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Does Democracy Foster the Creation of Innovation?

Disentangling the Interplay between Institutions and Political Regimes

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Abstract: Technological achievements in the form of innovations are important driving forces for an economy. Political leaders therefore have a direct interest in promoting innovations. However, the interrelation between different political regime types and their influence on the creation of innovations is unclear in current research. By establishing a micro model based on an economic agent's decision between innovating and imitating technologies, and a political ruler setting intellectual property rights protection in accordance with her preferred policy, we find that inducing innovation through strong intellectual property rights goes hand in hand with establishing a favorable environment for the success of new technologies. This model-suggestion is supported by our empirical estimation, which shows that there is a clear positive impact of intellectual property rights on innovations. Additionally, the democratic regime type is shown to have a positive influence on the strength of intellectual property rights. We conclude that the employed innovation strategy matters more than the regime type of the nation.

Keywords: Political Economy, Regime Type, Innovation, Institutions, Intellectual Property Rights

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1 Introduction

> "Democracy is the most effective form of government ever devised for delivering progress and opportunity and prosperity and freedom to people. And as two of the most innovative economies in the world [Sweden and the USA] we cherish that freedom that allows us to innovate and create."
> *- President of the United States, Barack Obama (Slack 2013)*

Institutions in their political and economic sense can be used to explain observed differences in today's economic world, since they directly influence economic factors. Explanations with their foundation in institutions are plentiful in recent public discourses and academia (Olson 1971, Pålsson Syll 2001, Acemoglu and Robinson 2012). The above quote is one example of a political leader seeking to attribute economic success to the institutions and convictions he represents. The quote was made by the president of the United States, Mr. Barack Obama, at a joint press conference with Swedish prime minister Mr. Reinfeldt. The statement is about how both the USA and Sweden have managed to foster great innovative environments.

The desired causality that Mr. Obama implied was between the common political form of rule, democracy, of Sweden and the US and the resulting economic outcomes, i.e. great success in innovation. At first glance such a conclusion seems intuitive and belief in such relationships between democracy and innovation appears almost obvious to a person raised in the western world. The belief is also shared by the US department of state, which mentions the increased democratization of the world since the 1970s as one of the great legacies of modern US foreign policy (US Department of State 2014). The same source calls democracy the one national interest that can help to secure all other national interests. However, when turning to academia the proper critical assessment of democracy's role in innovation creation is lacking. This can lead to premature valued judgments on the effectiveness of democracies in fostering innovations, as can be seen in Mr. Obama's statement. The result could be misinformed policy that fails to achieve its goals due to false convictions of the effectiveness of its strategy.

The main contribution of this thesis is towards improving the understanding of the effect that different political regime types have on innovation. The thesis starts out by modeling the relationship between institutional framework, regime types and innovation activity. The model implies that intellectual property rights play a predominant role in boosting innovation. It also shows that expanding on the use of market forces in the innovative process leads to more innovation, while government subsidies incentivizes agents towards imitation activities. The model is theoretical in nature and based upon our interpretation of previous research and the innovation process. To validate the relationships suggested by the model, we extend the thesis with an empirical examination of the effect of intellectual property rights on innovation and the effect of regime type on intellectual property rights. Using an instrumental variable approach we find that intellectual property rights increases the amount of innovation activity in a nation. Furthermore using a difference in difference method we find that newly transitioned democracies have higher levels of intellectual property rights protection than nations that have remained in autocracy. The overall findings of the thesis can be summarized as intellectual property rights do matter for innovation and regime type influences innovation activities through the institutional framework (intellectual property rights) promoted.

1.1 Research Question

It is the idea of this thesis to critically examine the effect of regime type on innovation activities. We seek to elaborate on the effects of different political regimes on the institutional framework of a nation while subsequently linking the institutional framework promoted to innovation behavior. This leads us to our research questions:

1. Is the extent of innovative processes of a nation influenced by the level of intellectual property rights protection of the nation?
2. Can regime type be said to influence the creation of intellectual property right protection and is there proof for a fundamental difference between autocratic states and democratic states in this regard?

By asking question no.1 the thesis limits itself in scope to deal with only innovations and not economic growth. We are also deciding to look at a specific factor, that serves as a good indicator of the overall institutional environment for innovation, namely intellectual property rights and the influence it has on the innovative environment of the nation. Question no.2 addresses the differences between autocratic and democratic societies. We postulate that if regime type can be said to influence the innovative behavior of a nation it does so through the channel of intellectual property rights. Limiting the scope of the thesis in this fashion allows us to stay focused on what, to us, is one of the most important relationships when it comes to determining strength of innovative environment in a nation.

1.2 Relevance and Purpose: Why Care about Innovations?

The premise of this thesis is that innovations matter for economic progress and that innovative activity can be influenced by regime type through the institutional framework promoted by the regime. The belief that innovations matter for economical outcomes is one well established in economic academia (Smith 1776 as quoted in Djankov et al. 2003, Schumpeter 1992, Romer 1990). This thesis seeks to employ the established theoretical framework and resulting empirical examinations of it to assess whether a democratic society is inherently better at generating an environment favorable to innovation than an autocratic society.

The claim made by Mr. Obama, at the Stockholm press conference, attributed the success of innovations to the democratic form of rule. In general, superiority of democracy is a belief that is commonly shared by the US administration and other western nations. Extending the belief to also affect innovation is not a large leap to make. The current US administration has been very eager to live up to its aspiration of maintaining its leading position when it comes to innovative activity (The White House 2014a).

The eagerness of nations to attain the position of top-innovator can also be seen in the aftermath of the recent economic crisis of 2008. The economic downturn was followed by large scale stimulus packages. Part of the packages were clearly intended to either protect the innovative sectors of the nations or further strengthen them. The economic recovery act spent approximately 3 billion USD on its Cash for Clunkers program, which intended to take old cars of the street

and replace them with new, more fuel efficient ones (The White House 2014b). Additionally, the recovery act allocated about the same amount on funding to the National Science Foundation.

The allocation of resources into innovation support highlight the importance of innovation for nations. There are several potential explanations that can account for a nation's interest in innovation. First of all, being innovative increases the self-reliance of a nation. Drawing from a pool of independently and internally created technologies means that costly acquisitions or imitations from other nations become unnecessary. A clear example of this phenomenon can be seen in the energy sector, where governments have increasingly shifted their focus towards new green technologies, which should put an end to the dependency on traditional energy sources such as fossil fuels. Subsidies given by the EU in order to widen the bio-fuel sector (European Commission 2014) and US protectionism over its fragile domestic solar-energy industry are just two examples, showing how energy-politics can create a craving for new technologies.

Secondly, innovations provide economic stability by increasing factor productivity and through this channel generated output. This is very much in line with standard economic theory, for example the Solow model. In the Solow model, once equilibrium has been reached, increases in output per capita relies to a large part on increases in technology, which is referred to as total factor productivity (Solow 1957). This knowledge has not passed without notice by political decision makers. After the economic crisis of 2008 the Obama administration began to look "for a new foundation strong enough to withstand future economic storms and support lasting prosperity" (Obama 2009). This foundation was in some part to be found in the creation of new innovative industries. In his state of the union address President Obama made his commitment clear by promising 45 manufacturing innovation hubs to be established in the next three years, in support of domestic new industries (The White House 2014c).

Moreover, if a country is able to create new industries within its economy due to innovation, it can lead to increased employment opportunities. In this regard, Mr. Obama has also made it clear that he wishes to defend the leading role of the US in science and technology by stating "(...) that the nation that goes all-in on innovation today will own the global economy tomorrow." (Obama 2014). In recent history the US has been feeling the breath of other nations down its neck when it comes to the top positions in innovative technologies. Success stories such as those of Silicon Valley are not exclusive to the US any longer, as used to be the case. Other nations have been catching up and are actively trying to end the predominance of the US (World Intellectual Property Organization 2013). The political leaders of nations with established economies are well aware of the fact that in order to further compete, innovations must be created to provide a competitive edge for domestic industries. So let us pick up the idea of job creation through innovation. If a nation should fail to innovate, new industries will be created outside its borders, leading to domestic technologies in the same sector becoming outdated and as a result loss of employment to other nations. For example, Sweden used to be the world's second largest shipbuilding nation, only surpassed by Japan. The industry peaked in the mid 1970s with around 39 000 employees. But due to increased competitiveness from Asia by the end of the 1970s almost all shipbuilding had stopped (Whilborg 2006, p. 3). Employment was lost in Sweden while Asia gained. Such scenarios are imaginable to politicians who have an interest in creating employment and receiving recognition for it and not be seen as job-destroyers.

Therefore, reasons for why to create new technologies from a government perspective are plentiful. However, choosing the appropriate policy to generate innovations poses itself as a

challenge, for both democratic and autocratic leaders. This is why it is important for policy decision makers to understand the relationship between political institutions and innovation.

One reason why democracy could be considered as favorable to innovations is that out of the world's leading innovators a lot of them are democracies.

Rank	Nation	Regime Type
1	Switzerland	Democracy
2	Sweden	Democracy
3	United Kingdom	Democracy
4	Netherlands	Democracy
5	USA	Democracy
6	Finland	Democracy
7	Hong Kong (China)	Autocracy
8	Singapore	Autocracy
9	Denmark	Democracy
10	Ireland	Democracy

source: The Global Innovation Index (2014)]

Nations with a polity2 score in 2012 of above 0 are labeled democracies, those with 0 or lower are labeled autocracies

Figure 1 **Top 10 of the Global Innovation Index for 2013**

Eight out of the ten nations that scored the highest in 2013's Global Innovation index were democracies. However these nations share other characteristics, besides regime type, for example a high degree of development, as evidenced by high GDP per capita levels compared to the rest of the world. It is not necessarily the observed difference in regime type that leads to the eventual difference in performance in the innovation sector.

Previous research has been aware of the need for further clarification as to what the different implications of political regime systems are in practice. A lot of the early research was focused on the area of economic growth and whether there is a significant difference between the performance of autocracies and democracies. The results were diverse in nature with some finding evidence of democracies outperforming autocracies, while others find evidence in the opposite direction (Limongi and Przeworski 1993, p. 61). Looking at economic growth might be too optimistic at this stage of research. Growth in and of itself is not something that economists have managed to completely understand (Limongi and Przeworski 1993, p. 64) and then trying to isolate the effect of political regime type could be a tremendous challenge. This thesis seeks to take a narrower approach with a focus on innovation, which is a contributing factor to growth.

The rest of the thesis proceeds as follows. In section 2 we delve into the previous literature in regards to this field of study. The literature review is followed by us constructing a model of the innovation process in section 3. The model section begins by outlining the theory employed and then goes in to the actual derivation of the model in the later parts. Subsequently the implications of the model are tested in section 4. We use an instrumental variable approach to help answer research question no.1 and then a difference in difference with propensity score

matching method to help answer research question no.2. This is followed by a discussion of the results of the model and the empirics and how they can be interpreted jointly in section 5. The thesis concludes in section 6 with a brief summary of what we consider the major findings of the thesis and implications for future research.

2 Background and Current State of Knowledge

This thesis is concerned with the protection of intellectual property rights and how outcomes differ depending on the degree of intellectual property protection. Understanding what has previously been done in the field of comparative economics is advantageous to the further development of how to answer the research question. Comparative economics is the field of research dealing with the differences between nations' economies.

The focus of the field lies in comparing and contrasting different capitalist economies. Djankov et al. (2003) suggest that comparative economics should focus on studying the differences between alternative capitalist models of the economy. What the authors think matters are the different private and public institutions adopted by different capitalist economies. The institutions have a wide variety of influences such as election of political leadership, how to solve disputes and how to secure property rights. This thesis is concerned with the protection of intellectual property rights and the different resulting outcomes that can be observed in the real world. Understanding what has previously been done in the field of comparative economics is advantageous to the further development of how to answer the research questions.

This section is structured into three main subsections. First of all we investigate what has previously been done in the field of innovation and political regime studies. Subsequently we investigate the two areas that directly applies to the research questions. We review the interplay between intellectual property rights and innovation and proceed to uncover what is previously known about the effects of political regimes on intellectual property rights.

2.1 The Interplay Between Regime Type and Innovation

One of the fundamental puzzles of economics is the difference in income between the different nations of the world. Out of the factors contributing to the differences in economic outcome, technological progress and accumulation of human capital is of great importance (Solow 1957). This puts emphasis on the need for innovation to create new technology in any successful nation. While this relationship is well understood, what causes a nation to achieve success or failure in innovative activities is as of yet not completely understood with little attention paid to the political dimension of the problem (Balalaeva 2012).

What previous research seem to agree on is that innovation creates winners and losers (Parente and Prescott 1999, Acemoglu and Robinson 2000). As a new technology is created any old technology associated with the same process tend to lose value. If this was only a question of economical losses redistribution could compensate those groups that suffer due to the innovation. However, associated with the loss of economical power is a loss of political power as well (Acemoglu and Robinson 2000). It is then possible that groups with vested interests will actively

work to block the adoption of new and more efficient technologies. One of the main differences between autocracies and democracies is the size of the support group needed to retain power. To rule in democracy you need a majority of the votes to win the election. An autocrat on the other hand can rule with a much smaller support group (Besley and Kudamatsu 2007). Mobilizing the support to oppose innovations would be harder in a larger than a smaller group (Olson 1982). Vested interest groups in autocracies would to a greater degree be able to oppose the implementation of innovative technologies.

There are other links between autocratic institutions and lower innovations. Brouwer (2006) argues that increased efficiency resulting from innovation could lead to worker displacement. This in turn would be harmful to the autocrat's bottom line if the workers are unable to find other employment. Unemployed workers are associated with costs for the autocrat that he would have to consider when deciding whether to promote innovation or not.

To increase human capital, which is associated with higher levels of innovation, providing good education is a potential path. People with more education are in general more interested in contributing on their own to society. This can put pressure on the political system to change into democracy as education levels increase (Glaeser et al. 2006). By creating a framework that is suitable for innovation the autocrat could be causing his own eventual demise.

Theory predicts that being open to international trade will lead to increased innovation. Mainly because it allows for citizens to access the accumulated knowledge of the rest of the world and this would help boost innovation of the nation (Grossman and Helpman 1991). Being open to international trade could be harmful for resource extraction of the autocratic leader. He does not necessarily need to rely on direct expropriation of his citizens to obtain resources for his private consumption. Instead he can adopt a market structure to generate surpluses through state owned enterprises. If these state owned enterprises are harmed by opening up trade to foreign competition it directly hurts the autocrat. Historically this has lead to autocracies closing themselves off from international trade and suppressing the creation of a merchant class (Brouwer 2006), for example Japan under the Tokugawa shogunate.

As can be seen most of the previous research seems to point towards autocracies underperforming when it comes to innovation activities. While it could be beneficial for the forward thinking autocrat to allow for innovation since it increases the amount that can be appropriated in later periods (McGuire and Olson 1996) there are several disincentive effects pushing the autocrat to clamp down on independent thinking.

2.2 How Intellectual Property Rights Affect Innovation

The field of economics has long been aware that innovations are one of the key factors to understating the differing economic performance of nations (Easterly and Levine 2002). One of the first researchers to bring attention to innovation and the role it plays was Schumpeter. According to Iwai (1984, pp.1-2) Schumpeter thought of capitalism as an evolutionary process where innovation creates market power for the innovator. He coined term of "creative destruction", which he understood as a "(...) process of industrial mutation (...) that incessantly revolutionizes the economic structure from within, incessantly destroying the old one" (Schumpeter 1992). Fagerberg (2004, p.6) further elaborates on Schumpeter's views with regards to innovation stat-

ing that Schumpeter was one of the first scientists to object to viewing innovation as a random phenomenon. Instead he emphasized three separate aspects of the innovative process. First of all, innovation is an uncertain process. Secondly, innovation rewards the first one that is able to innovate disproportionately meaning there is an incentive to innovate rapidly before someone else has the same idea and manages to implement it. The last aspect mentioned by Schumpeter is that of social inertia, meaning that every innovation faces resistance from society. People can be set in their ways and not willing to adopt new innovations. Vested interest groups do not want creative destruction to take place, since they then run the risk of their technology becoming obsolete.

Romer (1990) was one of the first economist to try and implement Schumpeter's ideas of innovation into a more formal model of economic growth. Romer's paper begins with the observation that output per worker in the United States has increased by a factor of ten in just a hundred years. Part of this he attributes to technological change. Changes in technology are the primary drivers of growth in Romer's model. These changes are the result of investments made by profit-maximizing agents reacting to incentives in the market. The model takes the outcome of innovation to be a non-rival and partially excludable good. It is non-rival in the sense that anyone can benefit from the innovation without exhausting the supply of it, unlike for example a deposit of oil. Being partially excludable means that the innovator can, to a certain extent, prevent others from using his innovation.

These types of goods commonly suffer from a problem of underinvestment. The investments desired on an aggregate level are not matched by the aggregate investments of the individual actors. This is due to the factor of competition post innovation. If the innovator has spent resources creating his innovation and is then subjugated to competition from firms that succeed in imitating his findings immediately upon entering the market, he never has the chance to recoup his investment. One potential way of addressing this problem lies in patents, which translates into enforcing intellectual property rights, that grant temporary monopoly power (Romer 1990).

There have been studies into how intellectual property rights influence innovation and growth in nations (Posner 1961, Dinopoulos and Segerstrom 2003). The resulting models are usually called North-South models. North represents the developed world and South the developing world. The basic dynamics of the North-South model of innovation is that North puts resources into innovation, which create new products and make North more competitive. South subsequently imitates the innovations of North, which causes Northern firms to face increased competition. In a perfectly competitive market profits will go to zero and the Northern firms will not be able to compete with Southern firms due to the initial investment into research and development for the initial innovation. Then North must innovate again to regain monopoly power.

The North-South model is, at its basics, an interesting way to see how institutional interplay can affect innovation. Increasing global intellectual property rights is not good for everyone in this type of setting. Northern firms will benefit, since better intellectual rights make it harder for South to imitate. Meanwhile consumers are paying monopoly prices in both territories for goods that could potentially be substantially cheaper. Southern firms lose opportunities for imitation of Northern goods. At the same time they have the potential to gain monopoly power themselves, if they can make the switch from imitation activities to innovation activities. For Northern firms the incentives to innovate could actually decrease with increased intellectual property protection. Without Southern firms threatening to overtake them through imitation,

they do not have the same incentive to engage in the risky process of innovation investments. Since they already have monopoly power they do not need to innovate to retain it. This is in stark contrast to the implications discussed in Romer (1990). Intellectual property rights' overall impact on innovation is disputed in much of the research. On the one hand enforcing the rights of the innovator enables him to recoup his losses which would boost investments (Romer 1990), on the other hand it decreases competition and this can decrease investments into innovation, which is the prediction of the North-South model.

The relationships above, being theoretical in nature, are testable through empirical observations. There have been empirical studies to confirm the impact of intellectual property rights protection on innovation. One example of such a study would be Chen and Puttitanun (2005). This study finds a positive relationship between intellectual property rights protection and the amount of innovation in developing countries. However the main focus of the paper is on the link between GDP and intellectual property rights protection. They do not take the political dimension into account. Their findings with regards to GDP and intellectual property rights are interesting in that they suggest an U-shaped relationship. Meaning that when a country first starts the transition out of low income, it first goes through a phase where it is beneficial to lower intellectual property rights. Then after a certain threshold of GDP per capita has been reached the incentives will shift and the country will find it beneficial to start raising intellectual property rights again. This suggests that different strategies could be optimal at different stages of development for a nation.

Research shows that innovation can be of utmost importance for a country to achieve growth and increases its surpluses. Understanding innovation as a non-rival and partially excludable good means that success is not guaranteed just because an innovation has been realized and firms will be weary of investing. Therefore, if appropriate measures are not taken investment into innovation will be below the optimal level for the aggregate population. To achieve optimal levels of innovation innovators must be allowed to recoup their losses and a common way for this to take place is through the enforcement of intellectual property rights.

2.3 The Influence of Political Regimes on Intellectual Property Rights

The importance of intellectual property rights with regards to innovation makes it crucial to understand the interplay between them and and political regime type to be able to determine the impact of regime system on innovation activity in a nation. The differences between autocracies and democracies in regards to growth performance have previously been studied but results remain inconclusive. Limongi and Przeworski (1993) provides a summary of the early work. A problem in this field of research is to establish the social and economic policy differences that exist between the two regime types, with some researchers finding little proof that any exist (Gil et al. 2004). This thesis focuses exclusively on one area of the growth puzzle (innovation) and one particular variable (intellectual property rights) that can be used to explain differences between regime types. Hence our efforts can be focused on determining differences in this one area instead of looking at overall differences which might be harder to determine.

In models of endogenous growth, innovation is thought of as something that is intrinsically good for the overall economy (Romer 1990, Grossman and Helpman 1993). Historically though

there have been episodes of nations knowingly impeding innovation. Schumpeter (1992) brought up social inertia as an important factor as to why innovation would be resisted. If hierarchy in the nation is based on tradition and has remained stable for a long period of time people become complacent in their lot (Brouwer 2006, p. 15). If the incumbent elite does not feel that their position is threatened there is no need to innovate. Innovation activities typically benefits from allowing the market to determine success and failure. This type of policy can be adopted by both democracies and autocracies. There is a trade off for the autocrat in doing this, as supporting free market structures (through for example intellectual property rights) directly curtails the prerogative of the autocrat to freely allocate surpluses at his leisure. He loses the power of directly rewarding supporters that might be crucial to maintaining the stability of his rule (Brouwer 2006, pp. 13-16).

Besides supporting intellectual property rights the government could increase innovation by assuming parts of the costs, through the channel of a subsidy. This could be a method for the autocrat to maintain the power over allocation of resources, while at the same time promoting innovation. A recent paper by Acemoglu et al. (2013) investigates the aftermath of the financial crisis of 2008. During this period many governments utilized subsidies or outright bailouts of major corporations to create national champions of industry that supposedly are able to pull the rest of the country along with them. The authors find that a large portion of new innovation takes place in market entrants. By subsidizing incumbent innovators the government allocates resources away from the new entrants to less efficient actors that have passed their innovative prime (Acemoglu et al. 2013). These are the same inefficiencies mentioned in Brouwer (2006). The incumbents cannot be relied on to innovate if business as usual is just as good for them.

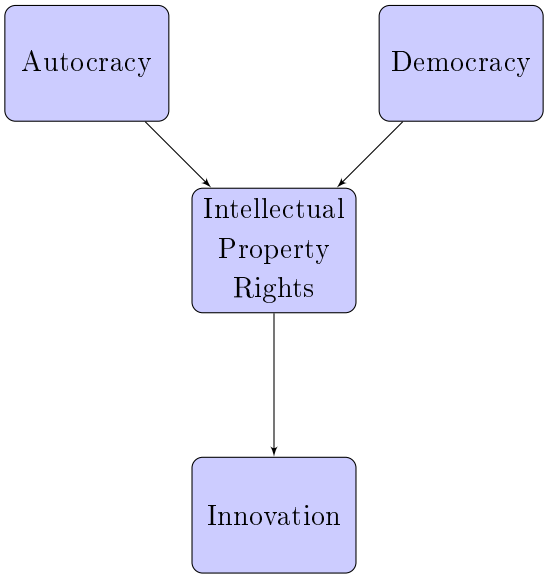
Direct subsidies and maintaining control over the markets could be linked to the behavior of some autocracies where state owned enterprises are a major feature of the economy. State owned enterprises normally face soft budget constraints that would allow them to keep operating even after a normal company would fail. For example China has historically been channeling a lot of its savings into favorable loans to state owned enterprises through the state owned banks. Since both the lender and borrower are owned by the state it is natural that the interests of the government are put first and foremost. Loans made from banks to parties that are directly related to the owners of the bank tend to perform much worse than loans that are made to parties with no direct connection to upper bank management (La Porta et al. 2003). The owners can be said to loot the banks for their own benefit, which is consistent with the view of autocrats extracting surpluses to allocate towards their preferred subgroups of the population. Subsidies appear to be a way to maintain the status quo.

The review of the literature highlights two main ways for the regime to promote innovation. First it can enhance intellectual property rights. This comes with some difficulties in the case of autocracies as they are forced to cede part of their power of redistribution. It is then suggested that autocracies could prefer subsidizing areas of interest to increasing individual rights. These concepts will be of great importance in section 3 where the theoretical model is constructed to differentiate between these two ways of promoting innovative activities.

3 A Theoretical Model of Innovation Based on Intellectual Property Rights

In order to assess whether a nation ruled in a democratic fashion posses an advantage over autocratic nations when it comes to innovations, we construct a simple micro-model. The idea being that different regime types might have varying impacts on the creation of innovations. It is our belief that the regime's impact on innovations is channeled through the institution of intellectual property rights.

The presented model is based on the idea of rational choice (Sugden 1991) between innovation and imitation by the economic agent, induced by different strengths of intellectual property rights. In the model the outcome is therefore influenced by different forms of political regimes, channeled through institutions, that create different incentive structures and risk factors for the agent of the model. It will be shown that political decision makers can positively influence the creation of innovations through strengthening intellectual property rights which establishes a favorable environment for the creation of new technologies.



Source: Author's own creation

Figure 2 **Outline of Modeled Interrelation between Regime Type on Innovation through Intellectual Property Rights**

The key idea of the reasoning behind creating the model can be expressed through figure 2. In essence, figure 2 describes the hypothesized relationship of political regime type and innovations, the interaction is through intellectual property rights. It is a first naive depiction of what will later be examined in more detail.

3.1 The Theoretical Fundament: Technology and Choice

Academic research into innovation is spread out over several different fields of study (Fagerberg 2004). The literature ranges from management textbooks, philosophical works and into economics (Vaitheeswaran 2012). Because of the cross-disciplinary nature of innovations no unifying theory has been presented. One reason a unifying theory of innovation is hard to pin down is that the notion of innovation, in its essence, is rather unfathomable. Innovation suggests the creation of a future object, currently unknown, through processes in the present.

An often proposed metaphor for this process is that of a black box. The mechanisms and inner workings of such a box are unknown. Subscribing to the idea of innovation as a black box makes research very difficult. Innovation is nothing that just happens passively without outside interference. It can be actively fostered and generated (Schumpeter 1992). This idea that measures can be taken to actively create innovation is fundamental to the theoretical model. This thesis does not claim to be the first to offer a coherent theory on innovation. The model is an attempt at bringing together certain threads and lines of reasoning to one coherent and simple theoretical framework.

A first step towards creating the model is to establish an insight into the theoretical fundamentals that form the basis for our understanding of innovation. It is important to be clear in regards to this as it has a fundamental impact on the model and how it will be shaped. To avoid misconceptions it is necessary to establish the terminology used in the rest of the thesis. When innovation is mentioned, it refers to technological innovation and not to social innovation. Social innovation is referred to as "new ideas that work" in a societal and social context (Mulgan et al. 2007). A case can be made for social innovation being fundamental to all technological innovation, but the model will for the sake of simplicity abstract from this, rather philosophical discussion.

Moreover, it needs to be established that innovation is not the same as invention. For invention to take place it is enough to create a new idea, an innovation additionally demands the successful introduction of the new idea into existing structures, such as a market. The thesis places emphasis on innovation and not on invention, because we believe successful technological implementation to be more meaningful for the overall benefit of nations than just the mere creation of technology. As can be seen in the literature review there are plenty of reasons that inventions might be blocked on their ways to becoming innovations (for example Acemoglu and Robinson 2000) In the following sections the two terms of new technology and innovation is used interchangeably. More precisely, when new technology is used to refer to innovations, the meaning of successful new technology is implied.

The term innovation does not necessarily imply that it has to be something new and revolutionary. A restructuring and improvement of existing technologies or production methods can already be considered an innovation. Innovation is contrasted by imitation, which in the context of the thesis is considered as targeted acquisition of already existing technology.

3.1.1 Conscious and Unconscious Innovation

After having clarified the terminology used, the focus is turned towards the theoretic substance of the matter. It is of great importance that the underlying ideas of the model are outlined, in order to grasp the intuitive statements that can be inferred from the results. Every economic model is based on certain presumptions, which have to be clearly expressed in order to maintain credibility. If underlying presumptions are not clearly stated a model can quickly become a tautology, meaning that outcomes are only results of made presumptions, which confirm themselves.

In its theoretical fundament the model will display how innovation relies on consciousness and choice. The economic agent, in the framework of the model, will make a conscious decision over different technology options, given different strengths in intellectual property rights. The strength of intellectual property rights is previously determined by the political ruler's chosen innovation policy.

The interrelation between choice and consciousness can be drawn in many theoretical models, however it becomes of special interest when thinking of the creation of new technologies. Consciousness, in that the environment can be examined and awareness of problems is created. Choice, in that the possibility to allocate ones efforts into the creation of the unknown and not only into the known, is available.

Consciousness leads to the recognition and critical inspection of ones environment. Subsequently, problems are determined and possible solutions are explored (Nightingale 1998). This line of thought does not necessarily only apply to the creation of innovations but it shows that consciousness is employed towards a certain purpose. This leads to an outcome driven form of ones mind, which is utilitarian in nature. The act of problem solving through consciousness becomes an end in itself, since it is strictly targeted at objectives. Purposeful application of ones consciousness is one fundamental element for being able to innovate.

A further fundamental element to innovation can be found in its unconscious aspect. The idea of a conscious purpose approach, which creates innovations for a certain end stands in contrast to this unconscious purpose approach. This term does not imply that there is a lack of consciousness, but that consciousness is not guided by pre-defined objectives. Another term for unconscious purpose might be nature, which acts almost randomly without any consciously determined guidelines.

Both conscious and unconscious purpose can create new technologies, where the former is targeted towards a certain end such as the discovery of clean energy sources and the latter emerges almost randomly such as the discovery of penicillin. Drawing up such a defining dualism gives a first outline to most of the underlying ideas of the model. Therefore, the distinction between two separate forms of consciousness that can lead to innovation is helpful to our model when we make a distinction between unconscious and conscious forms of innovation.

Unconscious Innovation Here, unconscious innovation refers to a bottom-up innovation process, which relies on creating the right institutional environment for innovations. To once again quote Mr. Obama "(...) change in this country comes not from the top-down, but from the bottom up." (Obama 2010) This is one example of a case where a democratic government sees itself as representatives of such innovation methods, but we do not tie the term directly to democratic regimes. It is referred to as a certain type of innovation policy.

Unconscious innovation relies on free economic agents, who are able to freely choose into which

form of technology generation they wish to invest. This means that winners are not chosen by the government before the race has even started, which is the implication of conscious innovation strategies. Unconscious innovation rather serves to bolster citizen's ingenuity and creativity on an egalitarian basis. This ties back to the mentioned notion of unconscious purpose, which does not target objectives but uses the creative process in an unconstrained environment to determine optimal solutions. Similarly, when supplying the representative economic agent with a certain freedom, we imply a supportive and unconstrained environment of innovation.

Even though the notion of unconscious innovation relies on the freedom of the economic agents it does not imply that the government should take a passive role of non-interference. On the contrary, the government needs to be involved in order to establish the appropriate supportive environment for the creation of new technologies. Such an environment can be created by establishing necessary rule of law, securing safety, providing a strong research sector, which is based on an effective educational system, and basic infrastructure such as electricity grids and communication networks. Therefore unconscious innovation should be based on horizontal measures that do not favor specific sectors, but equally strengthen each member of the economy engaged in innovative activity. An unconscious innovation policy will therefore induce an intellectual property rights protection rate favorable to innovation.

Conscious Innovation Contrary to the idea of unconscious innovation stands the notion of conscious innovation, with a top-down innovation approach. Here, the government makes clear decisions over which technologies to promote through imitation or directed innovation. In both cases, the government acts by funding preferred technologies through subsidies.

There can be various reasons for a government to consciously decide which technology to favor. First of all, a government can catch up rather quickly to other nations' technology standards by supporting the imitation of the other nations' technology. Moreover, situations within a country might arise which require conscious innovation policies. After an economic recession, for instance, a government might want to revitalize an already established industrial sector. This goal can be achieved through protective industrial policy, and directly supporting the favored technology through subsidies (Ford and Suyker 1990). This refers back to the conscious purpose approach, which is aimed at directly solving problems. Naturally, any type of innovation is only beneficial if it can be a solution to some kind of problem, but with conscious innovation the problem and possible solution are directed top-down.

A further reason for conscious innovation decisions might be given by political agendas to either protect certain industries or branch out into new sectors. Moreover, we define conscious innovation as an innovation policy that is targeted and inegalitarian, meaning that certain groups do receive benefits, while others are not protected through the appropriate political institutions. Here it is not free education that matters but targeted training of the workforce for specific industries. Conscious innovation is in essence a utilitarian approach to technology, which dislikes uncertainty of success for freely created innovations and trades it for highly subsidized technology acquisition policies. Therefore, a conscious innovation policy will induce an intellectual property rate that favors acquisitions of technology through imitation. Imitation, which is considered as targeted acquisition of already determined technology.

3.1.2 Intellectual Property Rights and their Influence on the Model

The model focuses on intellectual property rights as the main institutional incubator for innovations. The reason is that in order to capture the positive externalities of innovation a government needs to create the correct incentive structure for its preferred brand of innovation, conscious or unconscious. This is done by setting property rights so that the gains of innovation can be captured.

Standard economic theory suggests that primarily ownership of land and production inputs encourage economic activity. Engaging in productive labor holds a gain for the producer that can be consumed and not freely extracted by outside forces, as long as his property is protected from expropriation. This is in line with McGuire and Olson (1996) who portray extractive authorities that seeks to appropriate the maximum amount for personal consumption from the producers and in consequence discourage productive activity.

This theory implies that safety from coercion and ownership over produced goods leads to a shift from production structures, which covered bare minimums because of possible extraction, to settled production structures, which enables producers to fully employ their capacities. The containment of abusive power over economic agents led to the population engaging to a further extent in production. The thesis wishes to extend this idea towards intellectual property, which is not as tangible as for example the crops a farmer can harvest on his own land.

Nonetheless the creation of new ideas and technologies does lead to a benefit for its creator and potentially other market participants. It will be further argued throughout the the thesis that physical property and innovations which exist in the forms of objects, and not just ideas, are very similar in kind. In order to make this extension, intellectual property needs to be understood as a private good, similar to physical property, where positive externalities can be captured by its creator. The innovations of interest are expressible in objects and not in pure immaterial form.

An understanding of intellectual property as a pure public good does not cohere with the model. Moreover, there are more reasons to consider innovation as a private good than just for the sake of attaining model convenience. It could be perceived that when an innovation is introduced into the market, and therefore made public, the innovation itself becomes automatically a public good. Innovation behavior in for example the fields of health or educational research, which are not intended to generate private gains for the creator but only altruistic gains for humanity as a whole, for example Salk and the Polio vaccine, will not be a subject of the model. These types of goods can be considered public goods. This makes both the idea and the production process public property.

Innovations can also be created for private gains. It is therefore made clear that the modeling focuses on innovations, which are created for the benefit of the innovator. There can be positive externalities of the innovation that benefit society at large but the main driving force of the innovator is her personal gain.

Therefore, if the intention and the character of the innovation are clear, then conceivable decisions can be made over the innovation being a public or private good. However, the point of contention between perceiving innovation as public or private goods arises when the intention is not clearly perceivable. Then, it is argued, that an innovation is a public non-excludable good since from the moment of the introduction of the technology into the market the knowledge of it becomes publicly known and copyable (Plant 1934). Such a perception on innovation lacks the

distinction between the idea and the technology of an innovation. The idea captures the mere knowledge of the existence of the innovation, where the technology captures the knowledge of the substance of the innovation. If both the idea and the technology, i.e. production process, are made public then the innovation can be considered as public innovation.

However, if only the idea is presented but not the production process, it would be a fallacy to immediately regard the innovation as a public good. Knowing that the novelty of a touch-screen phone has been introduced into the market, does not mean that every market participant is able to immediately copy the technology. Acquiring the necessary technology and understanding to replicate the idea is a lengthy process, which can take years.

Nevertheless, intellectual property rights can be criticized for baring other external actors from the technology and also entry into the market. Patents can be misused and actually prevent further innovation (Kinsella 2001). There is a thin line between appropriate intellectual property rights and intellectual property rights that allows for excessive abuse. The distinction will be discussed in section 5.1. However, an innovator needs to be able to exert some form of monopoly power over his innovation in order to capture positive externalities (Schumpeter 1992, Romer 1990).

Before giving the detailed description of the model, the necessary assumptions will be outlined. In the model a clear aggregation assumption is made, meaning that the implications drawn from individual actors are expanded towards an economy with multiple actors. In order for the model to hold, the agents have to be homogenous and face the same investment decisions. This assumption abstracts from heterogeneity but increases parsimony and delivers a clear model, whose outcomes can be tested.

The model is set up to capture a dichotomous world, meaning that there are clear differences between the two choices of for example innovation and imitation or conscious and unconscious innovation. Such clearly defined dichotomy cannot always be found in observed policy decisions. Nevertheless, the assumption is made in order to keep the outcomes clearly differentiable. In order to depict the line of reasoning underlaying the model, a simple model of a small closed economy is established. There are two actors at work in this model: the economic agent and the political leader. It is a two period model, with a one time interaction between the two actors. In a nutshell, the model will outline how intellectual property rights have a positive impact on innovations and how the political ruler can influence the agent towards engaging in innovation. The output of the small closed economy relies on investments into innovation or imitation of technologies.

The economic agent faces a decision between either innovation or imitation, where positive returns of investments into innovation are uncertain. Investments into acquiring already existing technologies, through imitation, face an acquisition cost. The agent will solve for his optimal technology decision of innovation and imitation and then solve for the degree of intellectual property rights that make him indifferent between either technology.

The political ruler decides on the strength of intellectual property rights and then extracts generated output in the second period. By increasing intellectual property rights above the rate that makes the agent indifferent he encourages innovative activity and hampers the imitation of existing technologies, and vice versa.

3.2 The Economic Agent: Making a Choice between Technologies

As stated above, the individual economic agent faces a decision between two different technologies, which can be innovative or imitative in nature. Both technologies' characteristic traits are of importance for the model, but not their actual forms in which they appear, making types of imitation or innovations homogenous within the model.

This implies that the agent will have to make a clearly distinct selection between innovation or imitation. These two different forms of technology are the inputs to production, where the agent is the producer and the consumer of non-extracted output. Output can therefore be seen as created technology, through either innovation or imitation. In the first period the individual agent i agent receives an endowment e_t^i, which consists of resources that the agent can then subsequently invest or consume.

The output y_t produced by the agent in this economy solely depends on his investment into innovation ϕ or imitation θ of technology, where $\phi, \theta \in [0, 1]$, where the variables denote fractions of resources directed toward either technology. Further variables of interest are expressed as elements within 0 and 1, which allows an interpretation of relative percentage changes and not absolute quantities. Output is generated in the following period $t+1$ after initial endowments have been consumed. Moreover, we assume marginally decreasing returns to innovation and imitation, with $\lambda \in [0, 1]$. This model makes no assumption over differences in returns between innovation and imitation, which is why the same λ is assigned to both innovation and imitation. This results in the production function, which is an additive and composite function of technologies,

$$y_{t+1} = \phi_{t+1}^{\lambda} + \theta_{t+1}^{\lambda}$$

The model relies on the significant influence of intellectual property rights $\pi \in [0, 1]$, with a high value of π signifying strong intellectual property rights , which makes copying new technology more difficult. A higher degree of intellectual property rights, secures the consumption of innovation goods for the producer. A lower degree on the other hand, increases the amount of available imitated technologies. The production function is therefore a weighted sum between innovation and imitation, with intellectual property rights determining the strength of the respective weights.

$$y_{t+1} = \pi\phi_{t+1}^{\lambda} + (1 - \pi)\theta_{t+1}^{\lambda}$$

The level of innovation in the following period, is determined by today's investment into new technologies and the persistence of past innovations. The investment function for innovation I_t^{ϕ} displays certain features, that one can expect from an innovative process. First of all, investing into innovative technologies this period bears a certain amount of risk and uncertainty about success in the next period. This is captured by the parameter $a \in [0, 1]$. Being a multiplier of I_t^{ϕ}, the exogenous parameter a depicts a probability of success, implying that a low probability of success produces an environment unfavorable to innovation. Moreover, the persistence of previous innovations is captured in the variable $z \in (0, 1)$, which depicts in a sense a culture of innovation. Successful innovations rely also on past accomplishments in new technologies.

$$\phi_{t+1} = aI_t^{\phi} + z\phi_t$$

The investment function for imitation I_t^{θ} behaves in a different way. For one, there is no level of uncertainty when it comes to the imitation of existing technologies, that have proven themselves to be successful. It requires an investment I_t^{θ}, where pre-existing technologies depreciate at a rate of $\gamma \in [0, 1]$ However, the investment into pre-existing technologies does incur an acquisition cost, which is expressed through $(1 - q)$ with $q \in (0, 1)$, where a high value of q depicts high acquisition costs.

$$\theta_{t+1} = (1 - q)I_t^{\theta} + (1 - \gamma)\theta_t$$

The agent receives utility from consumption in the current and the following period, which is discounted by $\delta \in (0, 1)$. The utility function $u_t^i(c_t^i, c_{t+1}^i)$ is concave and twice differentiable.

$$u_t^i = \ln(c_t^i) + \delta \ln(c_{t+1}^i)$$

Once the initial endowment of e_t^i is received, the agent is then able to consume a fraction the supplied resources and allocate investments into either innovation or imitation, which feed into his investment function outlined above. This leads to the following budget constraint.

$$c_t^i = e^i - I_t^{\phi} - I_t^{\theta}$$

In the following period $t + 1$ the investments made into either type of technology lead to the production of output. To reiterate, output is considered as resulting technology based on innovative or imitative inputs. A certain fraction of the generated output is extracted through $\tau \in (0, 1)$. The influence of intellectual property rights on output has been outlined above.

$$\begin{aligned} c_{t+1}^i &= (1 - \tau)y_{t+1} \\ &= (1 - \tau)(\pi\phi_{t+1}^{\alpha} + (1 - \pi)\theta_{t+1}^{\beta}) \end{aligned}$$

Taking the utility function and its constraints, we are able to set up the following maximization problem, where we set $t = 1$. The maximization of interest occurs with respect to θ and ϕ.

$$\max_{\theta,\phi} u_1^i = \ln(c_1^i) + \delta \ln(c_2^i)$$

subject to:

$$\begin{aligned} c_1^i &= e^i - I_1^\phi - I_1^\theta \\ c_2^i &= (1-\tau)(\pi\phi_2^\lambda + (1-\pi)\theta_2^\lambda) \\ \phi_2 &= aI_1^\phi + z\phi_1 \\ \theta_2 &= (1-q)I_1^\theta + (1-\gamma)\theta_1 \end{aligned}$$

Solving for the optimal values of ϕ and θ in the second period, we wish to show the dependency of optimal technology decisions on the intellectual property rate and further variables, resulting in

$$\phi_2^* = \left(\frac{c_i^1}{c_i^2} a\delta(1-\tau)\pi\lambda\right)^{\frac{1}{1-\lambda}}$$

$$\theta_2^* = \left(\frac{c_i^1}{c_i^2}(1-q)\delta(1-\tau)(1-\pi)\lambda\right)^{\frac{1}{1-\lambda}}$$

It can be seen that both the optimal levels of innovation and imitation positively depend on initial consumption level and therefore endowment. This implies, that agents starting of with higher amounts of resources in the first period, will invest more in the second period, ceteris paribus.

Moreover, matching the framework the optimal level of innovation is diminished by a low probability of success for innovation, expressed through a, and increased through a high level of intellectual property rights. In the case of imitations, their level is negatively impacted by high acquisition costs and high intellectual property rights. Since both innovation and imitation levels are influenced by intellectual property rights, we solve for π^{ind} that makes the agent indifferent between innovation and imitation, which results in

$$\pi^{ind} = \frac{(1-q)}{a + (1-q)}$$

This equation is interesting because it shows that π^{ind} offsets the acquisition cost $(1-q)$ to the rate of success for innovation a. Everything else held constant, increasing a leads to a lower π^{ind}. This implies that if innovations are almost certain to succeed, π^{ind} simultaneously decreases in strength, since there is less of a risk to offset.

A different way of interpreting the cost of imitation is by setting $(1-q) = w$, where w is the strength of subsidies. The indifference condition of intellectual property rights can then be rewritten as

$$\pi^{ind} = \frac{w}{a + w}$$

In order to induce the agent to either innovate of imitate the political ruler must deviate from the indifference value π^{ind}. The economic agent has no influence over the strength of intellectual property. It is the political ruler, who sets π^{pol} either above or below π^{ind}. This leads to the introduction and discussion of the political ruler.

3.3 The Political Ruler: Inducing Technology Decisions through Different Innovation Policies

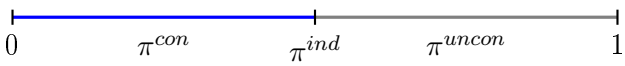
In the model, the political leader sets the extraction rate $\tau \in [0, 1]$ and the strength of intellectual property rights $\pi \in [0, 1]$. Both these variables are seen as the ruler's policy instruments.

The extraction rate can also be interpreted as a tax rate on the final output of the economy in each period. It determines how much of the agent's produced output will be consumed by the ruler. In this framework τ is constant across technologies, i.e. does not have a diverting influence on technology decisions by the agent. Moreover, since initial output is only dispersed in form of an endowment, extraction occurs only in the final period.

The next step is to investigate the intellectual property rights decision of the ruler. By exogenously setting a certain level of intellectual property rights, the ruler makes a credible commitment to the agents. The model therefore only makes sense if the set intellectual property rights are binding and the agents believe in their credibility. Therefore, deviations from the initially announced strength of π are not possible.

It is up to the political leader to decide how strongly he will protect the innovations of his people. According to our theory, a stronger protection of innovations should incentivize economic agents to engage in innovation by protecting their innovations from expropriation. Therefore, with the knowledge of π^{ind} the political ruler exogenously decides whether he wants to induce his agent to engage in innovation or imitation, by setting intellectual property rights accordingly.

Strong intellectual property rights are, as outlined above, are the result of unconscious innovation policies. On the contrary, a ruler who is interested in conscious innovation has no need to set intellectual property rights high. Different innovation policies are therefore expressed in different strengths of π.



Source: Author's own creation

Figure 3 **Choice over Innovation Policy through Different Strengths of Intellectual Property Rights**

Therefore, in accordance with the previously defined terms of unconscious and conscious innovation, deviations above π^{ind} are referred to as π^{uncon} and below π^{con}, promoting innovation and imitation respectively. Any upward or downward deviation from π^{ind} will, result in the agent being induced to either innovate or imitate technology.

imitate	*innovate*
$\pi^{ind} \geq \pi^{con}$	$\pi^{ind} \geq 1 - \pi^{uncon}$

The table above shows how π^{ind} can be expressed in terms of π^{uncon} or π^{con} given the chosen innovation policy. These policy decisions over the strength of π can then be inserted into the technology decision by the agent. This will show how different strengths of π impact and shift the resulting technology prevalent in the economy. First unconscious innovation is introduced to the agents optimal technology decision over ϕ and θ. Therefore,

$$if\ \pi^{uncon} > \pi^{ind}:$$

$$\phi_2^*(\pi^{uncon}) > \theta_2^*(\pi^{uncon})$$

$$\left(\frac{c_i^1}{c_i^2} a\delta(1-\tau)(1-\pi^{uncon})\lambda\right)^{\frac{1}{1-\lambda}} > \left(\frac{c_i^1}{c_i^2}(1-q)\delta(1-\tau)\pi^{uncon}\lambda\right)^{\frac{1}{1-\lambda}}$$

Here we can see that in order to attain higher levels of innovation through π^{uncon} the ruler has to provide an environment with a sufficiently large success of innovations. Decreasing the risk of failure for new technologies to succeed can be achieved by setting up the necessary infrastructure, rule of law, and educational system. The subsidies towards imitations w are held constant. These are factors, which are finally expressed in strong π^{uncon}. The model shows, that setting up π^{uncon} is directly connected to creating a favorable environment. If intellectual property rights are set upwards, without providing the necessary infrastructure then the policy decision is unsustainable. On the other hand, imitations are clearly discouraged by an increase in intellectual property rights.

Let us reiterate that the model is able to show that through high intellectual property rights, based on unconscious innovation policies, the resulting technology within the economy is shifted towards innovation. The model gives an insight into how property rights can be chosen for their intended purpose. Reasons for why a ruler might be interested in innovation have been outlined above, but not expressed in the model. The thesis set out with the claim that democracies will foster innovations. This claim will now be tested in the empirical analysis, looking at whether democracies will more often incentivize their citizens towards innovation, either directly or through innovation inductive strong intellectual property rights.

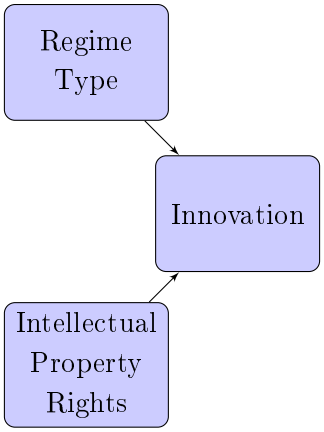
4 Empirical Analysis

The empirical portion of the thesis is set up to provide support for the model as well as further evidence on the relationship between intellectual property rights and innovation. Previously the model established that differences in innovation policies, resulting in different strengths of intellectual property rights, have a clear impact on innovation. Unconscious innovation, given the assumptions made, was shown to lead to increased innovation while conscious innovation instead promoted the imitation of already existing technologies. However, the model did not clearly

establish whether conscious and unconscious innovation policies are more likely to be favored in democracies or autocracies. The thesis aims to empirically establish the interplay between regime type and preferred innovation policies and if different policies can be linked to different outcomes of innovation.

4.1 Empirical Identification Strategy

The empirical strategy relies on two steps. First of all the relationship between intellectual property rights and innovations is investigated. This is done by examining the impact of intellectual property rights and regime type on patent applications of a nation. To increase the robustness and internal validity of the results an instrumental variable (IV) approach is used. The main findings are that intellectual property rights have a significant positive impact on patent applications in a nation, but the same cannot be said for regime type which becomes insignificant as controls are added to the regression.



Source: Author's own creation

Figure 4 **Strategy I: Influence of Regime Type and Intellectual Property Rights on Innovation**

The next step is to establish the relationship between political regime type and protection of intellectual property rights. It is of interest to see whether regime type could influence innovations through creating different intellectual property rights environments. Here nations that transition from autocracy to democracy are compared to nations that stay autocracies. The thesis makes use of a difference in difference method where the comparison between treatment and control is weighted by propensity score matching.

Source: Author's own creation

Figure 5 **Strategy II: Influence of Regime Type on Intellectual Property Rights**

4.1.1 Intellectual Property Rights, Regime Type and Innovation

The first estimations to find support for the implications of the theoretical model are computed through use of OLS regressions. This approach is then elaborated upon with a more complicated identification strategy. Since the dataset contains multiple observations for the same entity spread out over time, pooled OLS is used. The dataset is for the macro level and this results in a lower number of observations than if it had been micro level data. Pooled OLS allows for the incorporation of more observations while maintaining the macro nature of the data. The relationship of interest can be described as:

$$\begin{aligned} PatentApplications &= \beta_0 + \beta_1 IntellectualPropertyRights + \beta_2 PoliticalRegimeType + \beta_3 X_i \\ &\quad + \beta_4 RegionDummies + \beta_5 TimeDummies + u_i \end{aligned}$$

where X_i stands for a matrix of control variables that are likely correlated with intellectual property rights, political regime and patent applications. An example of a variable that should be a part of the matrix is GDP per capita. It can be argued that it has an effect on intellectual property rights level in that more developed nations, i.e. those with higher GDP per capita, in general tend to have higher intellectual property rights. More GDP per capita also implies more resources in the economy which can be used to fund research projects leading to an increase in patent applications.

Furthermore, two categories of dummies are included, region dummies and time dummies. Different regions of the world have different resource allocations and different comparative advantages. Some could be more predisposed to innovative behavior than others. The effect of regional differences is controlled for by including dummy variables corresponding to the major continents (Africa, Asia, Central America, South America and North America) that are represented in the sample of nations. Time dummies are incorporated to control for time fixed effects.

The variables of interest in the estimation are intellectual property rights and political regime type. From the model of innovation behavior it can be inferred that intellectual property rights play a major role in the creation of an institutional setting that causes citizens to want to innovate. The goal of the estimation process is to start out simple with just the effect of political regime and intellectual property rights on patent applications and then extend the estimation by including additional controls. Doing it this way there is the potential to see if political regime type appears to have a significant influence on the creation of new patents and what happens to that influence as more controls are added. Nevertheless, the regression as described above will not lead to conclusive and credible results. It is highly likely that it will be biased in some fashion. Because of this the regression is extend to include the use of an instrumental variable approach (2SLS). The main benefit of this method is that it helps to precisely identify the impact of intellectual property rights on innovations. Practical use of instrumental variable approaches are limited by the need to find an instrument that only impacts the dependent variable through its influence on the independent variable to be instrumented. We suggest that settler mortality, previously used to instrument for expropriation risk (Acemoglu et al. 2001), can be used as an instrument also for intellectual property rights. If certain factors, such as expropriation risk, are controlled for settler mortality will prove to both have an influence on intellectual property rights

of a nation and through that channel be able to affect the amount of patent applications. One disadvantage of employing settler mortality as a dummy is that there is no time series variation in it. Hence the time dimension of the dataset is lost, which leads to less variation in the first stage. The following first stage is obtained in the 2SLS approach:

$$\begin{aligned} Intellectual\widehat{Property}Rights &= \gamma_0 + \gamma_1 SettlerMortality + \gamma_2 PoliticalRegimeType + \gamma_3 X_i \\ &\quad + \gamma_4 RegionDummies + \gamma_5 TimeDummies + v_i \end{aligned}$$

From the first stage an estimation of intellectual property rights, given settler mortality and the other control variables, is obtained. This estimation takes the place of the observed value for intellectual property rights in the second stage.

$$\begin{aligned} PatentApplications &= \beta_0 + \beta_1 Intellectual\widehat{Property}Rights + \beta_2 PoliticalRegimeType + \beta_3 X_i \\ &\quad + \beta_4 RegionDummies + \beta_5 TimeDummies + u_i \end{aligned}$$

The benefit of the IV-approach is that if settler mortality, given the controls, is uncorrelated with u_i then the predicted estimate of intellectual property rights will also have this property and the estimated impact, β_1, will be without omitted variable bias. However, it is also important that settler mortality explains a sufficient amount of the variation in intellectual property rights for the results to have meaning. If settler mortality has little power of prediction when it comes to intellectual property rights, meaning low correlation between settler mortality and intellectual property rights, the estimated impact of changes in intellectual property rights between different samples can differ by a lot (Angrist and Pischke 2009, p. 117). If the correlation between settler mortality and intellectual property rights is small even a very weak relationship between settler mortality and the error term can cause major changes in the estimate for β_1 (Baker et al. 1995).To establish if the first stage is strong or not common practice in research is to look at the F-statistic, testing the hypothesis that the first stage has no explanatory power for the variation in the variable to be instrumented, of the first stage. If said F-statistic is above 10 the instrument is deemed to be strong enough (Staiger and Stock 1997, p.1). A discussion on the validity of our chosen instrument will be given in section 4.3.

4.1.2 Regime Type and Influence on Intellectual Property Protection

To investigate the potential link between regime type and intellectual property protection this thesis will exploit the panel nature of the data gathered. The method employed is very reminiscent of the approach employed in Persson and Tabellini (2007). The authors of that paper use a combination of difference in difference estimation and propensity score matching to look at the effect of transitioning in and out of democracy and autocracy on economic growth. This thesis will also look at the effect of transitioning from autocracy to democracy, but differs from Persson and Tabelini in that it looks at the effect transitions have on the level of intellectual property rights. By focusing on nations that are just making the transition it is more likely that the effect of the regime type can be isolated and estimated.

The difference in difference with propensity score matching method, like the IV2SLS-method, is split up into two distinct phases. First the probabilities of transitioning from autocracy to democracy for the sample of nations is estimated to obtain the different propensity scores. Secondly treated countries are matched with control countries that have similar propensity scores and the weighted difference in difference is computed, with the weights being determined by the propensity scores. This approach gives insight into the impact of transitions on intellectual property rights and compares it to the outcome for the nations that did not transition. Difference in difference with propensity score matching is an attempt to simulate the gold standard of econometrics of having access to both outcomes for the same individual.

To determine if a nation is an autocracy, a democracy or a transitioning nation the thesis make use of index scores. Based on movements in the index countries are assigned to either the treatment group or the control group. The treatment group in the estimation will be countries that have experienced a transition from autocracy to democracy while the control group are countries that have remained autocracies throughout the entire sample period. The years under investigation are 1960-2000. The intellectual property rights index is only computed for every fifth year starting in 1960, which means the data is in intervals of five years. 2000 is used as the last years because it leads to an adequate amount of both treated countries and control countries for matching to be meaningful. The exact steps taken to obtain the estimated impact follows those outlined in Persson and Tabelini (2007, pp. 10-11):

1. Since the variable of interest, when it comes to computing the propensity score, is binary, either a country transitions or it remains an autocracy, a logit regression is used. The transition variable takes the value 1 if the country experiences a transition into democracy at any point in the sample and 0 if it remains an autocracy from 1960-2000. Similar to Persson and Tabelini (2007) all control variables are time invariant. From this regression a probability of transitioning into democracy is obtained and that is what will be used to match treated to control countries at a later stage.

2. The next step is to compute the average score of the intellectual property rights index before and after the transition and calculate the difference for the treated countries. Ideally the average will be constructed from 3 observations, meaning a 15 year time span, of the intellectual property rights index. In some cases, for example if a country transitions in 1970, this is not possible and then the observations that are available are used. It is also the case for some nations that they start out in democracy, transition into autocracy and then transition back into democracy. Their averages do not include the first period spent in democracy. The measure takes the following shape

$$\triangle\text{IPR-index}_i = \frac{1}{N_i^a}\Sigma_{t>T_i}^{T_i+3} IPR_{i,t} - \frac{1}{N_i^b}\Sigma_{T_i-3}^{t<T_i} IPR_{i,t}$$

   where $IPR_{i,t}$ represent the intellectual property rights score for a certain point in time, T_i is the break date for country i and N_i^b and N_i^a the number of years for which observations are available before and after the break (normally 3).

3. Subsequently the above steps are repeated for the autocracies in the sample. Since the autocracies will be used as controls for all treatment countries the average is computed for

all different break dates of the treated countries. This facilitates subsequent steps where matching takes place. The resulting averages are denoted $\triangle$IPR-index$_i{}^c$ to differentiate them from the differences associated with the treatment countries.

4. At this stage there is enough data to compute the average difference in difference estimate. The difference for the treated country has the weighted differences for the control countries subtracted from it, using the timings of the break for the transitioning country to determine which control average is used. Control countries can and will be reused for more than one transitioning nation. Using the propensity scores from step 1 the differences for controls are weighted to create an average difference that is then what is subtracted from the difference for the treatment country.

$$\hat{\alpha_i} = \triangle IPR_{i,t} - \Sigma_c w_{i,c} \triangle IPR^c_{i,t}$$

The variable $w_{i,c}$ is the weight placed upon the individual control countries observations by the propensity score matching. For the matching an Epanechnikov kernel is used. This kernel has the benefit that it assigns more weight to observations that have propensity scores that are similar to the treatment country's. The bandwidth used is 0.1 which leads to only observations within a 50% span of the treatment country's propensity score being used (Vinha 2006, pp. 14-15). The, per treatment country, estimated effect of transitioning into democracy is labeled as $\hat{\alpha_i}$.

5. Naturally the next step is to add up all the $\hat{\alpha_i}$ and then average out their effects on the treated nations. This will give the average effect of transitioning into democracy:

$$\hat{\alpha} = \frac{1}{I} \Sigma_i \hat{\alpha_i}$$

I stands for the number of treated countries in the sample and $\hat{\alpha}$ is the average treatment effect of transitioning into a democracy from autocracy.

6. After having obtained an estimate of the impact of transitioning, the next step is to compute the variance for purpose of interpreting the significance of the results. The formula for the estimation of the variance is taken from the appendix of Persson and Tabelini (2007). To be able to compute the variance simplifying assumptions are made. First of all it is assumed that the treated countries all share the same variance and that the same is true for the control countries. Furthermore the weights used in the comparison of the treatment and control groups are computed in the first stage of the logit regression. This means that they are endogenous. We disregard this in the computation of the variance. According to Persson and Tabelini (2007) these assumptions are standard in this type of setting (see for example Lechner 1999). First we compute the variance for the case when the outcomes for the control countries are not correlated depending on the treatment country (for example $\triangle IPR^c_{i,t}$ and $\triangle IPR^c_{j,t}$). This will be the lower bound estimation of the variance. Additionally the variance is computed for the case when there is perfect correlation for observations drawn from the same control country but no correlation between different control countries'

observations. This estimated variance serves the role of an upper bound estimation of the variance.

$$Var_{LB}(\hat{\alpha}) = \frac{\sigma_T^2}{I} + \sigma_C^2 \frac{\Sigma_i \Sigma_j (w_{i,j})^2}{I^2}$$
$$Var_{UB}(\hat{\alpha}) = \frac{\sigma_T^2}{I} + \sigma_C^2 \frac{\Sigma_j (\Sigma_i w_{i,j})^2}{I^2}$$

There are issues that have to be confronted when creating these estimations. The main concern with employing this method in a macroeconomic setting is that there is a trade off in the estimation of the probability of transition. To be able to match there needs to be common support between the treatment and control group. Meaning, for example, if the probabilities of transitions taking place in the nations that do have transitions are all above 75%, while the probabilities for those nations that do not experience any transition are below 25%, matching is not credible. It is important that the propensity score estimated is valid so that it can credibly be claimed that countries with similar propensity scores are similar in their factors, with the major distinction being that some experiencing transition and some not, but it cannot predict transitions too well (Persson and Tabelini 2007, p. 16). By and large this paper tries to match the first stage logit regression of Persson and Tabelini (2007). Both papers are interested in the probability of a transition to democracy taking place and the difference appears in what said transition is supposed to have an effect on.

4.2 Data Description and Specifications

Data has been compiled from a variety of different sources. What follows is a detailed look at the data that is of most importance to our estimations and a cursory look and description of the variables used as controls. Patent applications, the Gianrte-Park intellectual property index, the Polity2 index and settler mortality each have a separate part in the section. The general control variables are discussed jointly.

WIPO Patent Applications for Innovations

This thesis uses patent applications as a proxy for the innovation level, since they represent innovations that are thought to be complete enough to warrant protection. Another potential proxy would be research and development expenditures, but it only covers the amount of resources spent on innovative processes and not the eventual outcome of the processes. Patent applications are more in line with the goal of the thesis, which is to find what fosters a successful innovative society not what leads to people allocating more resources to innovation. The data on patent applications is obtained from the World Intellectual Property Organization's (WIPO) statistics database. The variable used is patent applications per million citizens. This is a way to normalize the patent application statistics between nations of different sizes and make the outcomes comparable. Data is available for the years 1980-2013 and the index for intellectual property rights, only goes to 2005 resulting in a sample period of 1980-2005 for the IV-estimation.

While assembling the data it was noted that a large number of nations had spells of missing data in regards to their patent applications. Estimating the mean of the political regime indexes while removing nations with missing data could provide a clue if there is a pattern in which nations fail to report patent statistics.

	All Nations	Dropping Missing Years	Dropping Nations with Missing Years
	Mean (SD)	Mean (SD)	Mean (SD)
Polity2	2.382304	5.536184	6.850829
	(7.147216)	(6.2573)	(5.624832)
Freedom House	3.530744	2.528662	1.962567
	(2.159715)	(1.816012)	(1.521774)
Observations	618	314	187

Table 1 **Comparison of mean values for the indicators of political regime type before and after dropping missing observations**

Comparing the mean values for the Freedom House political rights index and the Polity2 score of political regime type before and after eliminating nations that have missing values for patent applications shows that nations with bad political rights or autocratic regimes tend to be the ones not to report their patent applications as stringently as nations with good political rights. As can be seen the amount of observations also decreases substantially when nations with missing values for patent applications are dropped. When all nations that have at least one missing observation are removed from the sample over 50% of the remaining sample score perfectly in political rights or as democracies when it comes to Freedom House and Polity2 score. When only the missing observations in and of themselves are removed the sample is more spread out and hence this option is employed in the estimations. This is also necessary to create more variation in the first stage of the instrumental variable regression. When all nations with a missing observation are dropped only 12 remain for the IV estimation. When only the missing years themselves are dropped there are 39 potential nations with both settler mortality data and patents applications statistics.

The Ginarte-Park Index of Intellectual Property Rights

The level of intellectual property rights is approximated by an index originally developed by Ginarte and Park (1997) and then extended by Park (2008) to cover a longer time period. The original paper creates a quinquennial index for the period 1960-1990 for 110 countries and the extension covers 1995-2005 and increases the total to 122 countries. 103 of the nations that are in Ginarte and Park (1997) are included here.

The index is an aggregation of five different subareas. First the authors look at how wide the coverage is for patent rights, meaning what type of innovations are patentable. Some countries might for example not allow patents in the pharmaceutical sector or other key industries. Membership in international agreements about patent rights is also weighed in. This shows to what extent patent protection is equal for citizens and international actors. Third Ginarte and Park

look at what causes a loss of protection. In some nations under certain circumstances patent protection can be lost. For example when an actor does not exert his patent by creating and selling the goods he has patented, he might forfeit patent protection. Since patent rights don't matter if they are not enforced, they also use enforcement of protection as a part of the index. The enforcement category deals with the options open to someone that thinks his or her patent is being violated. The final category is duration of protection. Countries that provide 20 years or more of protection are scored the highest in this category.

They score each category separately and then sum them all up, without any weighting, to get the index score, maximum of 5 and minimum of 0. The index is robust to different ways of construction, through different weightings (Ginarte and Park 1997, pp. 288-289). The fact that the index takes such a wide variety of indicators for intellectual property rights into consideration is beneficial to this thesis. All the categories that are scored can potentially be influenced, if not determined, by the government of the nation. This makes the index very suitable for testing the interaction between patent applications, intellectual property rights and regime type.

Polity 2 Index for Regime Type

To measure political regime type the Polity2 index from the PolityVI dataset is used. This index is non-binary meaning that different degrees of democracies and autocracies are included. This is represented on a scale from -10 to 10 where anything below 0 is considered to be an autocracy and anything above 0 a democracy. The similar Freedom House index has been criticized for being potentially biased towards the US and it's allies during the 1970s and 1980s (Steiner 2012), which is why it is not used in the empirical analysis. Similar claims have not been made for the Polity2 index to the best of our knowledge.

Settler Mortality

Of utmost importance for the IV estimation is the instrument that is used, settler mortality. The settler mortality data is originally from a seminal paper by Acemoglu, Johnson and Robinson (2001) where they investigate the effect of physical property rights on income levels.

To estimate settler mortality rates the authors used mortality rates for European troops in the colonies. The Spanish and Portuguese military did not keep as good records as the other Europeans so for Latin America they used Vatican records of mortality rates for bishops (Acemoglu et al. 2001, pp. 1382-1383). In a strike of good fortune there is an overlap between the colonies for which Acemoglu, Johnson and Robinson estimated settler mortality rates and the nations that Ginarte and Park created their intellectual property rights index for. 57 nations in total are present in both the Ginarte Park index and the settler mortality dataset. Among those 57 nations there is a wide variety of different outcomes. The mean of the Polity2 index when all nations with settler mortality data are included is around 1.8 which is close to the cutoff point between democracy and autocracy. When the the years where patent applications are not observed are removed the mean moves towards democracy, becoming 4.6. The spread however is between -9 and 10 meaning that all political regime types are represented. It is troubling that once these years have been removed the overall amount of nations left for the first stage of the instrumental variable regression is only 36 (some nations have missing data for the control variables as well). This is problematic since settler mortality is not time varying, meaning that even if the pooled OLS approach to the IV has 152 observations the meaningful variation in the first stage will only

be across these 36 nations.

	All		
	Mean	SD	Observations
Polity2	1.794643	6.72017	336
GP-Index	2.170616	.9996256	342
Patent Applications	47.66667	114.7478	162
	Dropping when patent is not observed		
Polity2	4.620253	5.921576	158
GP-Index	2.429447	1.124858	162
Patent Applications	47.66667	114.7478	162

Figure 6 **Summary statistics for nations where settler mortality data is available**

The settler mortality data created by Acemoglu Johnson and Robinson has received some criticism. Albouy (2004) argues that the original dataset, as compiled by Acemoglu, Johnson and Robinson, suffers from problems of imprecision due to how the data had to be estimated. Acemoglu Johnson and Robinson (2005) discard this criticism, stating that Albouy drew his conclusion on the basis of faulty estimations.

Control Variables

In regards to control variables the majority are obtained from the World Bank's development indicators. One concern is the level of development for nations. Originally, the settler mortality data was used to instrument for protection against expropriation and it was shown that through this channel it had a positive effect on income levels (Acemoglu et al. 2001). It it plausible that low settler mortality could be correlated with more developed nations. These nations tend to innovate to a greater degree. To control for development GDP per capita is used. This way of controlling is taken from Chen and Puttitanun (2005). GDP per capita in current US dollars is taken from the World Bank's world development indicators. Barring Myanmar, Iraq, Haiti and Somalia all nations have a continuous set of observation for GDP per capita from at least 1985 and forward.

Additionally for the IV-estimation education is included. Previous studies have indicated that education has historically played a significant role in the creation of a favorable environment for innovation (Feldman 1994, Jaffe 1989, Cowan and Zinovyeva 2013). Because of this a control for tertiary education is incorporated in the regression. The World Bank development indicators provide the Barro-Lee dataset for education. It contains data on the percentage of the population, age 15 and above, with tertiary schooling. The variable shows how widespread higher education is in the country which can serve as a good proxy for the presence of successful tertiary educational institutes.

Brouwer (2006) points out an interesting historical relationship between being open to international trade and being innovative. Those nations that were open to trade had better access to the accumulated knowledge and technology stock of the world which enhanced their citizens' capability for innovation. Because of this trade openness is included amongst the controls. It is

measured as the amount of trade to GDP in percentage terms. This data is also from the World Bank's world development indicators where it is labeled Trade(% of GDP).

Investment into innovation is often done for future benefit, it is very rare to see an innovation that pays off in the same period as the investment is made. This leads us to believe that the stability of the political regime can influence the amount of patent applications by citizens. A new regime or a generally unstable political environment could potentially lead to unrest, with new rules and regulations, which would change the net present value of the citizen's investment into innovative behavior, making it more risky. In the theoretical model of innovation riskiness of innovation investments played a role in how agents allocated their resources. Therefore the occurrence of coups in recent years is controlled for. This data is obtained from the Center for Systemic Peace's data-list "Coups d'Etat, 1946-2013." For coding purposes the control is included as a dummy variable. If there was a coup in either of the five years preceding the year of interest it is coded as a 1 otherwise it is a 0. When it comes to coups only those coded as 1 and 2 in the data-list, referring to successful coups and attempted but failed coups, are included. Plotted coups and allegedly plotted coups are disregarded.

As an additional step after the first IV-regression has been run, an additional one is run extended to incorporate physical property rights. The settler mortality data was originally used to estimate the effect of protection against expropriation, thus making this extension to the IV-regression important to validate the robustness of the findings. The source of the physical property rights protection index is the property rights portion of the Heritage Foundation's Index of Economic Freedom. Unfortunately this index is only available as far back as 1995 meaning that half of the sample is lost when it is included.

The logit regression, that is run to obtain the propensity scores for the matching in the difference in difference estimation, makes use of slightly different controls than the IV-estimation. Time-invariant controls are used similar to Person and Tabelini (2007, p. 10). When using the difference in difference approach we assume that countries are equally affected by time-varying shocks. Further it is assumed that if no transition took place the countries in the treatment and in the control group would experience the same level of change in their intellectual property rights. To make this assumption more credible the probabilities of transition is determined using using time-invariant factors. Countries that share similar characteristics are more likely to react in a similar manner to time-varying shocks, hence they will be matched together when it comes to the difference in difference estimation. While countries that are very dissimilar will not be matched at all in the difference in difference stage.

The same source for GDP per capita is used and the observation of interests is GDP per capita in the year the nation achieves independence or 1960 if independence was achieved earlier. GDP per capita is modified by dividing it with the year of interest's GDP per capita in the USA. This is done since several nations achieve their independence at later dates. For example Angola does not enter the sample until 1975.

The amount of years that the nation has been a part of the sample is controlled for. For those nations that have been a part of the entire sample (1960-2000) this score is 41. Persson and Tabelini (2007, p. 17) suggest that political history could play an important role in whether the nation transitions or not. Nations with a history of democracy are more likely to return to it, than those that have a long tradition of autocracy. The estimation includes political history in the form of democracy capital, a score compiled over the years 1900 to 1960. For every year

the Polity2 index is above 0, 1 is added to the score, for every year it is below or equal to 0, 1 is subtracted and from this the political history score is computed. Finally the amount of years the country has been involved as the primary part of an armed conflict between 1960-2000 is included. This data comes from the "UCDP/PRIO Armed Conflict Dataset." An armed conflict is counted as taking place if there are arms involved and there are at least 25 battle related fatalities (UCDP/PRIO 2014, p.2).

A central part of the difference in difference with propensity score matching is to determine which nations transition and which are to remain as controls. This is done through looking at breaks in the Polity2 index. It is fortunate that most clean breaks in the index are centered around 0. Rarely do we see a nation going from -1 to $+1$. It is more common to see a substantial movement such as Argentina going from -9 in 1980 to $+8$ in 1985. A transition in this thesis will be said to take place when a nation crosses the threshold of 0. For the transition to be counted it has to last over 5 years. If it does not, that observation is disregarded and we continue as if the transition did not take place. The reason being that changing the institutional framework, for example by promoting intellectual property rights, is a process that takes time and if the new political regime type does not prove lasting it is unlikely that it has been able to have any lasting influence on these types of policy. Out of the sample of nations included in the intellectual property rights index the most common transition is that from autocracy to democracy. The only nation to make a lasting transition into autocracy is Zimbabwe. Thus the thesis only look at transitions into democracy and their effects on intellectual property rights protection. There exists a problem in that some nations transition into democracy more than one time throughout the sample, for example Nigeria. These nations are eliminated from the overall sample as to not make the process more complicated than necessary. Overall it is rather uncommon phenomenon.

4.3 Validity of Instrument: Settler Mortality and Intellectual Property Rights

The original paper by Acemoglu Johnson and Robinson links settler mortality to current economic performance by arguing that European settlers implemented different types of colonization policies in different nations. These different strategies led to the creation of different institutional frameworks depending on which strategy was employed. Some colonies were set up for migration purposes and some for extraction of resources (Acemoglu et al. 2001, p. 1370). Acemoglu, Johnson and Robinson argue that the choice of colonization strategy was influenced by the feasibility of settlement. The crux of their argument is that the institutional framework established in colonial times persisted even post independence and has an effect on the institutional framework of today. Colonies where the Europeans settled with time became more and more like their original nations. The settlers enjoyed an institutional framework that helped them achieve their goals of individual freedom and the ability to get rich if one applied oneself. If these rights were not granted the settlers were willing to fight for them (Acemoglu et al. 2001, pp. 1374-1375).

Acemoglu, Johnson and Robinson looked at the effects of institutions, which to them meant protection against expropriation, on income levels. This thesis seeks to evaluate the effects of intellectual property rights on patent applications and through that make a statement about what can be expected to influence the propensity for innovation in nations. It is not immediately obvious that the same type of reasoning as in Acemoglu, Johnson and Robinson (2001) on the

effect of settler mortality on intellectual property rights can be applied. There exist fundamental differences between intellectual property protection and protection from expropriation. Intellectual property rights protect mostly against the actions of competitors, by providing protection against imitation. Protection against expropriation is more concerned with protecting the citizens against a predatory state. Theoretically expropriation could take place in both regime types only with different groups being the victims and beneficiaries. It seems unlikely that the early settlers were very concerned with the need for protection of intellectual rights and more concerned with limiting the predatory nature of the state.

We would argue that what settlers brought with them to the colonies were not only institutions that protected private property from expropriation but rather an institutional framework common with that of their nation of origin. Historically institutions have been shown to be path dependent, so that nations that share a common institutional framework and history are likely to develop similar institutions in the future (North 1991, pp. 108-111). The intellectual property rights protection in modern times is strong in Europe.

Looking at Park (2008) and his averages for patent rights protection, between 1960-1990, seven out of the eight nations with an average score over 3 are European (the only exception is the United States). It would seem that the institutional framework that has evolved in Europe puts weight on protection of intellectual rights. Being settled by a European nation should then bring with it the benefits of a sound early institutional framework and being on the same path to developing the institutional framework as those that stayed behind in the homeland. North (1991) mentions that at the time the British (one of the European in the top 8 of average scores) settled the new world, the home country was undergoing political turmoil with the influence of parliament increasing at the expense of the king, leading to sounder overall institutions for the promotion of individual efforts, for example secure property rights and land tenure. Spain (not one of the 7 European countries with an average score above 3) on the other hand conquered Latin America at time of decreased parliamentary power in the home country. Control over Spain transitioned to a central bureaucratic system.

In both of these cases the settlers brought their experiences and institutions with them to the new world and the colonies have continued to evolve along the same institutional path as their colonizer, especially if they were settled. The makers of the patent rights index that we utilize, Ginarte and Park, mention that African nations in general score higher when it comes to patent rights than what would be expected of developing nations. They attribute this to the African nations former colonial ties to Britain and France. Large sections of their patent legislation is taken from the colonizing country. This causes them to stand out when compared to other developing nations (Ginarte and Park 1997, p. 291). For example take Algeria with its close ties to France. From 1960-1975 the index value for Algeria is above that of Sweden. On the other hand there is for example Congo in Africa whom suffered under the ruthless exploitation and extraction of Belgium or the Latin American giants Argentina and Brazil whom are outperformed in patent rights by for example both Algeria (colony of France) and Nigeria (colony of Britain).

We agree with the hypothesis that settler mortality affected the settlement strategy decision made by early European settlers. Further we conclude that these settlers brought with them an institutional framework and history that put them on the same path as their European countries of origin when it comes to institutional evolution.

4.4 Outcome

The first results to be presented are are those from the estimation investigating the impact of intellectual property rights and regime type on innovation (figure 7). Since the results confirm the importance of intellectual property rights, the deeper investigation into regime type's effect on intellectual property rights is warranted.

	(1)	(2)	(3)	(4)
	Naive	Pooled OLS	IV-AJR	IV with Physical
VARIABLES	Log Patent	Log Patent	Log Patent	Log Patent
GP-index	1.127***	0.722***	2.875**	3.259*
	(0.0728)	(0.132)	(1.177)	(1.786)
Polity2	0.0705***	0.0233	-0.0556	-0.107
	(0.0143)	(0.0169)	(0.0508)	(0.109)
GDP per Capita		7.85e-05***	4.82e-05	7.87e-05
		(1.20e-05)	(5.03e-05)	(5.24e-05)
Tertiary Education		0.0702***	-0.0382	-0.0668
		(0.0270)	(0.0635)	(0.0990)
Trade Openness		-0.00375**	-0.00568	-0.00593
		(0.00151)	(0.00385)	(0.00777)
Coup d'Etat		-0.326	0.547	0.795
		(0.261)	(0.566)	(1.026)
Physical Property Rights				-0.354
				(0.320)
Constant	-0.522***	1.490**	-1.148	-2.255
	(0.194)	(0.605)	(2.320)	(2.517)
Continent Dummies	No	Yes	Yes	Yes
Time Dummies	No	Yes	Yes	Yes (95-05)
Observations	304	295	152	80
Number of Nations	-	-	36	34
F-score of First Stage	-	-	34.01	14.72
R-squared	0.478	0.728	0.083	-

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 7 **The impact of intellectual property rights and the diminishing effect of political regime type**

In the naive approach with only the GP-index for intellectual property rights and the Polity2 index both variables appear significant and their influence is in the correct direction. More democratic societies have more patent applications and societies with stronger intellectual property

protection can also be expected to have more patent applications (regression 1). As all control variables are added the significance of of both variables decrease, but the GP-index remains significant at the 1% level while the Polity2 index loses its significance at conventional levels (regression 2). The subsequent two regressions (3 and 4) are two different specifications both employing the instrumental variable approach. The main difference is that the latter controls for protection of physical property rights and hence the sample period is restricted to the years 1995-2005. In both cases the F-statistic is above the proposed cutoff value of 10 (Staiger and Stock 1997, p.1) and the log of settler mortality remains significant for explaining the score of the GP-index at conventional levels (for detail on the first stage see appendix B.2). The significance of the GP-index decreases when utilizing IV. It is significant at the 5% level in regression 3 and at the 7 % level in regression 4. The estimated impact of intellectual property right increases. If the GP-index is increased by one unit we expect to see an increase in patent applications by about 300%. This sounds like a lot, but one should consider that the spread for patent applications is quite large. In regression 4 the smallest observation is 1 application and the largest is 703 applications, with a standard deviation of 130 applications. So overall the estimated impact is not inconceivably large. Most importantly increased intellectual property rights, even when controlling for physical property rights, causes more patents to be applied for in the sample. This lends credence to the idea that intellectual property rights are important for the creation of a functioning innovative environment.

Since political regime did not seem to influence patent applications, after controls had been added to the regression, the next step is to investigate if it could have an impact through the creation of intellectual property rights protection. Looking at nations that have recently transitioned into a new political system seems appropriate in that it allows for estimations of what happens when one factor changes an others are held fairly constant. The matching method also allows for the grouping of treated countries with control countries that share similar characteristics as them. The first step is to predict the probability of a nation being one of those that transitions which will be used to match it to similarly scoring nations in the second step. There are 23 nations that remain autocracies and 40 that transition into democracy in the sample (for a detailed list see appendix B.3).

A simple logit regression is used to predict the probability of transition for all nations (for the results see appendix B.4). There is good overlap between the nations that do transition and those that do not, meaning that there is common support and matching can credibly take place.

Sample part	25th percentile	50th percentile	75th percentile
Transition nations	0.56	0.72	0.83
Autocracies	0.43	0.51	0.67

Figure 8 **Probability of transitioning for different percentiles of the treatment and control group**

The next step is done manually due to the complication of having different transition dates for the different nations in the sample. The results are:

Effect of Transitioning	0.1135
Lower Bound Estimate of the Variance	0.0071
Upper Bound Estimate of the Variance	0.0175

Figure 9 **Outcome of the difference in difference estimation with propensity score matching**

The outcome of transitioning is an increase in average intellectual property rights in the subsequent 15 years compared to the nations that stayed autocracies. The variances have been computed according to the formula from Persson and Tabelini (2007). It is assumed that the variance for the treatment and control group is the same inside the group. This variance is then used to compute the overall variance of the estimation. The variance for the treatment group, σ_T^2, is estimated as the variance of the differences between average GP-scores before and after treatment for the transitioning nations, while the variance for the control, σ_C^2, is computed as the variance of all the differences for the autocracies counting all potential transition dates equally. The weighting is then differently incorporated for the upper and lower bound estimations of the variance.

Even though the nature of the method used and the macro nature of the data leads to relatively few observations significance is still maintained for the results at conventional levels. Most importantly the treatment effect is positive. This indicates that democratic nations sets up a better framework for the promotion of unconscious innovation by promoting intellectual property rights. These results can be related to those of the IV-estimation. The average effect of a transition is an increase in intellectual property rights of 0.11. The IV-estimate was a 300% increase in patent application for a one unit increase of intellectual property rights. The estimated impact of a transition into democracy is an increase in patent application by about 30% from the resulting increase of intellectual property rights.

5 Results and Analysis

So, let us recall the quote that opened the thesis made by the president of the USA, Mr. Barack Obama. He stated that being a democracy and delivering freedom to its citizens is the foundation of innovations. The thesis has gone to some lengths to evaluate the substance of the statement and the evidence found only partially agrees.

The findings suggest that being a democracy does not directly lead to the creation of innovations, providing the right intellectual property framework does. This claim is supported by the initial estimations shown in figure 7 where intellectual property rights are shown to have a significant positive impact on innovations. In regards to the first of the research questions we can state that the institution of intellectual property right protection and the applied innovation policy are keys to increasing innovation activity.

But we can give the president of the US the benefit of the doubt and shine a different light on his comment in regards to the interrelation between democracy, freedom and innovation. On a

conceptual level, Mr. Obama spoke of democracy being a safeguard of freedom. A freedom that democratic nations, especially the US, have been trying to spread to other nations. Motivations for trying to spread the democratic regime type are manifold, be it the deterrence of opposing regime types such as communistic states or the establishment of democratic peace, which supposes that armed disputes do not occur between democratic nations (Russet 1993).

However, these are notions coined to address international relations rather than a nation's economy or its technologies. The expression of democratic freedom that the thesis is interested in lies in its influence on economic choices. It is the freedom from arbitrary expropriation and reallocation, through free and unconstrained choice over the allocation of ones efforts and the subsequent capture of its spoils. Following this reasoning it can be constituted that the protection of intellectual property is a safeguard of innovation, since it has a direct positive impact on the technology decision towards innovative technologies as shown in the model. In consequence intellectual property rights have been equated as an expression of freedom. Of course, this is an interpretation of the President's words, which is in line with the established term of unconscious innovation. Equal citizens, free from coercion, taking a bottom-up innovation approach, are the fundament of the previously defined term of unconscious innovation.

With this in mind we return to the second of the research questions, asking whether regime type has an impact on intellectual property rights. Firstly, the theoretical model gave insight into how the right level of protection can be considered; by increasing the strength of intellectual property rights through the creation of a favorable environment to innovations. Shifts of intellectual property rights imply a departure from an indifference rate, which makes the agent indifferent between the technology decisions. Upward increases of intellectual property in connection with unconscious innovation policies induce the agent to innovate. However, only increasing intellectual property rights without making innovations more likely to succeed is not in line with the model's statement, since they are directly interrelated.

This led to the second regression study, which employs difference in difference with matching, investigating the possibility of whether being a democracy positively influences the strength of intellectual property rights. It is shown that new democracies tend to have higher levels of intellectual property rights protection than countries that remain in autocracy, therefore being more likely to employ unconscious innovation policies. Unconscious innovation policies are not exclusive to democratic regime types, but according to the estimation, more likely to occur there.

5.1 Findings in Relation to Relevant Current Knowledge

We find our results to be in line with certain strands of previous economic research. The findings support the notion that increased intellectual property right protection is beneficial to creating more innovations (Romer 1990). The Romer model states that by implementing horizontal innovation through increased R&D expenditure, a greater variety of new technologies can be created. This finding is contrasted by the endogenous growth model of Aghion and Howitt (1992), who created a model based on the idea of Schumpeterian creative destruction. The implementation of vertical innovation, which replaces old technologies with new innovations, leads to quality increases in certain technologies.

As has been argued throughout this paper, we hold egalitarian and widespread innovation

methods to be more effective, which is why the thesis is more in line with horizontal innovation methods. Horizontal innovation is closer aligned to the idea of unconscious innovation, which is the preferred policy choice for innovation established through the model. However, one also needs to take into consideration that the Schumpeterian model by Aghion and Howitt (1992) makes inferences based on its dynamic nature, an aspect that is not captured in the model.

Endogenous growth models such as discussed above, came to fame for endogenizing technological growth. Before the creation of such endogenous growth models, it had already been established that technological growth, labeled as "Total Factor Productivity" or the "Solow Residual", is one of the main drivers for economic growth.

While the importance of increases in technology for the economy is an established fact, the impact of regime type on growth has been inconclusive (Limongi and Przerworski 1993). A reason for why such attempts have been inconclusive is that the institutional framework, which expresses the certain characteristics of the regime type and its policies, is hard to fully take into consideration. The research strategy of this thesis took the intermediary spheres of institutions between regime type and their impact on economic factors into consideration.

The democratic regime type can have a significant positive impact on the growth of new technologies, through the protection of intellectual property rights, which in accordance with previous research should also lead to increased growth of the economy. This conclusion is enabled by the previous distinction of institutional channels. A focus on certain aspects of the economy and peace-meal studies on them, as tedious as it might seem, gives respect to the complexities at hand and it is our belief that it can lead to meaningful results.

A point of divergence from some established viewpoints in economic thought arises in the perception of the characteristics of innovation technologies. However, before outlining the relevant discussion, most of the contention can be avoided by reiterating how this thesis define innovations. Innovations of interest to the thesis are expressed in objects, which are not as intangible as critics would like them to be portrayed. Innovations as in discoveries of new ideas, such as Einstein's famous equation of $e = mc^2$ are not the point of focus of the thesis.

A libertarian view on property rights warns against the unnecessary creation of monopolies through intellectual property rights (Palmer 1988, pp. 284-285). Critics draw up the problem of how to chose appropriate innovations and for how long intellectual property rights should be extended over them. It is argued that patents are likely to be exploited in order to prevent future innovations. The proof for their criticism is made by pushing the idea of intellectual property rights ad absurdum. Starting from their main premise that all innovations are intangible goods they conclude their can be no natural ownership over them, as with physical property. Their reductio ab absurdum then states that if one could posses and exert monopoly power over any innovation, why don't these rights extend into infinity. In theory car manufactures should pay the patent holder of the wheel. The length of property rights is stretched out into infinity in order to show their futility. We find such arguments to not be very convincing. In essence it is a straw-man arguments which denies a proposition by giving an inaccurate picture of the proposition and drawing its consequences into the ridiculous, In order to prevent such criticism, we made clear that we are looking at particular types of innovation and characteristics throughout our work.

Furthermore, contrary to the point of view of innovation inducing intellectual property rights, it is argued that the protection thereof leads to the creation of a Leviathan like state, which

robs the citizens from their freedom to innovate instead. State power over individual action is something that should be kept to the bare minimum, if anything. Therefore, intrusive intellectual property rights are not seen as favorable to innovation. However, in the our opinion, protecting intellectual property does not deter the citizens from innovation but rather imitation. Intellectual property rights can only be put into effect ex post to the innovation. Therefore it is hard to see how they could have prevented its creation. The only action that is deterred after the new technology has then been established is the imitation of it.

Further findings that are conclusive to those of the thesis are found in Acemoglu et al. (2013), who disfavor targeted subsidizes towards industries, which is in line with our suggested discouragement of conscious innovation in order to create innovations. Many targeted innovation policies find themselves to be ineffective and public resources are often spent in vain.

An example of a failed conscious innovation strategy implemented by a democratic nation can be found in France's creation of Minitel in 1982. Minitel was a national videotex communications network, which enabled users to communicate through messages or access booking systems. The government funded innovation was well ahead of its time and initially a huge success (Cats-Baril and Jelassi 1994). However, the French bureaucracy was not able to adapt the system by making it an open network. This rigidity in their previously determined technology led to Minitel becoming eventually obsolete.

5.2 Implications and Policy Suggestions

In modern times the world has been undergoing a clear transition towards democratic rule. At the middle of the 1970s there were about 30 democracies and now that amount has increased to around 120 (U.S. Department of State 2014). This is a tremendous success for the nations championing the virtues of democracy, chief amongst them the USA. Undoubtedly democratic systems have several beneficial effects, amongst them freedom from oppression and allowing for citizen voice in regards to how the society is run. However, it is not clearly established if democracy or democratic policies leads to economic growth. This thesis adds to this area by illuminating that the conscious policy of propagating democratic values and institutions over the world has helped boosting economic growth by inducing a favorable climate for innovation.

The thesis has established that to induce innovation a nation should focus on providing an egalitarian system of fundamental intellectual property rights. These types of policies are shown to be associated with a democratic form of rule. By spreading democratic values over the world nations help contribute to creating a more favorable environment for innovation overall. This can even have a kickback effect to the nation working to spread democracy through the knowledge diffusion in trade hypothesis (Brouwer 2006). If the relationship holds, increasing global strength of innovation will help all trading nations to innovate, since they can draw on a larger pool of commonly shared knowledge. It might not necessarily make any nation more competitive than previously, but it can increase global technology levels which will result in higher overall output, making all nations better off.

There are some tendencies towards creating a more unified global system of intellectual property rights. The TRIPS agreement that came into effect in 1995 was a first step towards providing a multilateral framework for intellectual property (World Trade Organization 2014). The most

recent example is the introduction of a unitary patent in the European union (European Patent Office 2014). Creating the unitary patent will enhance the availability of intellectual property protection for everyone, by making it cheaper and less bureaucratic to obtain. The results of the thesis are supportive of these efforts as they in the long run should create a better environment for the propagation of innovation.

In stark contrast to extending intellectual property rights, creating favored elite groups in society, that receive government support for innovation, is a policy that the results of the thesis vehemently rejects if the nation wants to create innovation. The literature review finds evidence of the inefficiency of subsidies in the innovative sector (Acemoglu et al. 2013). If a nation wishes to boost innovation it should try and focus on what is referred to as unconscious innovation policies and refrain from conscious innovation. While both systems of governance can implement both policies, the previous state of knowledge implies that autocrats are concerned with the idea of losing part of their powers to the market forces. The results of the empirical analysis show that autocracies are prone to having lower intellectual property rights than democracies and we suggest that the loss of reallocation power is part of the explanation. Given then that subsidy based innovation is inferior to a more market style approach the exodus from autocratic systems to more democracy based ones have served to increase overall innovation levels in the world.

An important implication of the model for creating an environment that is supportive of unconscious innovation, besides enforcing intellectual property rights, is to mitigate the risk faced by the innovators. While this can be done in an conscious innovation fashion by the government assuming part of the risks of innovation, we suggest creating supportive market institutions as a superior solution. Having a well developed capital market that can effectively put a price on future risks would assist with getting good projects undertaken. Assigning costs of capital according to market conditions, instead of through government channels, reduces the risk of nepotism. Since resources of any nation are limited improving the efficiency of the allocation so that projects with positive net present values are undertaken and not only projects that are in line with government policy, is expected to increase the technology accumulation of the nation. Both Switzerland and Sweden whom are forerunners when it comes to innovation, score in the top 15 when it comes to venture capital deals in the Global Innovation Index (2014).

Creating efficient capital markets would also help in that it increase ease of entrance into innovation. Innovative activity can be exuberantly expensive. If innovators cannot obtain capital for funding having a good idea is a moot point. The conscious innovation system favors incumbents and already established innovators. Excluding a large portion of the population limits the pool of creativity that the nation has to draw from.

Another way to reduce the riskiness of innovative activities is to increase the level of human capital in the nation.This can be done by focusing on the school system and especially tertiary education. Of course creating good education is not something that is easy by any means. Similar to how Switzerland and Sweden scored high in venture capital deals the same is true for collaboration between industry and universities (the Global Innovation Index 2014). This lends credence to the hypothesis that universities are important for the creation of an environment that enables innovation.

5.3 Internal and External Validity

The thesis concludes with an evaluation of the internal and external validity. In the thesis there is a clear example of a trade off between the two. When we enter into the empirical analysis we employ two methods that both exclude nations due to availability of data. Using the instrumental variable approach and the difference in difference propensity score matching methods greatly increases the internal validity of the results. They are both methods to deal with expected bias in the common OLS regression method. If the thesis had only employed a pooled OLS approach our results would not have been credible enough to warrant any consideration when constructing policy. While we are not claiming that the effects we find are absolutely without bias, we can claim that we have shown that we are aware of the problem of bias in regression models and that we have done our utmost to correct for it.

In pursuing internal validity the strength of the external validity becomes weaker. In both estimation models we are looking at treatment effects. The inference we draw from the IV model on the effects of intellectual property rights is dependent on settler mortality rates, while the difference in difference model looks at the effect of transitioning from autocracy to democracy. This has the side effect of limiting our samples to nations where settler mortality rates are observed or nations that are either autocracies or transitions from autocracy. We can no longer claim to have a sample that represents the world's total population. Instead our results are Local Average Treatment Effects (LATE). For example in both cases there are no European nations included in the regressions. The consequence being that it must be asked if the results can credibly be generalized to the entire world. The straight answer is that we do not believe that our empirical results can be generalized to apply to the entire world. Nevertheless, we claim that the results are of importance in that the areas we do have observations for are those that are affected by democratization efforts today. Most of Europe (bar Belarus) has transitioned into democracy already. The LATE provides insight into the possible results of democratization in Africa, Asia and Latin America. These are the places where nations actually consider transitioning to democracy or staying an autocracy. Making our results less externally valid but enhancing their credibility for application in these areas is a favorable trade-off for the thesis to make.

In regards to the model the trade-off is in the opposite direction. The model is used as a tool to provide a clearer understanding of the proposed effects of intellectual property policies. By necessity we make simplifying assumptions to be able to create a comprehensible framework. One example is that we limit ourselves to two periods. This does not match reality but the model can still serve its purpose and get the point across. For us external validity, that we try to build through connecting our assumptions to past research, is the most important to achieve with the model. The later regression are used to confirm that the relationships we propose also possess internal validity.

6 Conclusion

For innovations to truly succeed, being a democracy is neither a sufficient or necessary condition. Implementing unconscious innovation policies, however, is according to our model, a necessary

condition to innovations. Therefore, having a political leader who enforces some form of protection of intellectual property is a decisive factor, and more often achieved by democratic regime types than autocratic ones. We were able to cut the Gordian knot between democracy and innovation and show that the type of innovation policy, expressed in the institution of intellectual property rights is of major importance.

Moreover, our underlying presumption that intellectual property is very similar in kind to physical property held throughout our work and strongly supported our results.

For future research and possible extensions of our model, a dynamic approach is imaginable, where the ruler experiences some repercussions from innovating. This would then also imply, that the the ruler's decision over the strength of intellectual property rights would be endogenized, leading to an equilibrium π, which takes trade-offs of the ruler and the agent into account. Such a model specification could give further insights into how appropriate intellectual property rights should be set in order to attain the optimal amount of innovative technologies.

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A Appendix

A.1 Model

In this appendix we solve for the global maxima of technology solutions over ϕ and θ. We achieve a global maximum, since we deal with continuous and concave functions. The established constraints give a bounded domain, which then satisfy maximum conditions. We begin by arranging the Lagrangeian given the maximization problem and it's constraints. The Lagrangian displays equality constraints.

$$\begin{aligned}\mathcal{L} = \ln(c_i^1) + \ln(c_i^2) \quad &+ \quad \lambda'(e^i - I_1^\phi - I^\theta 2 - c_1^i) \\ &+ \quad \lambda''((1-\tau)(\pi\phi_2^\lambda + (1-\pi)\theta_2^\lambda - c_2^i)) \\ &+ \quad \lambda'''(aI^\phi + z\phi - \phi_2) \\ &+ \quad \lambda''''((1-q)I^\theta + (1-\gamma)\theta_1 - \theta_2)\end{aligned}$$

Next, we continue to take partial derivatives of variables of interest.

$$\frac{\partial \mathcal{L}}{\partial \phi_1} = \lambda''' z = 0 \tag{1}$$
$$\frac{\partial \mathcal{L}}{\partial \theta_1} = \lambda''''(1-\gamma) = 0 \tag{2}$$
$$\frac{\partial \mathcal{L}}{\partial \phi_2} = \lambda''(1-\tau)\pi\lambda\phi_2^{\lambda-1} - \lambda''' = 0 \tag{3}$$
$$\frac{\partial \mathcal{L}}{\partial \theta_2} = \lambda''(1-\tau)(1-\pi)\lambda\theta^{\lambda-1} - \lambda'''' = 0 \tag{4}$$
$$\frac{\partial \mathcal{L}}{\partial c_1^i} = \frac{1}{c_1^i} - \lambda' = 0 \tag{5}$$
$$\frac{\partial \mathcal{L}}{\partial c_2^i} = \frac{\delta}{c_2^i} - \lambda'' = 0 \tag{6}$$
$$\frac{\partial \mathcal{L}}{\partial I_1^\phi} = -\lambda' + \lambda''' a = 0 \tag{7}$$
$$\frac{\partial \mathcal{L}}{\partial I_1^\theta} = -\lambda' + \lambda''''(1-q) = 0 \tag{8}$$

In the following equation we solve for the Lagrangian-multipliers.

$$
\begin{aligned}
(5): \quad & \lambda' = \frac{1}{c_1^i} \\
(6): \quad & \lambda'' = \frac{\delta}{c_2^i} \\
(7)\&(5): \quad & \lambda''' a = \lambda' \\
& \lambda''' = \frac{1}{c_1^i a} \\
(8)\&(5): \quad & \lambda''''(1-q) = \lambda' \\
& \lambda'''' = \frac{1}{c_1^i (1-q)}
\end{aligned}
$$

After having determined the Lagrange-multipliers, we continue to solve for the optimal technology decisions for the agent for ϕ

$$
\begin{aligned}
(3): \quad \tfrac{\delta}{c_2^i}(1-\tau)\pi\lambda\phi_2^{\lambda-1} &= \frac{1}{c_1^i a} \\
\phi_2^{\lambda-1} &= \frac{c_2^i}{c_1^i a\delta(1-\tau)\pi\lambda} \\
\phi_2^* &= \left(\frac{c_1^i}{c_2^i} a\delta(1-\tau)\pi\lambda\right)^{\frac{1}{1-\lambda}}
\end{aligned}
$$

and for θ

$$
\begin{aligned}
(4) \quad \tfrac{\delta}{c_2^i}(1-\tau)(1-\pi)\lambda\theta_2^{\lambda-1} &= \frac{1}{c_1^i(1-q)} \\
\theta_2^{\lambda-1} &= \frac{c_2^i}{c_1^i(1-q)\delta(1-\tau)(1-\pi)\lambda} \\
\theta_2^* &= \left(\frac{c_1^i}{c_2^i}(1-q)\delta(1-\tau)(1-\pi)\lambda\right)^{\frac{1}{1-\lambda}}
\end{aligned}
$$

Finally, we equate the optimal technology decisions in order to obtain the intellectual property rate, equalizing the technology decision and therefore making the agent indifferent between technologies. This is in essence done by equalizing marginal utilities of the technologies, $MU(\phi) = MU(\theta)$.

$$
\begin{aligned}
\phi_2^* &= \theta_2^* \\
a\delta(1-\tau)\pi\lambda &= (1-q)\delta(1-\tau)(1-\pi)\lambda \\
a\pi + \pi(1-q) &= 1-q \\
\pi^{ind} &= \frac{(1-q)}{a+(1-q)}
\end{aligned}
$$

A.2 Empirics

A.2.1 Nations in the Instrumental Variable Regression

Nation	Settler Mortality	Years Available
Algeria	78.2	1995, 2000, 2005
Argentina	68.9	1980, 1990, 1995, 2000, 2005
Australia	8.55	1980, 1995, 2000, 2005
Bangladesh	71.41	1995, 2000
Bolivia	71	1980, 1985, 1995
Brazil	71	1980, 1985, 1990, 1995, 2000, 2005
Canada	16.1	1980, 1985, 1990, 1995, 2000, 2005
Chile	68.9	1980, 1985, 1990, 1995, 2000, 2005
Colombia	71	1980, 1985, 1995, 2000, 2005
Costa Rica	78.1	1980, 1990
Ecuador	71	1980, 1995, 2000, 2005
Egypt	67.8	1980, 1985, 1990, 1995, 2000, 2005
El Salvador	78.1	1980, 1985, 1990, 1995
Guatemala	71	1985, 1990, 1995, 2000, 2005
Guyana	32.18	1985
Honduras	78.1	1980, 1985, 1990, 1995, 2000
India	48.63	1980, 1985, 1990, 1995, 2000, 2005
Indonesia	170	2000, 2005
Jamaica	130	1990, 1995, 2005
Kenya	145	2005
Malaysia	17.7	1985, 1990, 1995, 2000, 2005
Mexico	71	1980, 1985, 1990, 1995, 2000, 2005
Morocco	78.2	1980, 1985, 1990, 1995, 2000, 2005
New Zealand	8.55	1980, 1985, 1990, 1995, 2000, 2005
Nicaragua	163.3	1985, 2000
Pakistan	36.99	2005
Panama	163.3	1980, 1985, 1990, 1995, 2000
Paraguay	78.1	2000, 2005
Peru	71	1980, 1985, 1990, 2000, 2005
Singapore	17.7	1980, 1985, 1990, 1995, 2000, 2005
South Africa	15.5	1980, 1985, 1990, 1995, 2000, 2005
Sri Lanka	69.8	1980, 1985, 1990, 1995, 2000, 2005
Trinidad and Tobago	85	1980, 1995, 2005
USA	15	1980, 1985, 1990, 1995, 2000, 2005
Uruguay	71	1980, 1985, 1995, 2000, 2005
Venezuela	78.1	1980, 1985, 1990, 2000

Settler mortality from Acemoglu et al. 2001

Figure 10 **The nations used in the instrumental variable estimations**

A.2.2 First Stages for the Two IV-Regressions

VARIABLES	GP-index	GP-Index
Log Settler Mortality	-0.2864**	-0.221*
	(0.114)	(0.1146)
Physical Property Rights	-	0.1677***
	-	(0.0483)
Polity2	0.0229*	0.0386**
	(0.0119)	(0.0181)
GDP per Capita	0.000017	0.0000003
	(0.000013)	(0.000013)
Completed Years of Tertiary Education	0.0134	0.0228
	(0.0232)	(0.023))
Trade Openness	0.0017*	(0.0021)
	(0.0009)	(0.0014)
Coup	-0.2604*	-0.3111
	(0.1343)	(0.2046)
Constant	2.4643***	1.6226**
	(0.4784)	(0.725)
Region Dummies	Yes	Yes
Time-Dummies	Yes	Yes
F-Stat	34.01	14.72

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 11 **First Stage of the Instrumental Variable Estimations**

A.2.3 Summary of the Nations in the Difference in Difference

Nation	Treatment Status	Propensity Score
Algeria	Autocracy	0.47
Angola	Autocracy	0.56
Argentina	Transition	0.84
Bangladesh	Transition	0.87
Benin	Transition	0.67
Bolivia	Transition	0.50
Brazil	Transition	0.90
Burkina Faso	Autocracy	0.40
Burundi	Autocracy	0.64
Cameroon	Autocracy	0.45

Chad	Autocracy	0.39
Central African Republic	Transition	0.40
Chile	Transition	0.72
Cote d'Ivore	Autocracy	0.37
Cyprus	Transition	0.87
Dominican Republic	Transition	0.67
Ecuador	Transition	0.86
Egypt	Autocracy	0.39
El Salvador	Transition	0.88
Ethiopia	Transition	0.35
Gabon	Autocracy	0.49
Ghana	Transition	0.49
Greece	Transition	0.72
Guyana	Transition	0.78
Haiti	Transition	0.50
Honduras	Transition	0.62
Indonesia	Transition	0.55
Iran	Transition	0.73
Iraq	Autocracy	0.77
Jordan	Autocracy	0.57
Kenya	Autocracy	0.70
Liberia	Autocracy	0.80
Madagascar	Transition	0.61
Malawi	Transition	0.36
Mali	Transition	0.39
Mauritania	Autocracy	0.51
Mexico	Transition	0.83
Morocco	Autocracy	0.60
Mozambique	Transition	0.58
Nepal	Transition	0.66
Nicaragua	Transition	0.74
Niger	Transition	0.43
Pakistan	Transition	0.81
Panama	Transition	0.93
Paraguay	Transition	0.69
Peru	Transition	0.75
Philippines	Transition	0.74
Portugal	Transition	0.60
Rwanda	Autocracy	0.47
Saudi Arabia	Autocracy	0.67
Senegal	Transition	0.66
Sierra Leone	Autocracy	0.81
Singapore	Autocracy	0.87
South Korea	Transition	0.87

Spain	Transition	0.52
Swaziland	Autocracy	0.45
Syria	Autocracy	0.58
Tanzania	Autocracy	0.42
Thailand	Transition	0.76
Togo	Autocracy	0.43
Uganda	Transition	0.82
Uruguay	Transition	0.88
Zambia	Transition	0.75

Table 2 **Nations, treatment status and probability of transitioning into democracy for the difference in difference estimation**

A.2.4 Results of the Logit-Regression

	(1)
VARIABLES	Transition
$\frac{\text{GDP per Capita}}{\text{USA GDP per Capita}}$	4.744
	(4.993)
Armed Conflict	0.00615
	(0.0322)
Sample Length	-0.0273
	(0.0803)
Polity2 First Year	0.125**
	(0.0601)
Democratic Capital	-0.0239*
	(0.0124)
Constant	1.461
	(3.264)
Observations	63
Robust standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Figure 12 **Results of the logit-regression to determine probability of transition**