capital form a club with a higher steady state productivity growth while, countries with less human capital would form a lower steady state club. See Durlauf and Johnson (1995).

While not necessarily in contradiction with the above models, reasons that are not typically modeled have been proposed to explain cross-country differences in productivity. For example, under the idea of multiple equilibria, Desdoigs (1999), finds support that geography (continents), religion (Catholic, Protestants), and club membership (OECD, non-OECD) seem to describe convergence clubs. That is country groups with different steady states.

Overall, a lot of interest and effort has been put to explain why certain countries lack productivity while in certain countries, productivity continues to increase. Such deep background factors as institutions and geography have been proposed to explain these differences. Indeed, reasonable explanations can be drawn from these factors. Yet, it remains controversial which factors ultimately caused the different growth paths between, for example, countries in Europe and countries in South America.

[2] Aghion and Howitt (2006) provide evidence that supports both of these cases by studying regressions with interaction terms. The interaction terms allow studying if the parameters are dependent on the economic development of an economy.

For example, Acemoglu, Johnson, and Robinson (2002) and Rodrik, Subramanian, and Francesco (2004) show strong evidence towards institutions. Whereas Gallup, Sachs, and Mellinger (1999) and Olsson and Hibbs (2005) stress that geographical factors are the ultimate source. Then again, the results by Glaeser, La Porta, and Shleifer (2004) suggest that human capital strongly predicts institutions. Political institutions, as growth factors, have also been studied. For example, Acemoglu, Naidu, Restrepo, and Robinson (2019) study the effects of democracy on growth. Glaeser, Ponzetto, and Shleifer (2007) point out that high education might be necessary for democracy.

More recently, Ashraf and Galor (2013) have proposed that genetic diversity might explain the economic differences between different regions' economic development. Accordingly, the distance to the cradle of humankind East Africa, explains the variation in global genetic diversity that explains differences in economic development. The further away from the cradle, the lower the diversity. Furthermore, genetic diversity has both adverse aspects and beneficial aspects. High diversity might increase mistrust and disorder and reduce cooperation. On the other hand, the high genetic diversity would mean more available traits, which would increase the possibilities of success in specialization in tasks, which would ultimately increase productivity.

Ashraf and Galor (2013) conclude that genetic diversity seems to have affected global economic development. Therefore, genetic diversity can explain economic development patterns that geographical, institutional, or cultural factors do not explain. Furthermore, because of low genetic diversity among Native Americans and high diversity among the African population, these regions have suffered from genetic diversity. In contrast, the intermediate level of genetic diversity in Europe and Asia has benefited economic development.

The study by Olsson and Hibbs (2005) rests on a book by Diamond (1997). He addresses that most cultivable plants and domesticable animals were present in Eurasia. This "bio-capital" provided the basis for hunter-gatherers to start shifting towards agriculture and forming stable settlements and, further on, civilizations. In other continents than in Europe and Asia, the number of nutrient-rich cultivable plants and domesticable animals was much smaller. This lead to a much slower shift from hunter-gatherers to agricultural civilizations outside Eurasia. Ashraf and Galor (2013) state that this remains a compelling argument, while they provide evidence that genetic diversity might also have had an important role in forming the roots of the variety in global economic productivity we now witness.

There is a clear distinction between the studies which examine modern growth typical for western countries and studies that try to explain the massive gap in productivity between developed and developing countries. Indeed, the Solow-Shawn (1956) growth model and modern growth models by Romer (1990) and Aghion and

Howitt (1992) explain this type of sustained long-term growth. The other branch of studies tries to explain the diversity of global economic productivity. Furthermore, it tries to answer why this modern type of sustained growth took place in the western countries and later in Asia, and shall it spread everywhere.

The growth models that model modern sustained growth related to developed countries are credible and functioning. However, they were not designed to model such growth behavior, which seems to describe the economies in the times before the industrial revolution. Before the industrial era, the growth period, featured with stagnation, slow technological growth, and slow population growth, is often called the Malthusian growth period. This is since Malthusian (1798) first provided a theory to describe population/economic growth before the industrial revolution.

According to this theory, technological advances will raise the population but not income per capita or aggregate productivity. This is since if income increases, people live longer and, as a result, will make more offspring. This raises the population, which reduces aggregate income per capita. Moreover, since the land area does not increase, and more people are now getting income from it, the number of people would stabilize at a level where income per capita has fallen back to where it was. This mechanism is also thought to work the other way around; if there is a drawback in income, then (peasant) families will have fewer children and so on. One key outcome of this model is that technological advances elevate the population level, but income per capita does not grow. Indeed, it seems that more advanced areas in those times were highly more densely populated (Galor, 2005).

The unified growth theory combines the Malthusian era growth behavior and modern sustained growth and model both within one framework. Galor (2005) describes this theory in detail. Here I give a brief description. This theory states that the transition from a Malthusian steady state equilibrium to a sustainable growth steady state equilibrium is due to an increasing demand for human capital, which is an outcome of technological development.

In more detail, in the Malthusian regime, technology develops slowly, and therefore there is a limited demand for human capital. However, as the population size grows sufficiently, this supports faster growth of technology. Due to this, at a certain point, households start to concentrate more on their children's quality and not only on the amount of them. As the level of technology increases, the amount of more specialized vacancies with higher wage increases. In this Post-Malthusian regime, income per capita level rises, and together with a modest demand for human capital, more effort is put into educating the offspring. As human capital investments continue, the economy moves to a Modern Growth regime where human capital increases the level of technology, which increases the demand for human capital, which then results in sustained economic growth.

The theory suggests that geographical and institutional factors explain the variation in the timing of the switch from the Malthusian growth regime to the Modern growth regime between countries. Thereby, the theory explains why convergence clubs emerged in the first place and why productivity growth in some countries has been strong while some countries have remained poor. Another implication of this model is that eventually, an economy will develop from stagnation to sustainable growth.

If we delve behind the curtain and look at the micro-level and the processes which form macro-level growth, we see that macro-level economic growth as a phenomenon is very complex. The models that have been constructed to reflect this phenomenon at the macro-level are simplifications of this complex reality. These models aim to capture the main features which describe economic growth at the aggregate level. Because of the same reasoning, at the macro-level, any reliable causal relations are hard to establish empirically, while compelling studies have also been done. Therefore, it remains controversial which factors are ultimately responsible for the differences in productivity growth between different countries and regions.

Overall, economics provides a vast understanding of the global cross-country difference in productivity levels and how these differences have developed. Yet, we still do not have definite answers for questions that relate to cross-country productivity differences. Furthermore, while we can make reasonable predictions of what will happen in the future, the related uncertainty is intense. In my first paper, I study recent cross-country productivity convergence developments with the Penn world tables 9.1 dataset, which covers more countries for a more extended time period than earlier releases of this dataset did. This paper provides answers and insights on whether we will see more countries of the world converge in productivity towards the Western countries in the future.

1.3 Persistent differences in productivity levels among developed countries

It is reasonable to ask to which point countries will converge. From a practical stand, it seems reasonable to think that even the differences between developed economies are somewhat persistent. Therefore, while the productivity levels are close to each other, they still stay slightly different. In theory, there is no reason why, for example, the EU15 countries would not eventually share the same productivity. However, it seems that, for example, the differences in labor productivity shrunk to a certain point, but after that, the dispersion of the labor productivity levels has been relatively stable.

The concept of conditional convergence states that since there are structural differences between economies, they will converge but conditionally to these structural factors. Four parameters capture these structural differences in the Solow-Swan (1956) growth model: rate of technological growth, population growth rate, depreciation rate, and savings rate. If these parameters are the same among different countries, these countries will eventually share the same productivity. If these differ between countries, then the countries will converge toward different steady states, and the productivity of these countries will vary. This model provides an intuitive and simplified description of why productivity levels differ between countries. A more sophisticated explanation is given by Howitt and Mayer-Foulkes (2005), in which structural parameters determine the proximity of a country to the world's technology frontier. These models concentrate on the aggregate-level.

Examining the industrial composition of economies can also explain the differences in productivity levels between developed economies. For example, the industrial composition between countries differs, and the productivity levels between different industries also vary. Furthermore, also the R&D-intensities between industries differ.[3] Since the composition of industries varies between countries, aggregate productivity levels might also differ to some extent between countries. This is because some countries concentrate more on high productivity industries than others.[4] The question is, why are the industrial compositions different between the developed countries? And will they eventually converge, or are they persistently different?

For a large part, the aggregate-level growth models explain reasonably well why the productivity levels differ between developed countries. However, since there are apparent differences in the composition of industries, for example, environmental factors could partly explain aggregate-level productivity differences, for example, by affecting the industrial composition of an economy. This is since it might be that certain geographical factors explain why specific industries form a larger share of an economy's production in other countries than in others. For example, Finland is covered by forest, and the paper and pulp industry has traditionally formed a large share of Finland's manufacturing industries.

Moreover, it is possible that to prevail in global competition, certain geographical factors, for example, the remoteness of a country, might have affected

[3] R&D-intensity is the critical driver of technological growth in the Schumpeterian growth model by Aghion and Howitt (1992).

[4] According to the results in Harrigan (1999) and Fadinger and Fleiss (2011), the TFP levels vary between developed countries' same industries. Note that, here, the point is that if some country concentrates more on a high-tech sector than an otherwise similar country, then its aggregate TFP should also be higher.

which type of companies and products have prevailed in a particular country. These background factors could have shaped the economies and resulted in individual characteristics that describe different developed countries. Furthermore, most economic development in a club of developed countries can be explained by the same growth mechanisms. Yet, some fixed features, which provide some advantages or disadvantages for an individual country, could partly shape its economic structure. Therefore, these fixed features could partly explain why these in many aspects (institutions) similar countries, remain characteristic.

Traditionally, the studies that examine the relations between economic growth or productivity and geographical factors are largely motivated by the wide dispersion of world countries' productivity. In many aspects, they aim to explain why some countries are rich and some poor. As noted above, whether geographical or institutional factors are ultimately behind these differences is yet controversial. Often it seems as if both are needed to result in beneficial outcomes. For example, Sach and Warner (2001) propose that natural resources can have an adverse effect on growth. This phenomenon is called the natural resource curse. Boschini, Pettersson, and Roine (2007) suggest that this resource curse is lifted if the underlying institutions are high in quality. Overall, this topic has been studied vastly; see Ploeg (2011).

Natural resources, anyway, are just one geographical factor that has been proposed to affect economic growth behavior. After all, natural resources can also relate to such "deeper" geographical factors as terrain. Other geographical factors that have been proposed to explain productivity differences are related to location or distance and climate. Kamarck (1976), for example, explains why climate might have adversely affected productivity growth as he describes why sustained economic growth took place mainly outside of the area between the Tropic of Capricorn and Tropic of Cancer. Such factors typical for the area between the two Tropics as severe diseases, high humidity and temperature, vermin and soil conditions, for example, are suggested to have slowed down the agricultural development of countries in this area around the world. As we now witness, many of the countries between the Tropics have developed significantly, for example, Brazil and India. However, also more recent studies, for example, Gallup, Sachs, and Mellinger (1999) and Easterly, W. and Levine, R. (2003), suggest that these factors have a role in explaining cross-country productivity differences. The latter of these emphasizes that these factors affect through institutions while the former suggests that these factors have a more direct effect, for example, through transportation costs.

Furthermore, location related geographical factors are often considered as possible variables that explain differences in cross-country productivity. These include such factors as terrain, central location, and remoteness. Many of these factors are assumed to affect the economy via transportation costs, see Gallup, Sachs,

and Mellinger (1999). On the other hand, for example, a central location might boost productivity through agglomeration and, more precisely, productivity spillovers. For example, Keller (2002) studies how geographical location might affect technological diffusion using certain OECD countries' industrial-level data.

Many geographical studies examine how these environmental factors can explain the gap between rich and poor countries. Maybe less attention has been put to study can these environmental factors explain the differences in aggregate productivity levels of the developed countries. In the second paper of this thesis, we study how natural resources and geographical factors might be related to developed countries' labor productivity levels. We try to address how these background factors might have altered different countries' economies and partly explain the productivity differences between developed countries.

1.4 Productivity at firm-level

The literature that relates to firm-level (or plant-level) productivity is vast. Here I aim to give a short preview of how micro-level and macro-level productivity relates to each other. This is since the third paper of this thesis studies how privatization might affect plant-level productivity. I also shortly comment on the micro-level studies related to the above discussion and theoretical issues related to privatization. For a comprehensive literature review on micro-level productivity studies, see Sylverson (2011).

Bartelsman and Dom (2000) present a simple sketch to help understand how the different micro-level processes are related to aggregate productivity. Firstly, innovations generate the technologies used in production. Firms choose their inputs and available technologies through adoption and diffusion when they organize their production. This process determines the productivity levels of each firm. Competition and interactions between firms determine the market shares of each firm. Finally, aggregate productivity is the share-weighted average of each firm's productivity.

That is, aggregate-level labor productivity can be represented as a weighted sum of the underlying industry, firm-level, or plant-level labor productivity. For example, the aggregate value added is the sum of value added of each firm in an economy.[5] Also, aggregate employment is the sum of employment in each firm. Therefore, aggregate labor productivity can be written as:

[5] For simplicity I here consider only firms, while other type of units in the economy also produce value added, for example, government agencies and non-profit institutions serving households.

$$Aggregate\ labor\ productivity = \frac{\sum_i Y_i}{\sum_i E_i} = \sum_i \frac{E_i}{\sum_i E_i} \frac{Y_i}{E_i}$$

In which Y_i is value added and E_i is employment in firm i. This simple equation here is to demonstrate how the micro-level firms form the aggregate macro-level labor productivity. This equation is static as it represents a chosen time period, for example, one year. At least two periods must be compared with each other to study productivity growth. Then one can decompose productivity to address better the micro-level dynamics underlying productivity growth between the two chosen periods.

Often aggregate labor productivity growth is decomposed into four groups; entry, within, between, and exiting firms. The decomposition of aggregate productivity bases on index theory; see Diewert, Balk, Fixler, Fox, and Nakamura (2010). Entry captures how new firms affect aggregate productivity, whereas exit captures how firms that exit the market affect aggregate productivity. Within component reflects how firms' productivity increases via improvements in, for example, technology and management practices. The between component captures the reallocation of resources. That is how inputs are reallocated from one firm to another.

This type of examination provides information on which type of companies are increasing and decreasing aggregate productivity. For example, Hyytinen and Maliranta (2013), using an extended version of the Vainiomäki-Diewert-Fox decomposition method and studying Finnish manufacturing and service sectors provide some general results. Often new companies that enter the market are first less productive than those already in the market. Firms that exit the market are often low productivity firms. Those firms that prevail in the market increase their productivity within a firm and by restructuring between firms. The within component is the main driver of productivity, while there are differences in its magnitude among different industries. The between component is positive for the manufacturing industries. They also find that the new firms are likely to exit the market at the beginning of their life cycle, especially among low-profitable firms.

Decomposing aggregate-level productivity to these components provides insights, for example, to such questions as to how competitive the economy is and what is the role of innovation, entrepreneurship, and creative destruction in it. However, it does not directly answer, for example, whether R&D activity improves firm-level productivity on average. Indeed, many factors are considered to affect firm-level productivity. In his comprehensive literature review, Syverson (2011) emphasizes that the study does not fully cover the gigantic literature. Anyway, it covers many central papers that study typical factors that either are seen to affect firm-level productivity or explain the differences in firm-level productivity. These

factors are technology, demand, market structure, competition, human capital, organizational form, managerial talent, incentive pay, the social connection among coworkers, and the size of sunk costs. Two more apparent subjects are how subsidies and taxation might affect firm-level productivity.

Above, it was pointed out that there are clear differences in the industrial composition of developed economies. This is true also at the firm-level. The distributions of companies are different between countries. Within a country, the firms differ in productivity between industries, but they also differ from each other within an industry, see, for example, Sylverson (2011). The question is whether there are factors and practices which might boost firm-level productivity (at least) on average. Moreover, if such an effect or relation exists in one country, can we assume that it also exists in other (developed) countries.

Traditionally, firms are modeled as profit maximizers, which implies cost minimization. This means that firms use the optimal amount of inputs in production, given the input prices. Often the CD production function given above is also used to describe firm-level production. However, when modeling firm-level production, it is more usual to use also more complicated production functions such as the CES productivity function. The same factor that modern growth theory considers as the key driver of technological process, that is, R&D, is also a heavily studied factor at the firm-level. Another factor that is more traditionally studied at the firm-level and that was mentioned earlier is agglomeration. That is, it seems that the physical concentration of R&D intensive or productive firms into certain regions or cities results in higher productivity growth due to productivity spillovers. Indeed, many of the factors that are supposed to affect productivity at the aggregate-level have roots at the micro-level.

Another subject that is studied at the micro-level and which relates to the third paper in this thesis is how ownership might affect firm performance, more specifically, whether there are differences between private ownership and state ownership. Vickers and Yarrow (1988) provide a comprehensive examination of the theoretical backgrounds behind privatization. They go theoretically through why and when state and private ownership might differ. One key factor that, according to theory, affects the outcome of privatization is competition. That is, does the company that is privatized face competition, or is it a natural monopoly.

Economic theory states that if a firm is a monopoly, it can determine the price-level it sells its products. Due to this, it produces fewer products that would be optimal for the overall economy. Since a monopoly maximizes its profits, it restrains its production, which increases the price-level to a point where its profits are maximized. This implies excess profits and less consumer utility. Contrary, a firm that confronts competition cannot affect the price-level and therefore cannot make excess profits and sets its production on an optimal level for the whole economy.

This same reasoning is the key to understand why there is a difference in the privatization of a firm that confronts competition and a firm that is a natural monopoly. Simplifying, if there is competition, there might be no difference whether the state owns the company or whether it is privately owned (assuming that both owners are profit maximizers). Furthermore, if the state-owned monopoly faces no competition, the state could still manage it to produce the socially optimal amount. However, if the state reduces its ownership in such a firm, it loses its power over the company and cannot directly regulate the company, which would lead to less production. In this situation, the state would have to regulate the monopoly, for example, through legislation to lower the monopoly prices.

In reality, of course, this is not as simple. It is questionable whether the state and its representatives manage the monopoly in a way that would end up in a socially optimal production. On the other hand, also regulation by legislation is rather difficult. Nor is it not simple to form artificial competition, which is one way to "regulate" a natural monopoly.

Furthermore, due to imperfect information, the decision over state or private ownership is subject to principal-agent related problems.[6] That is, there is some information that is available for the agent who uses this in his favor. To mitigate this problem, the principal can propose a contract that incentivizes the agent toward his objectives. In both cases, whether a monopoly or a firm in a competitive sector is privatized, these problems exist. If a monopoly is privatized, these problems relate to the following question; how to regulate the monopoly optimally. If a competition-facing firm is privatized, then the question is more about; is private monitoring of management more effective in reducing the adverse effects of problems that arise from imperfect information than state monitoring.[7]

Indeed, if firms operate in a competitive sector, the question largely boils down to whether private monitoring of management is more efficient than state monitoring. Also, such factors as bankruptcy and takeovers are likely to affect privately-owned companies more than state companies; see, for example, Vickers and Yarrow (1988) and Vickers and Yarrow (1991). According to Bloom, Sadun, and Van Reenen (2015), managerial competence is lower in state-companies than, for example, in public companies with dispersed shareholders.

Suppose that privatization does increase firm productivity. Then privatization could also increase aggregate productivity as the within component of aggregate

[6] See Salanié (2005) for more on these questions.

[7] Vickers and Yarrow (1988) point out that the manager's incentives of regulated firms are influenced by both the owners and the regulators. This, however, complicates these problems even more, and for this reason, in their analysis, they assume that the managers of regulated firms act as firm's profit maximizers.

productivity could increase. This would mean that privatization boosts TFP of a firm while inputs do not necessarily change. However, privatization might not increase productivity via the within component. It is more likely that privatization leads to a reallocation of inputs, then the increase in productivity comes from the between component. For example, privatization might result in the reallocation of excess employment. If these workers are employed in high productivity firms, then aggregate productivity most likely increases. Another possibility is that the laid-off employees start new businesses, which might more like decrease aggregate productivity, at least in the short run. It is possible that privatization results in the closing of unproductive privatized firms (plants). Therefore, aggregate productivity could increase as unproductive units exit the market and due to possible related reallocation.

In the third paper of this thesis, I study how the privatization of Finland's state-owned companies affected plant-level productivity (sales divided by employment). I concentrate on firms that operate in the competitive manufacturing sector.

2 Summary of Essays

2.1 Cross-country convergence: To be or not to be, that is the question

After the seminal paper of Baumol (1986), cross-country convergence has been studied vastly. One could imagine that this topic is exhausted. Quite the contrary, globalization continues to develop. At the same time, it is still controversial whether there exists absolute convergence (at least to some extent) globally or only conditional convergence. Furthermore, the data coverage of different countries continues to broaden, and the available data is more and more harmonized. Therefore, this subject remains topical. A recent literature review by Johnson and Papageorgiou (2020) reviews the literature so far. The papers this review covers are anyway published before the release of the new Penn World Tables 9.1 dataset. In this thesis's first paper, I study cross-country convergence of labor productivity with this new dataset.

Economic convergence is an exciting subject to study. This is since it provides answers to such questions as what to expect of the economic growth of developing countries in the future. Therefore, the study of economic convergence can be motivated by its tendency to provide answers to rather practical questions. However, as it has clear links to growth theory and the empirical findings also reflect what we should think of this theory. To give a concrete example, it provides evidence on whether absolute convergence is a realistic implication or should we instead discard it as a simplistic feature of the Solow-Swan growth model when considering real-world development. More generally, it broadens our understanding of how we should model modern sustainable growth and technological diffusion. At the same time, it enlightens us on whether we should think that other types of growth regimes exist.

Much of the literature has concentrated on so-called beta-convergence. Beta-convergence is seen to exists if we can relate lower initial productivity levels with higher growth rates. In other words, are countries that are developing growing faster than developed countries. There are, however, clear problems related to beta-convergence tests. In some sense, a better test of convergence is a sigma-convergence test. That is, whether the dispersion of cross-country productivity levels is decreasing over time. To study convergence, I utilize traditional sigma-tests and a

new sigma-test proposed by Kong, Phillips, and Sul (2019). I further study sigma-convergence with a similar type of test, which provides further information over the time-series properties of the evolution of the productivity levels' dispersion.

I study convergence in all country groups traditionally tested with the harmonized Penn World Table 9.1 dataset. The analysis suggests that countries within a specific club converge unconditionally towards a stochastic steady state and when in this state, the convergence process seems to switch to conditional convergence. The tests support unconditional convergence from the 1970s, even in such a country group where only Africa's countries are excluded. Furthermore, it seems that the dispersion of the productivity of all the world countries has started to decline after 2000. Additional to these findings, according to the tests, convergence occurs in the following country groups: OECD, EU, and APEC. Furthermore, convergence exists also in Europe and Asia. This indicates, for example, that the former Eastern Bloc countries are catching up. The convergence process is much more uncertain or even non-existing in other continents, namely Africa and South America.

2.2 Productivity in Developed Countries - The Role of Natural Resources and Geography

The persistent productivity difference between developed countries, which in many aspects share similar institutions and other structures, makes one wonder why the productivity differences do not disappear. Of course, there exist reasonable and well-established explanations. The countries converge toward their steady states, and the steady state determining structural parameters vary among developed countries. Or, the structural factors which determine the long-run proximity to the technological frontier differ among developed countries. Yet, there is also a possibility that fixed environmental factors have a role in a country's economic development. Similarly, as geographical factors might explain partly why modern sustained economic growth started in certain areas earlier than others, resulting in the productivity gap between developed and developing countries, geographical factors might partly explain the productivity differences between the developed countries.

We place hypotheses on how these geographical factors might affect the aggregate economy and aim to find evidence to support them. For example, we study the following hypotheses: density within a country creates agglomeration externalities and increases the intensity of R&D; the abundance of natural resources tends to expand GDP and lower the intensity of R&D; internal density (agglomeration) and central location diminish local overall school investments by attracting foreign talents; share of intermediate and investment goods production positively correlate with R&D-intensity.

To study such hypotheses, we form a new dataset from several different sources. This dataset contains geographical variables (centrality, density, and population) and natural resource variables (arable land, forest, gas and oil reserves, and mineral resources). Furthermore, it contains variables that describe economic structures, that is, R&D intensity, the share of consumption goods of total manufacturing, and education. We use these variables to study how these environmental variables are possibly related to developed countries' labor productivity. Our dataset consists of 42 countries and covers the time period 1995-2011.

We argue that the geographical and natural resource variables can be treated as exogenous. This is since the cross-sectional differences of these variables have been similar for at least several decades. For example, some countries are covered with forests, while the share of fertile land is larger in others. More so, the geographical and natural resource factors are largely determined by such factors as climate, terrain, and distances. Therefore, the differences in these variables between countries are quite stable over time. For this reason, we take averages of these variables before the actual estimation period and treat them as exogenous time-invariant variables.

We estimate different specifications with our dataset. Using the estimates, we predict what could happen to labor productivity if there would be a change in a geographical or natural resource variable. In other words, we try to address how large these variables' role could be in explaining the differences between the productivity level. In our predictions, we also allow for the possibility that these environmental variables work through the variables that describe the economies' structural differences. We then compare the predictions with our hypotheses.

To study these questions empirically, we must make some compromises in the estimation. Therefore we cannot avoid certain issues (for example, omitted variables) that make the reliability of the results somewhat questionable. However, we anyway consider these findings as directional and find some clear relations. The predictions suggest that a change in many of the environmental variables might lead only to a minor change in the productivity level. However, we find supportive evidence that education and R&D intensity might counteract the disadvantages of a sparse population and remote location.

2.3 Privatization in Competitive Environment: Evidence from Finland's Manufacturing Sector

Aggregate-level productivity is formed from firm-level productivity. The dispersion of productivity among different kinds of firms is notable, even within a specific industry. This is expected as firms are very different in many aspects from each other. The question is that is there some factors that might explain systematic differences between firms, and more importantly, when such a factor is identified can we alter it

by policy to potentially increase aggregate productivity. One such factor, which might affect productivity is ownership structure. More precisely, there might be a clear difference in productivity between state-owned firms and privately-owned firms. Furthermore, the privatization of a state-owned company might lead to an increase in productivity.

Privatization is a vastly studied subject; see, for example, Bachiller (2017). However, the results in this extensive literature are conflicting. While, on average, privatization seems to affect positively firm productivity (sales/employment), the variation between the results in different studies is considerable. There are some key reasons what could explain this variation. Firstly, background factors such as competitiveness and country development behind the privatized firms might explain the differences in empirical results. Secondly, the methods used to estimate the effect of privatization varies a lot between different studies. In any case, there is a clear demand for more comprehensive analyses and more reliable results considering the possible effects of privatization. I aim to provide a comprehensive analysis of Finland's state-owned companies' privatization, which operate in the manufacturing sector. That is, I concentrate on such state-companies that operate more or less in a competitive environment.

This study's main contribution is that it provides a carefully done analysis of privatization and thereby evidence how privatization might affect firm-level and establishment-level performance. Furthermore, the set-up allows using methods that ideally produce estimates of causal effects. Since the privatization of the state-owned companies, I study, where done in step rather than a single sale, I also study how clear changes in the state ownership might affect firm performance. This type of "privatization in steps" is less studied before and probably not at all with the generalized event study approach, see Schmidheiny and Siegloch (2020). I also study whether the establishment-level employment structure is affected by privatization.

I use establishment-level (plant-level) data from Statistics Finland. This data contains all plants of firms registered in Finland. I use this data also to form an artificial control group of private establishments. Additionally, I have collected data over the exact share the state owns of the consolidated company the establishment belongs to, which I can link to the establishment-level with collected data of the state-owned companies' organization structure. I also use register data for Finnish residents to form such factors as average wage, average age, and average education level of employees in an establishment.

The results suggest that the privatization process increased plant-level productivity (sales/employment). This is due to a decrease in employment, whereas there seems to be no robust decrease or increase in sales. While this result is quite robust, there are some concerns, for example, due to the relatively small sample and the methods' assumptions. While the results are directly from the establishment-

level, keeping some caution in mind, these results also reflect the firm-level. This is since these establishments are mainly large and form the core of the company's operations in Finland. Furthermore, it seems that privatization did not have a systematic effect on the number of establishments in a subsidiary firm. Finally, I do not find that privatization would have affected the employment structure of the establishments.

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