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Behavioural and international economic extensions of the theory of optimal patents

PhD dissertation theses

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Szeged, 2013.

1. Justification of the topic

Innovation is an important moving force behind today's modern, knowledge-driven, information economy. Day after day new products, production processes are being invented and implemented at companies, which promise greater profit for the company and enhanced satisfaction of needs for the consumers.

The generation of new technological knowledge and the implementation of inventions, however, is not always smooth. The creation of new technological knowledge requires high costs, copying it, however, costs next to nothing (especially in case of codifiable, explicit knowledge). Is it possible, is it practical to block the free diffusion of technological knowledge?

There is a conflict of interests between the innovator and society. The innovator would like to have some advantage over the competitors in return for the high costs and many years spent researching a new product or technology. He would like to have monopoly power over the innovation to appropriate its returns. The competitors would prefer the newly born technology to be freely accessible to everyone, since thereby all could produce a better product with more efficient technologies paying only the low cost of reproducing the knowledge. The consumers also would find the quick and universal diffusion of the new knowledge advantageous, attaining higher satisfaction from consuming the goods produced in better quality or at a lower price. Knowledge is a source of positive externalities, thus, from the point of view of society one could argue that its free availability would increase efficiency. Free access to new technologies, their treatment as public goods would tempt to free riding, ruining the incentives for potential innovators to bear the high costs of research and development.

Scientific study, along with research and development have their intrinsic rewards to some extent. Researchers or companies achieving new scientific results become famous, their professional reputation increases, it can even grant them extra income. Innovating companies can have a head start over their competitors for some length of time. In some industries, however, more then these is needed to resolve the above mentioned conflict of interests. Especially in industries like medical equipments, biotechnology or pharmaceuticals (Arora et al 2008) patents as institutional methods of creating private property rights over newly generated technological knowledge are an important way of incentivizing research and development. „Patents are licenses for a monopoly over information" (Nordhaus 1967, p.1.).

Transforming knowledge as quasi-public good into a private good through the institution of patenting is a long standing concept in economics. After the seminal analyses of Machlup (1958) and Arrow (1962) a line of study analyzing patents systematically on neo-classical foundations started out following Nordhaus (1967). The purpose of the new research program called *theory of optimal patents* is to determine the socially optimal length of patent protection, the life of the patent. The government has to set the patent term, taking into account the profit maximizing behavior of the innovating companies to balance the static efficiency losses (that are immediate and have their effects temporarily in the nearer future) and dynamic efficiency gains (that apply only in the longer run, in the more distant future).

The immediate but temporary efficiency loss attributable to awarding patent protection is due to it distorting the market. The introducer of the innovation will enjoy a monopoly position on the market in question for a certain time (either by producing an innovative new product, or by being able to produce an already existing product with a more efficient technology), and the resulting price above marginal cost is a known source of deadweight loss. Its necessity is justified by the fact that without the promise of this monopoly power the innovator would not spend resources on research and development, and the innovation would not be made at all. The new, innovative product or process promises in turn after the expiration of the patent protection an increased consumers' surplus: this is its long run efficiency gain.

The optimization task for economic policy-makers is to determine how long of a wait on the part of the consumers for this prospective future gain justifies how large a market power for the producer, and that in turn will induce them to what level of research and development to produce technological knowledge.

A central notion of the dissertation is the strength of patent protection. In the theoretical study of Nordhaus, this is simply the length or life of the patent that can be set to be optimal depending on variables like the cost reduction attributable to the innovation (the importance of the innovation), the price elasticity of the demand function or the interest rate. As a result of his model he finds that the patent term can be long (as long as 25-30 years) in case of the most trivial innovations, for important ones on the other hand it should be very short (1-1,5 years) (Nordhaus 1967, p.29.). The patent system is most often more complex than this, and its strength is determined by other factors such as the breadth of the patent protection, whether there is compulsory licensing or what can be patented at all.

If we look at the impact the institution of patents bears on innovation from the global perspective of interconnected national economies, we should interpret these welfare losses

and gains more broadly. Since there is no such thing as a world patent, only different national patent protection regimes of various strength, it is useless to search for the globally optimal patent design. While the individual countries' national patent regimes strive to promote innovation within the given country, they can also encourage the diffusion of innovation from abroad. If a foreign innovator finds that his intellectual property rights are appropriately protected in another country as well, he might be more willing to make the innovation or the innovative product available in that county also.

In my dissertation I study the influence that the strength of the patent protection regime has on the one hand on the creation of innovations within a closed economy, and on the other hand on diffusion of innovations between open economies.

2. Aims of research and hypotheses

The dissertation aims to extend the literature on the impacts of patent strength with two hitherto neglected factors.

The first of these factors fits into the theory of optimal patents, but extends it with a behavioural economic viewpoint. In the theory of optimal patents the government has to evaluate welfare gains and losses that are realized at different times and by different actors to balance the immediate and long run welfare effects of an innovation against each other in setting the optimal patent term. Following Fischer (1930) and Samuelson (1937), economists automatically use capital budgeting techniques based on exponential time discounting for such comparisons: expected future costs and benefits of long-term projects are converted to present value using the exponential discount function, making costs and benefits realized in different time periods commensurate.

Behavioural economics have voiced critiques against this discounting model (Ainslie 1992, Loewenstein – Prelec 1992). In experiments they found that intertemporal choices of test subjects can better be described using a different discounting model: a hyperbolic or quasi-hyperbolic discounting. Decision-makers exhibit increasing patience in time: in the short run they are more impatient, while in the long run, they are more patient than an exponentially discounting decision-maker would be. In my dissertation I wish to incorporate this time-dependent patience into the theory of optimal patents and answer the first two research questions:

1. *How can non-exponential discounting models be used to determine the time value of flows of income(utility), and how do present- or future values calculated with these models relate to present- or future values calculated using exponential discounting?*

2. *If the discounting behaviour of consumers can better be described by non-exponential models, then how does the greater short run impatience and long run patience implied in these models influence the socially optimal patent term to be set by the government?*

If we universally apply the exponential discounting model to consumers' choices, we will get misleading result, since the exponential model under- or overvalues gains and losses at different points in time, relative to the consumers' non-exponential, mental discounting. This difference in valuation will be even more empathic for flows of income(utility) over a longer period of time. If we, on the other hand, would apply the non-exponential discounting universally for capital budgeting it would result in conflicts, since due to the dynamic inconsistency characteristic for these models investors would not carry out tomorrow the plans they made today.

In the dissertation I argue that in certain decision situations it is reasonable to use a *combination* of the two models. The theory of optimal patents is one such field of decision situations. Combining the two models is reasonable on the one hand because costs and benefits associated with patent protection can be divided into two qualitatively different parts. One share of the costs and benefits are real monetary outlays and incomes for a company (research and development costs, production cost reduction due to the innovation and increased profit due to the monopoly power of the patent holder), while another share is only "virtual", mental gain in the sense that it cannot be deposited on a bank account at an interest and also cannot be used as a collateral for a loan (this is the increased consumers' surplus resulting in the long run from the innovation). Because this divisibility and qualitative difference, in case of the former one should continue using exponential discounting, while in case of the latter, one should rather apply non-exponential discounting models. On the other hand, combining the two methods is also possible, since the consumers, to whom the non-exponential discounting is applied, are not the ones making the decision about the patent term, thus the dynamic inconsistency characteristic of the non-exponential models do not cause problem.

A second factor with which the dissertation wishes to extend the existing literature can be analyzed within the realm of international economics, assuming an open economy.

In the literature whenever the impact of patent protection strength is investigated, it is investigated through its effect on international flow of products or capital. The relationship between the strength of intellectual property rights (IPR) protection regimes and bilateral trade flows has been investigated in the literature in various ways by many authors in theory, using models (Chin – Grossman 1988, Deardorff 1992, Ivus 2011). Two main effects are identified determining this relationship: the market expansion effect and the market power effect. A given innovative company is only encouraged to enter the foreign market in some way (be it a joint venture, foreign direct investment or in the most simple case just plain exporting) if its property rights to its innovation are appropriately protected in the other country. A new market means a new possibility for the knowledge embodied in the innovative product to leak: the company has to evaluate if this risk is worth taking. Market expansion effect means that due to the strong foreign IPR protection the innovator has the opportunity to get monopoly profit on a greater market than before. The market expansion effect induces the innovator to increase exports. The second effect, the market power effect means, that the strong IPR protection not only increases the market, but also makes it less price-sensitive. Stronger protection means smaller probability of imitation, and smaller risk to the exporter. This will in turn induce the innovative exporter to increase price and decrease export. All the models assume, that the IPR protection at home is constant, thus these models can not analyze how a change in the strength of the home IPR regime affects the export decision of the company.

3. *How does a change in the strength of the IPR protection regime in the home country influence the export decision of an innovative company?*

To investigate this, a model has to be able to quantify the strength of the home IPR regime as well as that of the foreign country. In the dissertation I argue that the important factor influencing the export decision is the relation between the strengths of the IPR regimes in the two trading countries, and the change in this relation. To quantify this relation, I introduce the notion of *relative IPR strength*, as a quotient of the indices measuring IPR strength in the two countries, and also the change in this proportion. This relative IPR strength can signify many different relationships between the IPR regimes of two trading parties. If the exporting country is a developed county while the importing country is a less developed one, the relative IPR strength in the importing country is generally less than one, meaning that intellectual property rights are less strictly protected in the importing country than they are in

the exporting country. Changes in the strength of protection (it becoming stricter or more lax) are now possible in both countries. Although there is a general tendency of IPR protection measures becoming stricter in every country, a different degree of strengthening in the two countries will result in different changes in the relative IPR strength. If IPR protections becomes more strict in both countries, but to a greater degree in the less developed importing country, then the importing country's relative IPR strength increased: the importing country is catching up with the exporting country. If it is the other way around, and the degree of strengthening in the less developed county is smaller, then the importing country's relative IPR strength decreased and the importing country is falling behind the exporting country.

4. *How is the export decision of a developed country exporter company influenced by the relative IPR strength of another country, and the change thereof?*

In the model I developed in the dissertation the ceteris paribus strengthening IPR protection in any of the trading partner countries decreases the probability of imitation of the innovative product thereby encouraging the developed country exporter to enter the foreign market with less complex products that are less difficult to imitate technically. Introducing less complex products in the foreign market means increasing the range of products in the high-tech and low-tech industries to a different degree.

The model developed leads to an empirically testable hypothesis that can be put forward as follows:

Hypothesis: A change in the relative IPR strength increases import to a greater degree in high-tech products relative to low-tech product in importing countries catching up than in importing countries falling behind.

To test the hypothesis I used bilateral trading data of 32 developed exporter and 80 less developed importer countries in total from two 5-years time intervals among high-tech, medium-tech and low-tech products. Creating country-pairs from the trading parties we can always determine whether any one specific importer is catching up or falling behind any one specific exporter, based on change in relative IPR strength. The statistical method of difference in differences allows us to test whether the two groups of country-pairs exhibit significantly different trade patterns.

3. Structure of the dissertation and methods used

The central topic of the dissertation is the strength of patent protection and its effects. The linking concept in the dissertation is that patent protection is an official license issued by a government to an innovator enabling him to monopolize a certain technological knowledge (embodied in a better product or a more efficient production process). I investigate two distinct effects of patent protection. One of this plays a role in a closed economy, and it is in connection with the *generation of technological knowledge*. The other can only be interpreted in an open economy, and it is connected to the *international diffusion of technological knowledge*. These two effects are investigated within a strictly restricted framework.

In the first chapter I try to shed light on the connecting points of knowledge, innovation and patent from a wide viewing angle. Providing an overview of the whole innovation literature is certainly not an aim of the thesis, since researchers of innovation use various different approaches to innovation and its effects on companies and national economies. Not all of these approaches use explicitly the institutional variable I want to study: the patent protection and its effects on innovation.

The innovation literature often uses models to better understand and describe presumed relationships. The impacts of patent protection can also be quantified and studied through models, even if sometimes using very restrictive assumptions. The starting point of the *second chapter* is the theory of optimal patents starting out from Nordhaus. This approach has strong neo-classical foundations and studies the effects the institutional variable of patent protection bears on innovative resource allocation of companies and on the welfare gains of society generated by innovations. The theory of optimal patents use a highly simplified model (perfect competition, downward sloping linear demand curves, constant marginal cost of production, decreasing returns in research and development, etc.) to describe how the government should set the life of patents in a way that it induces profit maximizing potential innovator companies that take this preset patent life as given, to allocate just as much resources to R&D that is necessary to achieve maximal social return. Modifications to the original optimal patent framework allows for relaxing some of the restricting assumptions (competition in R&D, sequential innovations, costly imitation, transaction costs in patent protection enforcement etc.), incorporating alternative mechanisms of protecting technological knowledge (trade secrets, lead time, prizes) and adding more dimensions to the patent design (patent breadth, compulsory licensing etc.).

In the third chapter I incorporate the positive model of quasi-hyperbolic (non-exponential) discounting from behavioural economics into the normative model of optimal patents. The normative, neo-classical optimalization model of optimal patents is extended after the institutional variable also with a behavioural aspect. Again, the question this chapter seeks to answer is how the government should set the life of the patent (this will be the only measure of the stringency of the patent system in this chapter) so that it induces the profit maximizing companies to the socially optimal innovation, taking into account the non-exponential discounting behaviour of the consumers.

The first three chapters studied how the strength of patent protection affects the production of technological knowledge. In the last two chapters I use an open economy setting, and the question is how the strength of patent protection affects the international diffusion of technological knowledge, in particular, only the portion of it that happens through the international flow of trade in products. In these chapters I will regard the innovations and knowledge as already existing, the question is only whether the owner of the knowledge (the patent holder) transfers it to a foreign country by exporting the product protected by the patent or the product that is produced by a protected technology, and thereby also incurs the risk of imitation in a foreign country.

In the fourth chapter I build a static partial equilibrium model concentrating on the individual company's exporting decision. I explore how bilateral trade is influenced by the importing country's relative IPR strength. Inter-country trade is explored by extending the north-south trade model.

The fifth chapter continues to investigate the role patents play in knowledge diffusion, with an empirical study. In this chapter I employ the statistical method of difference in differences, which composes groups along multiple dimensions from the basic population and establishes if there is a significant difference in the behaviour of the different groups. Composing country-pairs from countries that engage in trade with each other a basic distinctive criterion among the country pairs is the change in the importer's relative IPR strength, according to which criterion the country pairs are divided into importers catching up with or falling behind of the exporter. Another dimension was the change in the value of trade in different industry groups (high tech, medium tech and low tech). In this chapter it constituted an important task to actually measure the absolute and relative strength of IPR regimes for different country pairs. The stringency of the IPR regimes in any given country can be measured by an index developed by Ginarte and Park (1997), which is a much more pragmatic measure than the abstract variables that models use for this purpose (which is

sometimes only the length of the patent protection, sometimes a combination of patent length and breadth and sometimes a not specified complex variable describing a whole IPR regime). A country's relative IPR strength is defined as a quotient of the Ginarte-Park indices of the trading parties, the change in relative strength is thus the change in time of this ratio. Bilateral trade data are from the UN Comtrade data bank, the classification of countries along national income is done according to the data available from the World Bank, and relative catching up or falling behind is calculated using the latest Ginarte-Park indices for the countries available at the website of Walter G. Park.

4. Summary of the results

(1) Extension of the quasi-hyperbolic model, and its application to the calculation of time value for flows of income(utility).

The quasi-hyperbolic discounting model has not hitherto been applied to the calculation of present values for flows of income(utility).

In a typical experimental setting to establish non-exponential discounting behaviour researchers study what immediate reward is equivalent to a given reward of a given delay (matching), or which of a smaller-sooner reward or a larger-later reward a given test subject would choose (choice). Based on such experiments, behavioral economists pointed out that decision makers repeatedly choose contrary to what exponential discounting would predict, and that their actual discounting behaviour can better be described by other types of discount functions (Thaler 1981, Loewenstein – Prelec 1992). Non-exponential discounters exhibit greater short run impatience but also greater long run patience, relative to an exponential discounter. This means, that exponential discounting will overvalue in the short run, but undervalue in the long run. One can identify a point in time when the exponential and non-exponential discount factors equal each other: this time will come later the greater the short run impatience, and/or the smaller the long run patience.

Experiments, however, always involved a comparison of (or choice between) single payoffs of different value due at different points in time. In the dissertation I apply the experiment-based non-exponential models to evaluate flows of income due during a longer period of time (perpetuity or deferred perpetuity).

The present value of a perpetuity discounted with the quasi-hyperbolic model is greater relative to its present value discounted with the exponential model the smaller the short run impatience or the greater the long run patience of the quasi-hyperbolic discounter.

For deferred perpetuities (which is, flows of utility starting from a later point of time and due until eternity) one can determine a point in time so that a perpetuity starting earlier than that time will have a higher present value discounted exponentially than quasi-hyperbolically. This point in time directly proportional to the short run impatience but inversely proportional to the long run patience.

My results have been published in the following scientific publication:

Nagy Benedek (2010) Hyperbolic Discounting and Economic Policy. *Review of Economic Perspectives*, 3., 71-86. o.

(2) Incorporating the present values of utility flows calculated using quasi-hyperbolic discounting into the theory of optimal patents.

The quasi-hyperbolic discounting model which is established by behavioral economics to be more psychologically realistic has not yet been applied to the theory of optimal patents. Based on the previous results I incorporated the method of calculating present values for deferred perpetuities using the quasi-hyperbolic discounting into the model of optimal patents.

An innovation results in increased consumers' surplus for the consumers once the patent protection has expired and the technology has become freely available to everyone. This increased consumers' surplus is treated in the optimal patent models as a deferred utility-perpetuity, thus one can apply quasi-hyperbolic discounting when calculating its present value. My model shows a qualitative difference between the optimal patent life L^* calculated using exponential discounting and the optimal patent life L^{**} calculated using the quasi-hyperbolic discounting model so that $L^* > L^{**}$. The difference is qualitative meaning the magnitude or even the direction of the difference between the two can not be attributable to the long run discount rate used for the quasi-hyperbolic model (r_h) being lower than that of the exponential model (r_e). This is true even if the parameter used in the quasi-hyperbolic model to account for greater short run impatience (β) is ultimately absent from the formula determining the optimal patent life. When r_h approaches r_e from below, the optimal patent life calculated with the quasi-hyperbolic model approaches that calculated with the exponential model, so that $L^* = L^{**}$ when $r_h = r_e$. This is because the exponential case is a limiting case of the quasi-hyperbolic. This does not hold in the opposite direction: when r_e

approaches r_h from above, even if $r_h = r_e$, $L^* > L^{**}$ will still hold. If our optimal patent life model takes into account the mental discounting of the consumers, the optimal life of the patent will be shorter than if exponential discounting is assumed of the consumers.

The interpretation of the results lies in the consumer quasi-hyperbolically discounting welfare gains realizing in the distant future to a lesser degree than an exponential discounter, thus the exponential model overvalues welfare gains in the near future and undervalues gains in the distant future. According to the model, decreasing the patent term will push the time of innovation later, but brings the expiry of the patent protection earlier. Decreasing the patent term will be socially beneficial if the consumers in reality discount the short run welfare losses due to the later innovation to a smaller extent, and the long run welfare gains due to sooner patent expiry to a greater extent than exponential discounting would suggest.

Later it can be interesting to incorporate these alternative discounting models in more sophisticated models, or quantify the welfare losses resulting from non-optimal patent term for these models as well. Incorporating them in other optimal patent models can prove how robust my results are.

The theory of optimal patents is but one of many possible fields of application. The optimalization problem I discuss in my dissertation is a part of a larger class of problems, the so called Ramsey-problems. In these problems the government tries to set an optimal value of some parameter to achieve maximal social welfare under certain restricting constraints. Similar to what I have done, the quasi-hyperbolic discounting can be incorporated in models of optimal tax policy or the regulation of congestible goods.

My results have been published in the following scientific publication:

Nagy Benedek (2012c) A kvázi-hiperbolikus diszkontálás alkalmazása az optimális szabadalmak elméletében. *Szigma*, 1-2., 37-58. o.

(3) Introducing the notion of relative IPR strength and its incorporation into the literature studying the relationship between patent protection and international trade flows.

In the literature studying how the patent system affects international trade the relative IPR strength of trading parties have not yet been used.

In my dissertation I develop a static partial equilibrium north-south trade model, in which an export decision of an innovative company is influenced not only by the strength of the patent protection in the foreign country, but also the strength of this protection in the home country.

The possible imitation of an innovative product is determined by two things in my model: the technical and legal possibility to copy and market a product. In the model, the technical possibility to imitate depends on the complexity of the product: the more complex the product, the more difficult it is to imitate. The patent system is introduced into the model as a means to restrict the legal possibility to imitate an innovative product. In this sense of the word it can be paralleled with the patent breadth as it is used in the theory of optimal patents. In the model, every level of legal protection determines a marginal imitation risk, showing what technical imitation risk is worth for the innovator to take, given the risk of the legal possibility of imitation; which are the least difficult products to imitate he should export to the foreign country. When patent protection gets stricter, the probability of a successful imitation of the given innovative product (or technology embodied therein) decreases, encouraging the company to bring even technically more easily imitable products to the foreign country: marginal imitation risk increases. The model shows that the exporter might be willing to export more even with constant foreign patent protection strictness if protection is getting stricter in the home country. The simultaneous strengthening of the foreign protection increases his willingness to export even further.

If foreign patent protection is less strict both before and after the change than in the home country, but it gets stricter to a greater degree then the less developed country's relative IPR strength increases, it catches up with the developed exporting country. If a less strict foreign patent protection both before and after the change is combined with a lesser degree of strengthening, then the importing country's relative IPR strength decreases, it falls behind the developed exporting country. Both the importing country's catching up and falling behind has the same direction of effect on the export decision of the exporting country's innovative company, only the magnitude is different. A given absolute strengthening of patent protection in the less developed country increases the marginal imitation risk more, if the less developed county is catching up with its trading partner than when it falls behind it, regarding relative IPR strength.

Increasing marginal imitation risk affects the scope of products worth exporting differently in different industries. In my model I divided the high tech and low tech products. Within the high tech industries, the share of more complex and therefore technically less easily imitable products is higher, while for the low tech industries a larger share of the products is less complex and technically more easily imitable. Increasing marginal imitation risk will first increase export in the high tech industries, then later in the low tech industries. Thus, if catching up and relative strengthening of the importing country's IPR protection

increases the marginal imitation risk to a smaller extent, it should affect high tech products more. Falling behind then, by increasing marginal imitation risk to a greater extent will affect trade in low tech products more.

My results have been published in the following scientific publication:

Nagy Benedek (2009a) IPR Protection Strength and the Market for Knowledge. In Bajmócy Zoltán – Lengyel Imre (eds.) *Regional Competitiveness, Innovation and Environment*. JATEPress, Szeged, 183-197. o.

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(4) Examining bilateral trade flows depending on the change of relative IPR strength

To test the predictions of the model built in the dissertation, I investigated the effects of catching up or falling behind in terms of relative IPR strength using country pairs of developed exporter and less developed importer countries. The hypothesis stating that export of high tech products will increase more than low tech products with the increase of relative IPR strength for importers catching up than for importers falling behind can neither be rejected nor be accepted. I used multiple specifications to test the hypothesis, and whenever significant difference between the country groups (countries catching up versus countries falling behind) and industries (high tech versus low tech) could be identified it was in accordance with the hypothesis. From a total of 2520 cases, the difference in differences were found to be statistically significant at the 10% level in 672 cases (26,4% of total cases).

I divided the industries into three groups: high tech, low tech and medium tech industries. I compared change in trade value between these groups, then I pooled the high and medium tech, then the medium and low tech industries to compare changes in trade value with the remaining group. The high tech and the low tech industries are those that exhibit significant difference the most times (266 cases) between countries that catch up and countries that fall behind. High tech and medium tech comparisons resulted less times in significant differences (205 cases), but changes in trade value for medium tech and low tech product resulted the least times in significant differences (only 103 cases). Medium tech industries seem to be more similar to low tech than to high tech industries.

I carried out the study for two periods of time (1995-2000 and 2000-2005) and also for the pooled data. The first of the two time periods was more successful (resulting in significant differences in 317 cases), and the second period was the least successful, whereas the pooled data showed 147 cases of significant difference.

Based on the research we could say that high tech product export grew more than low tech product export to countries that catch up with their developed trading partners relative to those that fall behind their developed trading partners, in respect of relative IPR strength.

Changing the scope of exporter and importer countries to enter the sample based on their income levels, in most cases (220) a significant difference can be shown if the exporters are only those with high income while exporters can include countries with low, lower middle or upper middle income levels. If we exclude upper middle income importers, we will only find statistically significant differences in 173 cases. If we modify the original specification by including the upper middle income exporters, 157 cases of significant difference results. Making both the exclusion and the inclusion simultaneously the number of cases where significant differences are found fall back to 122 cases.

Both the model and the empirical study suggest that relative catching up and falling behind as a determinant of trade flows is a promising future line of research. It is important to identify further factors of influence (how to measure imitation ability, absorptive capacity, how to handle income disparities). The impact of changes in relative IPR strength can be investigated for specific groups of countries or other channels of knowledge diffusion (like FDI) as well.

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