INTELLECTUAL PROPERTY RIGHTS AND ECONOMIC GROWTH

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ABSTRACT

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Abstract

Striving for greater economic growth, requires a great understanding of the underlying factors. One of the factors may be the intellectual property rights and the level of its protection. Whether it is and how does it behave are the questions answered by this thesis. The theoretical framework comes mainly from the Schumpeterian growth model. The empirical methodology uses GMM in order to obtain reliable results.

The level of intellectual property rights protection in the country does seem to have a positive effect on the country's growth rate. Furthermore it seems that the relation is non-linear: The incremental changes are different between low and high starting levels of the IPR protection.

Keywords
Economic growth, GMM, imitation, intellectual property rights, patent protection, product market competition, Schumpeterian growth model

Säilytyspaikka Jyväskylän yliopiston kauppakorkeakoulu

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1 INTRODUCTION

This thesis is from the realm of economic growth. In numerous countries and economic zones, economic growth is one of the most important goals of political decision making. A lot has been studied of the nature of economic growth, but not so much the key variable of this study: intellectual property rights. The main questions I pose are: Is stronger intellectual property rights generally good for the growth? And whether the incremental changes are different in low protection and high protection.

The role of the first question is to tell whether thinking about intellectual property rights is generally important when the goal is to achieve enhanced economic growth. Following the news related to litigations in certain economic zones reveals that at least the companies seem to be acting according to the existing intellectual property laws. Innovators do want to protect their achievements and if necessary they will go to court to get justice. This tells that the intellectual property rights are doing their task, and the changes in the relevant legislation it is not without consequences.

Of course whether or not the changes end up having an effect on growth cannot be determined solely based on following the news. Thus I will discuss the nature of growth and the development of our understanding of it in theoretical sense, to see what we already know. Along the discussion I am constantly reminding of the role of technological progress, innovative activities and ultimately intellectual property rights, when applicable. I will then go through the main findings of the previous empirical studies, and after that I will do an empirical study to answer the questions I posed myself.

The second question takes an attempt to inspect more in-depth the nature of the relationship between intellectual property rights and economic growth. It is aimed to give advice to the policy and law makers on how to improve or adjust the legislation concerning intellectual property. After all, wrong

decisions might turn the patent protection into a barrier for further innovations, like David Sener (2012) said. What is the appropriate level for intellectual property rights turns out to be a tricky question as Howitt (2006) explains: He points out that there is a fundamental dilemma about how the patent laws can both give the incentive to produce new knowledge, and also to share it. A patent secures the use of the innovators idea for producing specific kind of product for a specified period of time, but as Howitt points out "it does not give the producer the right to monopolize the idea for producing further ideas." And if the patents starts to protect too extensively also from the creation of those further ideas, they inevitably inhibit the flow of new ideas and innovations. The general approach to the subject is based mostly on Schumpeterian growth theory.

The answer to the first question by this thesis' empirical study is yes: Stronger intellectual property rights cause greater growth rates. The answer to the second question, the more detailed view on the nature of the relationship between IPR and economic growth, my study answers that yes there is a difference in the incremental changes depending on the starting level of patent protection. In the higher levels of IPR, its effect diminishes and possibly even turns to negative. The results for the second question are however weak, non-definite results that requires further studying to be confirmed. More discussion of the results is found both in the chapter 5 that covers the results and chapter 6 of conclusions.

The methodology of the empirical part is by the most relevant parts done by using Generalized Method of Moments (GMM). The setup, data and methodology will be presented in the beginning of the empirical part. In the end I will discuss my results in the light of the prevailing theory and compare it to other empirical results. I will also give my policy suggestions accompanied by words of caution.

2 KEY CONCEPTS AND DEFINITIONS

2.1 IP, IPR

Intellectual property itself consists of such things as inventions, literacy and artistic works, symbols, names, images and designs used in commerce as Atun, Harve and Wild (2007:280) lists. When we are discussing the rights to control the intellectual property we are talking about patent protection, trademarks, copyrights, designs and trade secrets (World Intellectual Property Institute, 2006). Boldrin and Levine (2002:209) point out that IPR can also be divided into two components: "the right to own and sell ideas and the right to control the use of those ideas after sale." Basically a right like a patent makes the intellectual property, such as an invention, the same as any physical property and you can buy it or sell it, rent it or hire it. In the empirical parts in many studies, and also in my case, the concentration will be on patents, which are neatly quantifiable and therefore applicable in empirical research.

2.2 TRIPS

TRIPS is an abbreviation which refers to Agreement on Trade-Related Aspects of Intellectual Property Rights. The introduction of this trade related agreement by World Trade Organization in 1994 is one of the reasons behind many of the empirical studies of optimal level of intellectual property rights and their protection. The Agreement establishes minimum standards on copyright and related rights, trademarks, geographical indications, industrial designs, patents, integrated circuits and undisclosed information. The TRIPS agreement is something the industrialized countries wanted to enforce on the developing countries, basically to raise the level of intellectual property rights protection on the same in developing countries as it is in developed countries, according to Correa (2000).

2.3 Arrow's Replacement effect

Kenneth J. Arrow (1962) discussed the difference in incentives to innovate for a monopolist and for a competitive firm. He showed that monopolist always has a weaker incentive to innovate than competitive firms, since the incumbent is already enjoying the monopoly rents, and successful innovation will be just replacing its own product.

3 INNOVATING AND IPR IN GROWTH THEORIES

3.1 Neoclassical growth model

I will start this discussion about the role of intellectual property in economic growth theories as far as from the neoclassical growth model from 1956 and go through the path that the theories have taken to the most modern views. I do this in order to shed some light on how the role of innovations and intellectual property has changed, especially increased, when more understanding has been gained on the factors behind growth.

According to Howitt (2007) the traditional view had the big problem of seeing the causation between technology and economy going to only one direction, from technology to economy. In the early neoclassical models, that Solow (1956) and Swan (1956) independently developed, technological progress was seen as a completely separate activity and was taken as given to the model. Technological progress was clearly recognized as an important factor for growth, since with 0 technological progress, in this model, there wasn't any growth. The equation can be presented for example this way for a Cobb-Douglas production function:

EQUATION 1 $$Y = AK^{\alpha}L^{1-\alpha}$$

Here the notation is standard; Y is the output, A is technology and L stands for labour. Now the technology A is exogenous, just taken as given, whatever the scientist happen to come up with, and it crucially determines the economic growth. The technological progress can be presented with a simple production function with the assumption of Harrod-neutrality (technological progress means that producers can produce more with less):

EQUATION 2 $$Y = K^{\alpha}(AL)^{1-\alpha}$$

Being innovative and improving technology is not seen in this model as something each firm would be trying to do. Improving technology to achieve $\dot{A}$ comes outside the companies' interests, as an injection to the economy, created by the university laboratories or such. In this model when steady state y (= Y/L) has been reached there is no more growth from inside the system and ultimately growth rate then depends on how well the scientists can provide this exogenous injection of improvement in the technology A.

Although the concept of patents had been in use for a long time already and the first US patent had been granted to Samuel Hopkins over a century ago in 1790, according to the US patent and trademark office, the economic growth theory did not recognize the two-direction causality and complicated nature of creation of intellectual property and the incentives behind the creation and protection of it. If this would still be the dominating theory for growth, I would set my hypothesis to be that strengthening intellectual property rights is harmful for growth, since it is constricting the flow of new knowledge to everyone's use. The incentive to innovate –aspect does not exist in this model, so there is no upside in protecting ones intellectual property.

But according to Howitt many economists were already at the time of neoclassical growth model challenging the idea of where technological progress comes from. That it cannot be regarded as being only an activity outside the realm of economy, but instead it comes in the form of new products and techniques and whole new markets. And they are not created solely by scientists in universities or something like that, but rather by private companies when they are trying to seek profits.

3.1.1 Human Capital Model

Even though the idea of Human Capital models were presented after the endogenous growth theories had hit the main stream, it is still mainly an extension to the Solow's neoclassical model and that's why I shall mention it quickly here before the story moves on to the endogenous growth theory.

The Human Capital model, the augmented Solow model, was presented by Mankiw, Romer and Weil in 1992 in their article A Contribution to The Empirics of Economic Growth. It starts with the words "This paper takes Robert Solow seriously", and that it indeed does. The main shortcoming of Solow's model as Mankiw et al points out, is the inability to explain the international differences in income. According to the empirical testing by Mankiw et al the Solow model's predicts correctly the direction that saving and population growth affects income. Even so, the fundamental issue lies in the magnitudes, that the Solow model is incapable of correctly predicting. To address this problem, Mankiw et al improved the standard model by including the accumulation of human capital in addition to the accumulation of physical capital. The reason for doing this addition is that they believe that with "any given rate of human capital accumulation, higher saving or lower population

growth leads to a higher level of income and thus a higher level of human capital; hence, accumulation of physical capital and population growth have greater impact on income when accumulation of human capital is taken into account."
Mankiw et al presents the production function in the Human Capital model this way:

EQUATION 3 $$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta}$$

Where the notation is still standard Y for output, K for capital, L for labor and A for the level of technology. The newcomer is the H which now represents the stock of human capital.

The model is also proved relevant, since the paper by Mankiw, Romer and Weil is an empirical one and their model seems to according to themselves almost completely explain why some countries are richer and others poorer. Indeed the ability to explain the international differences in growth was the big advantage this model had.

While this model does not include innovative activities by competitive firms in such way as the more modern models, it does still interest me from IPR point of view because of the acknowledgement it gives to the accumulation of human capital. Just thinking about the terminology; 'human capital' and 'intellectual property' does not sound to be too far away from each other. It was recognized both in theory and in empirical results by Mankiw et al that the human capital amplifies the effects that other factors have. Nevertheless this discussion mainly included the education and skill level of the workforce, not striving for development through research to obtain some new significant intellectual property.

3.2 Endogenous Growth Theories: The AK theory

The increasing amount of disagree with the prevailing theory eventually lead to the development of the endogenous growth theory by Romer in 1986 and Lucas in 1988. The model that Romer proposes in his paper in 1986 offers two new, crucial differences. First he discards the old, fairly fundamental assumption of decreasing returns to scale. According to Romer the old assumption was the issue behind the problematic difference between what the old theory predicted about growth rates and what we could actually empirically observe. He incorporated techniques for dealing with increasing returns to scales that had been developed in the studies of industrial organization and international trade, as Howitt(2009) points out.

The second big new thing, and the more interesting from my own point of view is the change in how technological change is seen. The model presented by Romer is an equilibrium model of endogenous technological change. So technological change is no longer exogenous and as Howitt comments on the

AK theory "technological change is as much an economic phenomenon as is capital accumulation". The focus is finally shifted to the accumulation of knowledge by "forward-looking, profit-maximizing agents." This knowledge is intellectual capital. And as Howitt comments it is much like the already mentioned physical and human capital except that it is not tied to machinery or the workers in the same way. Also according to Romer's theory the production of this new form of capital, knowledge, by using research technology, faces diminishing returns, unlike physical capital. Romer also cleverly points out the natural externality of the investment in knowledge: "The creation of new knowledge by one firm is assumed to have a positive external effect on the production possibilities of other firms." This comes from the nature of knowledge: It cannot, be *perfectly* patented or kept secret as Romer puts it. The significant difference in Romer's model for production is that knowledge and other inputs exhibits increasing returns. And as Romer further defines, knowledge may have an increasing marginal product and will grow without bound. This assumption lead to the conclusion that it will never be optimal to stop at some steady state where there is no more research to further develop knowledge.

So not only did Romer include in the theory the new angle on technological advancements, but he also mentioned something about patents. Reading into it means that if we are talking about patents, we are talking about something to be patented. That something is then the technological advancement, the accumulation of new knowledge, the product of *innovative activities*, it is…intellectual property! And finally due to the properties of the new growth theory, according to Howitt's review, long-term growth was revived as an objective of economic policy. Remember that in the introduction I was stating without any argument that the topic is relevant, and the development of endogenous growth theory revealed this relevance.

3.3 Schumpeterian growth theory

3.3.1 Introduction

When the nature of technological change was discovered to be endogenous in economic growth, it meant that it could possibly be affected by different kind of policies. But why would policy regarding intellectual property rights, patent laws, be the relevant policy? This question gets an answer with the development of Schumpeterian growth theory. Romer's work had laid out a solid base for the growth theory, and corrected some previous faulty assumptions. It changed the way we see growth. But as Peter Howitt points out, it was missing one critical social aspect of the growth process: "Technological change is a game with losers as well as winners." The biggest leap, from my intellectual-property-focused angle, to the modern view on growth came with this idea called "Creative Destruction" presented by Joseph Schumpeter that

was mathematically formalized into a growth model by Philippe Aghion and Peter Howitt.

3.3.2 Joseph Schumpeter's Creative Destruction

The characteristic of the Schumpeterian theory is the idea of creative destruction. Joseph Schumpeter describes this phenomenon as a form of competition. It is competition that does not just threaten the profit margins, it threatens the whole existence of the current form of business. According to Schumpeter the fundamental impulse that forces the economic structures to be revolutionized from within by destroying the old one and creating a new one, comes from "the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization." And this is the revolutionary idea that raised innovations to play the lead role in the theory of economic growth. The role, that seems to be both the hero and the villain of the story simultaneously: The very same inventions that creates fortunes for some people and raises the standard of living for everyone, also devalue and render obsolete the old skills, equipment and technological knowledge. One more point to note from the ideology of creative destruction is that this kind of behavior clearly implies that we are not discussing only the increase in the sheer number of innovations, but more importantly the improvement in the quality.

3.3.3 The basic model

The basic model by Aghion and Howitt has a simple economy with discrete time periods t = 1, 2, … each of which has a fixed number L of individuals, who each lives just for this period and possess precisely one unit of labor, which they supply inelastically. The individuals are risk-neutral and their utility depends solely on their consumption, thus their objective of maximizing utility comes true when they are maximizing their consumption. This consumption is the consumption of the "final good". The final good is produced by perfectly competitive firms using labor and a single intermediary product. The production can be presented with a Cobb-Douglas production by the following way:

EQUATION 4 $$Y_t = (A_t L)^{1-\alpha} x_t^{\alpha}$$

The notation by Aghion and Howitt is still fairly usual, but the interpretation of them is important. Y_t is the output of the final good in period t. A is still related to the level of technology, but this time the description is that the parameter A_t "reflects the productivity of the intermediate input" in the period t. X_t is the amount of the intermediate input used in the production of the final good. L is the amount of individuals as it was already mentioned, and in this economy all

the individuals are working to produce the final good, thus let us call it the labor force. Now according to the simple model by Aghion and Howitt, the final good is used by a monopolist in each period to produce one, and only one intermediate good. The gross domestic product of this economy is what is left of the final goods after using some for the intermediate good production.

EQUATION 5 $$GDP_t = Y_t - x_t$$

In this model growth comes through innovations that increase the productivity parameter A, which means improvement to the intermediate product. Innovations come through research conducted by an entrepreneur in each period. There is uncertainty involved in the research activities, a possibility exists that the entrepreneur either succeeds or fails in developing a new innovation, raising the value of the parameter A. These activities are costly, final good has to be invested in it, and if the research fails to produce a new innovation, these investments are lost. However, in Aghion and Howitt's simple model, spending more on research increases the likelihood of successful innovation. And the reward for successful innovation is the position of a monopolist for producing the intermediary good. This comes from the fact that the successful innovator's product is simply now better than everyone else's.

Economic growth, the increase in per capita GDP, is also the proportional growth rate of the productivity parameter A_t

EQUATION 6 $$g_t = \frac{A_t - A_{t-1}}{A_{t-1}}$$

And as the specification of the model requires, in each period the parameter A either gets improved (probability μ) to a new level, the growth for that period is $g_t = \frac{\gamma A_{t-1} - A_{t-1}}{A_{t-1}} = \gamma - 1$, or innovation fails (probability $1 - \mu$) and there is no growth $g_t = \frac{A_{t-1} - A_{t-1}}{A_{t-1}} = 0$. And all this leads to the important proposition of the Schumpeterian growth theory, that the economy's long-run average growth rate equals the frequency times the size of innovations.

According to the innovation function presented by Aghion and Howitt, the probability μ that innovation occurs in period t depends positively on the amount of R_t, the amount of final good invested in research.

EQUATION 7 $$\mu_t = \phi(R_t / A_t^*)$$

A_t^* is the new improved intermediate product's productivity if the research is successful. And the logic behind the inverse dependency between probability of successful innovation and the value of A is that it is believed in this model by

Aghion and Howitt, that it is easier (thus more likely) to success in research when we are operating in lower levels of productivity, and it becomes harder and harder when technology gets more advanced and complex. The relation R_t/A_t^* Aghion and Howitt nominate the "productivity-adjusted expenditure" which they then denote simply by n_t.

The entrepreneur will take into account the likelihood $\phi(n_t)$ and magnitude of the potential reward, profit Π_t^* , and the cost R_t of the research activity and chooses his level of investment in the research by maximizing the net profit which is the difference between the expected return and the research cost R_t :

EQUATION 8 $$\phi(n_t)\Pi_t^* - R_t = 0$$

The formal presentation of the equation of the first order condition of the maximization process Aghion and Howitt calls the Research Arbitrage:

EQUATION 9 $$\phi'(n_t)\pi L = 1$$

The notation is slightly different here, but π is just a shorter way to express the impact of alpha from the Cobb-Douglas production function and it equals $(1-\alpha)(\alpha^{\frac{1+\alpha}{1-\alpha}})$. Simply put the left-hand side is the marginal benefit of research, which consists of the incremental probability times the value of a successful innovation. The right-hand side is the marginal cost of research. Whatever we change to raise the marginal benefit or lower the marginal cost, is going to increase the equilibrium research intensity. And recalling that the research activity's success probability depends on the intensity, it also means that the same changes increase each period's innovation probability. As I already mentioned earlier the innovation probability can be interpreted as the frequency of innovations in the long-run, which in turn ultimately determines the long-run average growth rate. Thus it can be concluded that changes that raise the marginal benefit of research, raise the long-run average growth rate.

3.3.4 Intellectual Property Rights in Schumpeterian theory

I shall zoom out for a moment to paint the bigger picture: In his article (chapter of a book) *Growth and Development: A Schumpeterian Perspective* Peter Howitt presents the basics of the simple model in a very neat way by dividing the growth through creative destruction in "two long-run relationships between the rate of economic growth and the amount of capital per efficiency unit of labor."

The first one is the SS curve of the figure and it is an old one from Swan-Solow model. It tells that given the economic growth rate how much capital per efficiency unit of labor would the economy end up with in the long run. The SS curve takes the economy's savings rate as given. An increase in the saving rate

shifts the curve to the right, which means higher capital stock per efficiency unit of labor for any given growth.

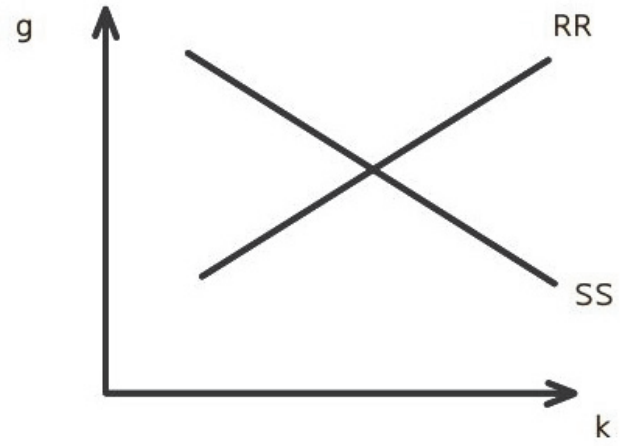

FIGURE 1
The two fundamental relations in the Schumpeterian growth model

The more interesting relationship from my point of view is the RR curve. It refers to the entrepreneur's optimization decision that I mentioned earlier, the Research Arbitrage. The research arbitrage is what reflects the entrepreneur's, or in the real world any firms, incentives to perform research and development activities. These incentives are strongly affected by the nation's or economic area's institutions; policies and laws regarding competition policy, intellectual property rights, patent protection and so on, basically anything affecting either the cost of R&D or the expected profit of its fruits.

Movements along the RR curve happens when the capital stock per efficiency unit of labor changes. It happens due to having for example more capital per worker following more income per worker, for any given level of techology. Howitt continues reasoning that with higher incomes, people will spend more on newly invented products, thus raising the incentives to perform R&D, resulting in a higher economic growth rate, a movement up the RR curve.

Shifts of the RR curve up or down happens when any institutions, policies, laws affecting the incentives to perform R&D changes. When the incentive to perform R&D can be increased through some change in one of these factors, the whole rate of R&D raises and hences results in a higher long-run economic growth rate for any given capital stock per effective unit of labor.

In this way that Howitt presents the Schumpeterian model of growth, the economic growth rate is determined by the intersection of the SS and RR curves showed in the figure 3.1. My interest is in how the intellectual property rights affect the behavior of the RR curve. The comparative statics of the simple

schumpeterian growth model suggests that the effect is fairly clear and straight-forward: "Growth increases with the degree of property-rights protection – which increases the costs of imitating the current technology in the intermediate sector." And this should lead to more intense R&D activity due to the increased expected profits to a succesful innovator. More intense research should in turn result to higher growth. Also just basic intuition tells that the intellectual property that has been achieved with costly research and development efforts, has to be protected to ensure the incentives. Howitt mentions that if the patent and copyright laws were so weak that innovations could be copied with little effort and no penalty, then the incentives to innovate wouldn't exist. He also points out that this is exactly the reasoning for the emphasis that United States has been putting on stronger protection of intellectual property in international trade negotiations.

Quickly reviewing it seems that the relationship between intellectual property rights and growth from a schumpeterian perspective is clear. However despite the first impression, there might be more to the relation than we think. Next I will present and discuss some more rigorous inspection of the relationship of interest, which shows that it is not quite so simple matter and that the general assumption might not hold equally in all situations, conditions and environments.

3.4 Too strong patent protection – does it exist?

3.4.1 Imitation

Imitation is the embodiment of lose enough patent laws. When the protection for intellectual property is not complete, there is a possibility for imitation. Immediately as a term "*imitation*" seems to get a fairly negative ring on it, and we have already learned from the Schumpeterian model that patent protection is good for the growth, thus it should follow that imitation is bad for growth. However from several point of views this argument does not seem to hold always. One argument to for the necessity of some amount of imitation is, that it is actually one part of the process of technological progress. Grossman and Helpman (1991) tells that even though innovation is what creates the new processes and products, it is imitation that spreads this new knowledge through the economy. And these two together form the technological progress.

3.4.2 The world divided in two

Grossman and Helpman (1991) studies the interesting relationship between the two phenomena innovation and imitation. The world is seen as such that it is divided in two regions: the North and the South. The North is an industrialized area where most of the innovation, the creation of intellectual

property happens. It has a great supply of the educated, trained, specialized labor force together with the appropriate equipment to conduct R&D. The South instead is a middle-income area where the factor cost conditions are advantageous compared to the North. Thus entrepreneurs are capitalizing on that advantage, by importing production methods and product designs from the North. Now this "importing" is what can be called in Grossman and Helpman's set-up imitation. It might often mean infringement on intellectual property rights. The whole set-up by Grossman and Helpman is especially interesting from international trade point of view. As already mentioned US's stand on the trade pacts is that IPR and its protection should be made stronger everywhere, as they see imitation as a threat to growth. It is still however unclear that how the trade between the innovative and imitative areas contribute to each areas growth.

In Grossman and Helpman (1991) products and production processes are described to evolve in cycles. This cycle starts by successful innovations in the North. The innovators will earn monopoly profits for a while, because their improved products are superior to other producers'. Eventually however the monopoly profits come to their end, when the entrepreneurs in the South have successfully been able to imitate the product or process. Now the southern imitators are earning the monopoly rents, thanks to having lower manufacturing costs than their northern competitors. Eventually the imitators in South will lose their position, when the next cycle begins by someone in the North upgrading, through investing resources to R&D, the product to the next, improved generation and introduces it to the market.

The model is theoretical, seeking a steady-state equilibrium. Still it seems as such a credible description of the world, that I find its findings carrying great importance for further discussion and empirical work. Their model was based on Schumpeterian growth theory, thus being recent and relevant, and connected to my previous discussions. The main finding was, that strengthening international patent protection in the South, in order to reduce the amount of imitation, does not only reduce the flow of imitation, but it can also even weaken the incentives to innovate in the North. The reduction in the flow of innovations is caused by the increased wages in the North. The wages rise because now that the South is imitating less, more of the production stays in the North, thus there is a higher demand for labor in the North and the labor force drifts out of R&D into manufacturing. And with less R&D, there is less innovations, less technical progress, and ultimately decreased rate of economic growth in the North as well as in the South. This approach then suggests that imitation is a crucial part of the technological progress in today's globalized markets, and perhaps it is for no-ones best to try to eliminate all the imitation by forcing extremely high IPR protection everywhere.

3.4.3 IPR and PMC

PMC is tightly related to intellectual property rights, since weaker patent protection means that it is easier to imitate, and more imitation can be interpreted as tighter competition.

Competition policy is perhaps even trickier to figure out than patent policy. Competition in its self should be a good thing as Howitt (2007) puts it: "Given enough competition, in the absence of externalities, markets should produce socially efficient outcomes." And this is based on the idea that inefficient firms should be driven out of the market by those who serve their customers efficiently. But from the basic Schumpeterian model suggest that competition might be harmful for long-run growth. One of the comparative statics result is that growth should decrease with the product market competition (PMC). This is a result of lower value of successful innovation when there is more competition to threaten the monopoly rents of the successful innovator. And when the value of innovation is lower, the incentives to perform R&D are also lower, thus lowering the growth rate. In terms of the previously mentioned research arbitrage curve (RR), it means shift down of the curve, which implies lower growth rate.

However as Aghion and Howitt (2009) and Howitt (2007) points out, the theory's suggestion of PMC's effect on growth is often contradicted by the empirical evidence. For example Porter (1990) conducted a ten-nation study related to the subject and one of his results was that competition is good for growth. He explained it by the angle that tighter competition forces firms to innovate in order to survive. Porter suggested that firms should rather "seek out pressure and challenge" in order to have greater pressure to innovate and escape the competition. Since the evidence contradicted the theory so clearly, it forced the theorists to rethink the model.

The incentives for innovations where brought back to the discussion by Aghion et al. (2001). They point out the first very important difference to the previous Schumpeterian models: the incentives depend on the incremental rents, not the absolute ones. That means that the relevant part is the difference between a successful and unsuccessful innovator's rents. This has not been given that much thought earlier, because due to Arrow's replacement effect, the incumbent monopolist is thought to not innovate. All the innovation has been made by outsider firms. Reality is slightly different: a lot of innovation is going on in existing firms that are already earning rents. The reason is simple: no one can afford to stop innovating or they will fall behind. Or expressed in another way: firms want to innovate in order to escape the competition. This means that actually the more there is competition, the more there is to escape from, the

more incentives to innovate. Aghion et al. emphasizes especially escaping the competition from "neck-and-neck" rivals. More PMC means that there is more of neck-and-neck rivalry and more of innovative activity in order to escape the current situation. If this supposed reason for innovating is important enough, and its effect stronger than the usual negative Schumpeterian effect, then it would mean that PMC is actually growth-enhancing. And since weaker patent protection through increased imitation also creates more neck-and-neck competition, it might have similar nature.

The findings by Aghion et al. are that at least a little competition is always good for growth. And in most cases the "positive ceteris paribus effect of competition on growth continues to hold as the degree of PMC rises to its maximal level." So even perfect competition might be better than anything less. With the words of Aghion et al. the incentives from escaping the competition "almost always" outweigh the usual negative Schumpeterian effect. However imitation is a different story. It is easy to understand when you think of the situation where there is no IPR at all, the imitation grows to maximum and the incentives to innovate are gone, because there is not even temporary monopoly rents. But more interestingly they find that some amount of imitation is "almost always growth-enhancing." So raising the level of imitation above zero, meaning the relaxation of the patent laws of their fullest potential, is generally good for the economic growth. The effect comes again from the increased amount of neck-and-neck rivalry. This result together with the previously presented North-South set-up suggests that the optimal level of patent protection might be conditional.

3.4.4 Rent-Protection-Activities

David and Sener modifies the Schumpeterian theory by adding Rent-Protection-Activities in it. In their paper Davis and Sener (2012) discuss rent protection activities (RPAs), which are costly actions taken by innovators to impose their patents and the following monopoly position. These RPAs act as a barrier for further innovation which in the model actualizes as a reduced probability of a new innovation and "thus suppress growth" as Davis and Sener (2012:1458) concludes it. Although Davis and Sener (2012:1452) points out that the rent protection activities caused by intellectual property rights are not only retarding the growth, but the RPAs also enlarge the expected market share of the innovators furthermore which, in turn, accelerates economic growth. So the overall effect stays unclear.

In this model there is a continuum of industries and in each of them researchers innovate higher quality products. By obtaining patents successful innovators hold the legal right to use their technology. Higher quality products are preferred over lower quality and with limit pricing patent holders force the lower-quality producers out of the market. This monopoly faces two threats: further innovation which makes the old one obsolete and imitation which

reduces the expected market share. Patent holders fight against both of these phenomena by hiring lawyers. Now the function of the lawyers is this whole concept of Rent-Protection-Activities. (Davis & Sener, 2012)

Intuitively this theory seems to imply some costs to the activity of ensuring the monopoly profits for successful innovators. It is important to notice also that even though in theory it could be said that the lawyers are fighting against the two different phenomena: new innovations and imitation, we cannot observe definitely which one they are in each case fighting against. We cannot conclude much based on this model, but it does shed little bit more light again on the nature and role of intellectual property rights.

4 PREVIOUS EMPIRICAL RESEARCH

4.1 The dominant starting point for empirical studies

The starting point in the empirical studies is usually what the basic Schumpeterian growth theory also suggests: the function of intellectual property rights is to give and increase incentives to innovate and also to invest in R&D. Boldrin and Levine (2002:209) expresses this idea by saying: "No economic agent exercises productive effort without the certainty of controlling its fruits." These "fruits" are private gains, but actually harmful for the general welfare. The justification is the benefit for society in the form of economic growth. Like David M. Gould and William C. Gruben (1996:323) points out in their paper, growth is nowadays explained with the successful innovating motivated by the potential excess profits. These profits or "fruits" are guaranteed by the legal system protecting the rights of intellectual property. However like I previously discussed, there are some theoretical arguments supporting that idea that imitation should not be eliminated completely with the enforcement of very strong intellectual property rights such as patent protection.

4.2 IPR have a statistically significant positive effect on growth

David Gould and William Gruben in their empirical paper in 1994 try to answer the question: "Can intellectual property protection explain any variation in economic growth once human capital and other determinants of growth are held constant?" They mention that ideally this kind of study would use some sort of comprehensive index which would include measures of copyright protection, trade secret laws and patents. However because the practiced law might differ from the written law and because the importance of patent protection may vary between industries, Gould and Gruben finds it difficult and impractical to try obtain a comprehensive index. Instead they choose to use

a patent protection index as their proxy for the intellectual property rights, defending the decision by saying that it is potentially the most important form of intellectual property protection for economic growth. The index used in Gould and Gruben's research was developed by Rapp and Rozek (1990). It produces a number from one to six to describe a country's level of patent protection, score one meaning the nation has no patent law at all. Unfortunately this index is just about the written law and does not consider the enforcement or implementation of the laws.

Gould and Gruben starts by doing a simple regression without controlling other factors of growth. The result suggests a positive but weak relationship between patent protection and growth. However for some reason they found that countries with second lowest score grew faster on average than countries in the middle levels of patent protection. But as all the factors were not present yet, they could not draw any conclusions from these results.

In the next phase Gould and Gruben added the intellectual property rights to their benchmark model which had included physical capital savings, a proxy for human capitals savings (the log of secondary-school enrollment rates), proxy for stock of human capital (literacy rates). They kept on adding even more control variables: government spending, the degree of political instability and dummy variables for sub-Saharan Africa and Latin America. Because of the existence of possible measurement errors when using the patent protection as a proxy Gould and Gruben decided to use instrumental variable estimation. It has also the advantage of taking care of potential endogeneity problems. As a result of the IV technique intellectual property rights have a statistically significant positive effect on economic growth. Furthermore Gould and Gruben studies the effect the trade regime has to the importance of intellectual property rights. The result was that intellectual property rights are more significant in open than in closed regimes.

Kim, Lee, Park and Choo did a similar study about the intellectual property protections effect on economic growth. Their goal was to see if the development level of the country was significant and also to study the different types of intellectual property rights. Results from Kim et al. (2010) are consistent with Gould and Grubens results in the sense that stronger intellectual property rights again lead to higher levels of innovation and growth. Kim et al. goes even further and manages to empirically show that also the type of protection and the market environment matters. For example the technological capacity of a firm, available resources and the development level of the market are significant variables. Main differences to the Gould and Gruben study is that Kim et al. also studies the effect of utility models, which is slightly weaker form of intellectual property rights than patents. Also the patent protection dataset is from Park (2008) and has over 120 countries from 1960 to 2005. They also handle the measurement errors and endogeneity problems with different method. Unlike Gould and Gruben who used IV method, Kim et al. used generalized method of moments.

Kim et al. recognize that tailoring the design and strength of the intellectual property rights according to the relevant factors would be the way to create the appropriate incentives for innovation. This result implies that there is some growth-enhancing and growth-retarding effects in the current patent protection systems. This result seems to be in line with the theoretical work by Aghion et al.

Studies have also shown that on the strengthening of patent rights increases investments in innovation on firm level (Allred & Park, 2007). The effect however seems to vary greatly between industries, being stronger in some and weaker in others. Allred and Park are using data of over 700 firms in ten industries and 29 countries contributing to the reliability of the study. However the patent protection index (Park, 2000) allows the use of more than 120 countries and thus even broader and further studies are possible. Believing the basic assumption of Schumpeterian theory that more investments in innovation enhances growth, means that ultimately the firm level decisions should lead to increased growth figures.

However the effect of patent protection and imitation on growth, has not been studied neither theoretically nor empirically too much yet, which means that nothing sure can be said without more research on the topic. Especially I am interested in seeing whether having little bit of imitation is truly better for growth than full protection. This might not however be possible yet due to lack of data. Still it is possible to get encouraging results that do not strictly deny the possibility of such characteristic for intellectual property rights. Next I shall start my own empirical testing of the effect intellectual property rights have on growth

5 EMPIRICAL STUDY OF INTELLECTUAL PROPERTY RIGHTS EFFECT ON ECONOMIC GROWTH

In this section I will attempt to empirically test the hypothesis that stronger intellectual property rights enhances growth. I will also try to categorize countries by their level of protection and then examine whether the effect of strengthening patent protection is different when we are moving from a very low level of protection to slightly higher level, compared to when we are moving from already high level of protection to even higher level. The purpose of the latter study is to try to test Aghion et al. (2001) theory that generally higher IPR is growth-enhancing, but extremely high might be growth-retarding.

5.1 Methodology

The relationship between IPR and economic growth might not be, econometrically speaking, to just one direction. Higher growth might in a way lead to higher IPR also, and not just higher IPR leading to higher growth. This kind of dynamic relationship, a possibility of reverse causality, has to be addressed by proper econometrical methods. Otherwise the results will be likely biased by endogeneity problems. These are the problems of the correlation between the independent variable(s) and the error term. There are a wide set of methods that can be used to take care of the problems, and what is the best way to do it depends on different factors such as the type of the model and the data etc. Also, as so very often in life, the absolutely best way to do it, might not be possible for some reason, and so we seek for the best feasible way to do it.

One very commonly seen method in econometric studies is instrumental variable method. Properly used it can handle both measurement errors and endogeneity problems. That is the reason why Gould and Grouben (1996) used instrumental variables while studying the effect of IPR on economic growth.

Instrumental variable technique however requires one (or possibly several) key thing: a good instrument. A good instrument is one that is valid, meaning it should not correlate with the primary regression's error term. It should also be relevant, meaning it has to be correlated with the independent variable it is instrumenting for.

By using enough creative thinking and time one will probably eventually come up with a valid and relevant instrumental variable. However even when you come up with one, it might not be as easy to then get proper, quality data for it, especially for free. Thus I have decided to go with an alternative method that has gain in the past few years increasing amount of attention: generalized method of moments (GMM). The differences and system GMM estimators work well even if the number of time periods in the data is small (Roodman, 2006). And as I am trying to smooth out the business cycles from my growth data by taking the growth in five-year periods my 1960-2010 GDP data eventually offers me only a T of 10. According to Roodman (2006) also dynamic processes, and some endogenous regressors are allowed when using the difference and system GMM estimators.

However I will first execute a naïve OLS regression to give some general direction. I will then take a step further, or even too far, and use fixed effects (FE) panel estimation method. After these two exercises I will perform system GMM estimation.

5.2 Data

My data is a strongly balanced panel data where the dependent variable is economic growth and the main independent variable of interest is intellectual property rights. The unit of the panel is country and time periods are from 1960 to 2010 in five year intervals, totaling to a T of 11. Enough data for each variable was found for 111 countries. The panel is perfectly balanced, there is not complete amount of observations for each country on each variable.

5.2.1 Independent variable: IPR

The independent variable of my main interest is the level of intellectual property rights. The data used for the intellectual property rights variable is in the form of patent protection index. Ideally the IPR variable should cover copyright protection, trade secret laws as well as patents, but the easiest one to quantify and also the most significant one for economic growth, according to Gould and Gruben (1996:332), is the patent protection. For empirical testing purposes I shall for now believe that patent protection level is a sufficient indicator of the level of IPR. However the possibility of it not being a perfect proxy and causing measurement errors, needs to be noted later when drawing inferences of the results.

In the index, constructed by Park most recently in 2005, each country gets a score based on five categories:

1. Coverage: split into eight different categories such as patentability of pharmaceuticals and patentability of software. Each category gives 1/8 points if they are available and 0 if not.
2. Membership in international treaties: 5 different treaties, each worth 1/5 points
3. Duration of protection: 1 point if the country provides full duration, fraction of 20 years from the date of application or 17 years from the date of grant if not full protection.
4. Enforcement mechanisms: 3 different types of legal mechanisms, each grant 1/3 points
5. Restrictions on patent rights: 3 different types of restrictions, each grant 1/3 points if they do NOT exist.

Each of the five sections gives maximum of 1 point and the country's overall score in the patent rights index is the sum of the points of these five sections.

The most recent publically found index is from 2005. However along this index was not provided a full index from 1960-90. I tried to combine the earlier work to the more recent one, but found these two to be, despite the fairly similar descriptions, slightly different and thus inconsistent. However the full index from 1960 to 2010 was provided to me by Walter G. Park on his personal webpage and this solved the data issues.

Before going any further and taking the patent protection as a variable, I shall take a look how has the index changed in time. The mean of the patent rights score has been increasing drastically over the years.

The standard deviation has not changed significantly. Park (2008:762) points out that the distribution has changed from being positively skewed in until the late 1990s to being negatively skewed thereafter. The development of the mean and skewness suggests adoption of stronger patent laws across the countries. As Park (2008:762) says, one reason for this is probably the enforcement of TRIPS. Another reason is that governments around the world probably recognize the need of having at least some level of patent protection, if the economy wants to grow through innovations.

The fact that the patent protection comes in five year intervals should not be an issue, since the dependent variable economic growth is actually also wanted in five year periods. This however does reduce the number of time (T) observations in the data compared to having yearly changes, and the low T has to be taken into account when choosing the appropriate way to execute GMM.

5.2.2 Dependent variable: Growth

I have taken the economic growth data in the usual form of GDP per capita growth. The data is from The World Bank. Reasons for choosing this data is that it covers all the countries that I have the patent data for, and it is also free. Business cycles are smoothed by a commonly seen method (for example Kim et al. 2012): taking the growth for five-year periods at time. As already mentioned it ends up also matching the patent protection data intervals nicely giving a nice constant data sets.

5.2.3 Control variables

Based on previous similar studies (Kim et al. 2012, Gould & Gruben 1996) at least the size of the economy and the education level of the country. The size shall be measured as GDP per capita and the believed effect of it is that countries with smaller GDP per capita are lagging behind and will growth more quickly as they are catching up. The period t growth is always explained with the previous period's t-1 economy size. Meaning that growth from 1990 to 1995(t) is explained with 1990(t-1) economy size. The GDP per capita data is from World Bank.

Education level shall be measured by average years of schooling attained and is taken from Barro & Lee's (2010) most recent education attainment dataset. A handful of countries are missing compared to the patent data, still leaving over 110 ones that match through my panel data.

5.3 Results

5.3.1 OLS regression

I will start with a naïve OLS regression where per capita GDP growth in 5 year growth spells is explained by patent protection index, previous period' s GDP per capita level and level of education. The time dimension in the basic OLS is included with dummy variables for each year.

EQUATION 10

$$\begin{aligned} GROWTH_{it} = {} & \alpha + \beta GROWTH_{it-1} \\ & + \gamma_1 IPR_{it} + \gamma_2 IPR_{it-1} + \gamma_3 IPR_{it-2} \\ & + \delta_1 GDP_{it-1} + \delta_2 GDP_{it-2} \\ & + \theta_1 logEDU_{it} + \theta_2 logEDU_{it-1} + \theta_3 logEDU_{it-2} \\ & + year1960_{it} + \cdots + year2010_{it} \\ & + \eta_i + u_{it} \end{aligned}$$

It is basically an AR(1) model since it includes the first lag of the dependent variable which is growth. The η_i term is an unobserved individual-specific effect that does not vary in time and u_{it} is a disturbance term. Together ($\eta_i + u_{it}$) form the error term.

TABLE 1
OLS estimates on 5 year average per capita GDP growth from 1960 to 2010

	OLS Coefficient
$\boldsymbol{Growth_{t-1}}$	-0.1062745**
	(0.035296)
$\boldsymbol{IPR_t}$	0.8048276***
	(0.1509656)
$\boldsymbol{IPR_{t-1}}$	-0.5824337**
	(0.1902689)
$\boldsymbol{IPR_{t-2}}$	0.0349342
	(0.1307013
$\boldsymbol{GDP_{t-1}}$	-0.0000134***
	(3.64e-06)
$\boldsymbol{GDP_{t-2}}$	7.71e-06
	(4.75e-06)
$\boldsymbol{LogEdu_t}$	0.419808**
	(0.1494348)
$\boldsymbol{LogEdu_{t-1}}$	-0.4141986
	(0.2373996)
$\boldsymbol{LogEdu_{t-2}}$	0.1366787
	(0.1423343)
Time dummies	Yes
R^2	0.4350
Number of observations	885
Number of Countries	111

Standard errors are in parentheses.
* 10% level of significance
** 5% level of significance
*** 1% level of significance

The OLS estimation results suggests a positive effect of patent protection on growth. The coefficient is positive and statistically significant at 99% level. The first lag IPR estimate is also statistically significant (at 95% level) and causes some head scratching with its negative sign. However otherwise the results are as expected, even the magnitude of the IPR estimate matches fairly well what Kim et al. found when remembering that my values have been scaled to 0-1 from the original 0-5 scale, thus expecting the estimate to be roughly five times the size of the original one. The OLS results support the Schumpeterian hypothesis that stronger patent protection enhances growth.

When it comes to the control variables the results are also in line with expectation, at least the sign of the estimates. The previous periods GDP per

capita has a statistically significant negative coefficient, hinting towards convergence theory. And education has a positive coefficient as expected.

One problem of the OLS regression in this case is that the first lag of growth is correlated with the error term, thus making the estimator inconsistent. According to Bond (2002 s.144) the OLS estimator is biased upwards. This is still useful figure, since it provides an upper border while looking for a consistent estimator.

5.3.2 Fixed-effects estimation

Fixed-effects estimator takes care of the problem of the individual effects in thus a logical next step.

TABLE 2
Fixed-effects estimates on 5 year average per capita GDP growth from 1960 to 2010

	FE Coefficient
$Growth_{t-1}$	-0.2342185***
	(0.0363598)
IPR_t	0.4771841***
	(0.1635546)
IPR_{t-1}	-0.5190629***
	(0.1900082)
IPR_{t-2}	0.2994257**
	(0.1470787)
GDP_{t-1}	-0.0000168***
	(3.69e-06)
GDP_{t-2}	-4.22e-06
	(4.85e-06)
$LogEdu_t$	0.0321985
	(0.1611526)
$LogEdu_{t-1}$	-0.1987847
	(0.2363818)
$LogEdu_{t-2}$	-0.2078003
	(0.1648541)
Time dummies	Yes
Number of observations	885
Number of Countries	111

Standard errors are in parentheses.
* 10% level of significance
** 5% level of significance
*** 1% level of significance

The first lag term has now even lower value and it is still statistically significant. The coefficient of my main interest, IPR, has gone down greatly, but continues to be statistically significant. The individual effects have been cleared out now, but fixed-effects does not handle the dynamic panel problem (Roodman, 2006, 103) and the estimator is still not consistent. However when the OLS estimator was biased upwards, the FE estimator is biased downwards (Bond, 2002, 144), which means that a reliable estimator ought to be somewhere between the two values: the OLS and the FE estimator. These two inspections are to help with evaluating the consistency and reliability of the next-to-come GMM estimators.

5.3.3 Two-step Generalized Method of Moments

I started by running the estimation with the default settings for lagged values. Indeed the first lagged value of the dependent variable growth goes neatly between the limits set by OLS and FE regressions.

TABLE 3
GMM estimation on 5 year average per capita GDP growth from 1960 to 2010

	(1)	(2)
$Growth_{t-1}$	-0.1140856***	-0.1115105***
	(0.067306)	(0.007931)
IPR_t	0.6970563***	0.3337531***
	(0.0415927)	(0.0368073)
IPR_{t-1}	0.479858***	0.5027986***
	(0.0587022)	(0.066095)
GDP_{t-1}	-0.0000217***	-0.0000191***
	(8.69e-07)	(7.59e-07)
$LogEdu_t$	0.1144527	0.0884211
	(0.1234982)	(0.1067696)
$LogEdu_{t-1}$	-0.5796159***	-0.3819189***
	(0.106173)	(0.0855237)
Hansen	0.027	0.057
AR(2)	0.00	0.062
Number of observations	780	580
Number of Countries	111	111

Standard errors are in parentheses.
* 10% level of significance
** 5% level of significance
*** 1% level of significance

Patent protection has a positive sign and is statistically significant even at 1% level. Now even the first lagged value of IPR has a positive statistically

significant value, which is much more in line with expectations. It could be that it takes some time after the strengthened intellectual property rights affect growth. Even though the t-1 value of growth estimator fits between its OLS and FE equivalents, the first estimation, done with default settings, suffers from some issues. The Arellano-Bond test points to serious second order autocorrelation. In addition to that the null hypothesis of Hansen test for over-identifying restrictions is rejected at 5% significance level, suggesting that the instruments might not be valid.

I attacked these issues by modifying the lags that are being used as instruments. Unfortunately when my time periods are restricted to 11, I cannot adjust the lag amounts that much, and doing so reduces the significance. Still by some restrictions on the lags, tolerable instruments were found with Arellano-Bond and Hansen test values that are not rejected at 5% level.

The results of the lag-adjusted model is in the column (2) of Table 3. The lagged value for growth is still inside the hoped limits, giving more support to the specification of the model.

The coefficient of the patent protection -variable stays positive - when inspecting the whole sample – and is statistically significant. The final finding and main result, answer to the first question of my thesis is that stronger intellectual property rights cause greater growth rates. Thus the results of this empirical study supports the previous empirical results, and also the Schumpeterian theory's view on intellectual rights effect on economic growth.

5.4 Quantile study for the hypothesis of too strong IPR

I will attempt to empirically test if there is a difference how the strengthening of intellectual property rights affects in different starting levels of patent protection. The theory by Aghion et al.(2001) hints to a possibility that increased patent protection in the very high levels, might not be growth enhancing anymore.

TABLE 4
GMM estimation with different quantile dummies

	Deciles	Quintiles	Quartiles	Tertiles
	(1)	(2)	(3)	(4)
$Growth_{t-1}$	-0.1133508***	-0.1151425***	-0.1111904***	-0.1075603***
	(0.007954)	(0.0057054)	(0.0087538)	(0.0074039)
IPR_t	0.4180275***	0.3089402***	0.3595212***	0.929027***
	(0.0383305)	(0.0803878)	(0.0558366)	(0.0617711)
IPR_{t-1}	0.4800431***	0.5487283***	0.5018897***	0.5453188***
	(0.0624942)	(0.0627164)	(0.0656793)	(0.0566811)
GDP_{t-1}	-0.0000208***	-0.0000172***	-0.0000191***	-0.0000212***
	(8.09e-07)	(8.12e-07)	(8.81e-07)	(8.81e-07)
$LogEdu_t$	0.1353963	-0.0091263	0.0717876	-0.0287802
	(0.1136829)	(0.1345017)	(0.1070966)	(0.0988733)
$First\ Quantile$	0.3525006***	-0.0405922	0.0239397	0.245359***
	(0.1375728)	(0.1044044)	(0.0411413)	(0.0310692)
$Last\ Quantile$	0.0567831***	-0.0780697***	-0.0142915	-0.180419***
	(0.0152724)	(0.0287578)	(0.0177412)	(0.0255073)
FirstQ = LastQ	0.0314	0.7658	0.4288	0.0000
Hansen	0.054	0.057	0.05	0.059
AR(2)	0.052	0.062	0.057	0.075
Number of observation	588	588	588	588
Number of Countries	111	111	111	111

Standard errors are in parentheses.
* 10% level of significance
** 5% level of significance
*** 1% level of significance

My threshold study design is fairly simple and straightforward: creating dummy variables for selected quantiles of the level of patent protection and comparing the coefficients. I focus on the extreme ends, since the strongest effect is expected to be observed when moving from 0% protection, and the weakest, possibly negative effect when moving to 100% protection. One shortcoming for today's world's data however is that no country is hitting the perfect 5/5 score, which would be interpreted as 100% patent protection. Over 80% protection however is already quite commonly observed and of course there is no lack of very low protection levels from the past decades.
The estimation is done with dividing the starting protection level by deciles, quintiles, quartiles and tertiles. The dummy variables are added to the previous well behaving GMM model.

The first look suggests that the data somewhat supports the hypothesis of some patent protection being always growth enhancing, but high levels being less useful for growth. From Table 4 it can be noted that the first quantile

dummy was almost every time clearly greater than the last quantile dummy. The only odd bird being the case of quintiles when the first quintile actually got a negative sign. However that one suffers from a large standard error making the estimator nowhere near statistically significant. The null hypothesis that the first and last quantile estimators are not different was not rejected at 95% level twice: at modes (2) and (3). The models (1) and (4) where there was a statistically significant difference between the first and last quantile estimators the difference between them seemed surprisingly clear. The most convincing result supporting the hypothesis of too strong patent protection not being growth-enhancing is from model (4) which was done with the tertiles. One argument also to support the hypothesis is that three times out of four the last quantile's coefficient has a negative sign and four out of four times it is smaller than the first quantile's coefficient.

The final results of this part are too weak to definitively claim that at very high levels of IPR its effect would diminish and even become negative in terms of growth. There is however at least some weak support for the hypothesis, and on contrary, there is no evidence that for example the opposite would be true, that stronger IPR is always better for growth rate. Despite the inconclusiveness of the results, they are definitely enough to spark more discussion and further studies on the subject.

6 CONCLUSIONS

6.1 Support for the hypotheses

I started my study by wondering, what is the general effect that intellectual property rights have on economic growth and continued by additionally considering whether it is possibly for a country to end up having harmfully high level of intellectual property rights, such as patent protection. Studying the different theories of economic growth, both classic and modern, revealed that intellectual property rights are generally believed to enhance growth. This is mainly due to their crucial role in creating incentives to exercise innovative activities in Schumpeterian growth model. However further inspection and elaboration on the Schumpeterian model, for example by Aghion et al. revealed that it is possible that moving towards full patent protection, the kind that would eliminate all imitation, could be growth retarding even.

The previous empirical studies have found that in general the Schumpeterian assumption holds: the stronger the intellectual property rights, the greater the growth. However the methodology varies a bit, and also I had in my use more recent patent protection data than the other studies so seeing whether my study would be able to replicate the results was interesting enough. In the beginning of my own empirical study I also found results along the same lines: when the model was well enough specified to be valid and reliable, it produced results that supported the traditional Schumpeterian assumption. Coefficients of estimators were mostly of the sign that was expected: patent protection and its first lagged value both were positive and statistically significant. Not only does it support the hypothesis, but it also reveals some additional information: some of the effect from strengthening intellectual property rights affect economic growth with a delay. So not only were my results in line with previous empirical results, but also with what theory suggested.

To answer the second question that I presented in the beginning: "Can intellectual property rights be too strong?" I conducted otherwise similar

empirical study than the previous one, but added dummy variables to reflect the starting level of patent protection. This way I could study whether it matters if we are moving from non-existing protection to weak protection, or from semi-strong protection to very strong protection. The hypothesis presented by the theory was that when moving from strong protection to even stronger protection (in order to eliminate more imitation) the effect is weaker, or even negative. The results were surprisingly clear to support the hypothesis: it indeed seems, according to my empirical study, that the positive effect of intellectual property rights gets much smaller or even negative when moving to the top quantiles of the patent rights index. However there is not that much data yet on the high, especially very high values of patent protection, and that makes the results less reliable. It also makes finding an actual threshold value, where the strengthening of IPR would have reached the point where all the gains have been achieved and further strengthening would be harmful, hard. But maybe the general idea and trend is anyway more important and interesting. My results are strong enough at least not give any reason to reject the hypothesis. I cannot confirm the hypothesis, but the results are enough to support the possibility at least.

6.2 Policy suggestions

The results give grounds to give some policy suggestions. In the most recent index of patent protection from the 114 countries there is still 39 countries below 60% level of protection. And from the world's over 190 countries the ones that are not included I would assume to have less than average score on the index, meaning that even more countries of the world probably lie still under the arbitrary level of 60% protection. At least in those countries it is expected that strengthening the intellectual property rights will enhance growth. Although the results suggest that strengthening them today, might affect growth only after several years. In the other extreme there is 30 countries with score of 80% or higher level of protection. In those countries the strengthening of intellectual property rights should be done with caution, since it does not seem to have great positive effects anymore, and might in some cases lead to retarding growth. The clear leader in the index is United States with the score of 97.5%. Especially in US any new increases in patent protection should come along with some strong argument of their necessity. The US patent protection score has stayed the same since 1990 so there is no constant improvements going on anymore regarding it.

6.3 Words of caution

Some words of caution for the policy suggestions are in place however. The suggestion to improve intellectual property rights meant in this context to do

some changes in patent protection laws that lead to increased index value. However how those changes in laws in reality affect individual countries economic outcome depends on how they are in the end applied. That again differs depending on the legal system of the country. There are two main legal systems: common law and civil law. Civil law further can be divided in subsystems of the tradition: French, German, socialist, Scandinavian (LaPorta et al. 2008). The legal origin has been shown by LaPorta et al. to affect how and what judicial institutions are being used, which in turn LaPorta et al. show that affect, among other things, property rights. This might also mean that for example in US, where the English origin common law is in use and the previous cases strongly affect the future interpretation of a law, the precedents hugely affect the real level of intellectual property rights, even though the patent protection index that is decided with the written law has been unchanged for two decades. The precedents can change the real level of patent protection and US might take steps towards IPR level values where it turns to growth-retarding, or on the other hand, take steps away from fullest protection allowing intellectual property rights to work more for the good of economic growth. These things would go however unobserved in the kind of study I have just performed.

6.4 Further research

The historical trend of the level of intellectual property rights suggests that they will keep on getting stronger where ever they are not strong yet. This means that in future there is going to be more and more data available for cases when we move along stronger protection. This could open up more possibilities to study, where the optimal level for intellectual property rights lies.

My study did not consider the joint-effects of PMC and IPR and that further research on that topic might shed new light on the nature of them both. Another thing to be studied empirically is how the changes in one country's intellectual property rights, affect its trade partners growth. This would be inspecting the North-South set up discussed theoretically by Grossman & Helpman (1991).

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APPENDIX 1

TABLE 5
Data sources

GDP per capita "Gdp per capita is gross domestic product divided by midyear population. Data are in current U.S dollars."	**The World Bank** http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/
Growth Economic growth is calculated with natural logarithms from the GDP per capita data.	**The World Bank** http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/
Education The education data is from Barro-Lee Educational Attainment Dataset.	**Barro-Lee Educational Attainment Dataset** http://www.barrolee.com
Intellectual Property Rights Intellectual property rights are in the form of a patent protection index, created by Walter G. Park.	**International Patent Protection: 1960-2010** http://nw08.american.edu/~wgp/patent%20index.xls

APPENDIX 2

List of countries and 2010 patent protection values

Country	Code	2010(%)
Algeria	DZA	55.5
Argentina	ARG	71.16667
Australia	AUS	86.66667
Austria	AUT	86.66667
Banglad.	BGD	31.5
Belgium	BEL	93.33333
Benin	BEN	55.33333
Bolivia	BOL	57
Botswana	BWA	67
Brazil	BRA	68.5
Bulgaria	BGR	77.5
Burundi	BDI	39.66667
Cameroon	CMR	57.83333
Canada	CAN	90.83333
Cent. Afr.	CAF	55.33333
Chile	CHL	93.5
China	CHN	84.16667
Colombia	COL	68.5
Congo	COG	57.83333
Cost. Rica	CRI	61.83333
Cote d'Ivoire	CIV	57.83333
Cyprus	CYP	62.8
Czech Republic	CZE	86.66667
Denmark	DNK	93.33333
Dom. Rep.	DOM	57.66667
Ecuador	ECU	75.16667
Egypt	EGY	57.83333
El Salv.	SLV	75.16667
Fiji	FJI	47.9
Finland	FIN	93.33333
France	FRA	93.33333
Gabon	GAB	57.83333
Germany	DEU	93.33333
Ghana	GHA	67
Greece	GRC	89.33333
Guatemala	GTM	71
Guyana	GUY	33.16667
H. Kong	HTI	76.16667
Haiti	HND	58
Honduras	HKG	60.33333
Hungary	HUN	86.66667
Iceland	ISL	77.5
India	IND	75.16667
Indonesia	IDN	55.33333
Iran	IRN	47.33333
Ireland	IRL	93.33333
Israel	ISR	79.16667
Italy	ITA	93.33333
Jamaica	JAM	67.16667
Japan	JPN	93.33333
Jordan	JOR	66
Kenya	KEN	64.33333
Korea	KOR	86.66667
Liberia	LBR	51.33333
Lithuania	LTU	77.5
Luxemgb.	LUX	82.83333
Malawi	MWI	48.83333
Malaysia	MYS	73.66667
Mali	MLI	55.33333
Malta	MLT	73.66667
Mauritan.	MRT	62
Mauritius	MUS	51.33333
Mexico	MEX	75
Morocco	MAR	71
Mozamb.	MOZ	60.33333
Nepal	NPL	43.7
Netherlands	NLD	93.33333
New Zealand	NZL	73.5
Nicaragua	NIC	61.83333
Niger	NER	55.33333
Norway	NOR	88.33333
Pakistan	PAK	44.66667
Panama	PAN	67
Papua New Guinea	PNG	55.33333
Paraguay	PRY	57.83333
Peru	PER	68.5

Philippines	PHL	77.66667	Syria	SYR	41.33333
Poland	POL	80	Tanzania	TZA	62
Portugal	PRT	86.66667	Thailand	THA	64.5
Romania	ROU	80	Togo	TGO	55.33333
Russia	RUS	73.5	Trin.& Tob.	TTO	75
Rwanda	RWA	49.66667	Tunisia	TUN	65
Saudi Arabaia	SAU	51.33333	Turkey	TUR	77.5
Senegal	SEN	55.33333	Uganda	UGA	62
Sierra Leone	SLE	62	Ukraine	UKR	77.5
Singapore	SGP	84.16667	United Kingdom	GBR	90.83333
Slovak Republic	SVK	86.66667	United States	USA	97.5
South Africa	ZAF	77.5	Uruguay	URY	64.5
Spain	ESP	86.66667	Venezuela	VEN	55.5
Sri. Lanka	LKA	64.5	Vietnam	VNM	68.5
Sudan	SDN	46.33333	Zaire (Dem Rep Congo)	COD	42.16667
Swazil.	SWZ	48.66667	Zambia	ZMB	44.66667
Sweden	SWE	90.83333	Zimbabwe	ZWE	51.16667
Switzerl.	CHE	84.16667			