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The Effects of Firing Costs on the Pattern of Trade, the Degree of Specialization and the Innovation Effort

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Abstract:

In this paper I investigate the impact of firing costs on the pattern of trade, the degree of specialization and the innovation effort. It shows that it is important not only to focus on the effect of labour market institutions on employment levels. I find evidence that mature industries benefit from firing costs because it creates a comparative advantage in mature industries. However young industries are negatively affected by firing costs. This implies that young and mature industries are not affected similarly by labour market liberalization. In addition I find a negative relation between firing costs and R&D activity. In a country with high firing costs this can limit the amount of innovation spill-overs. It may also harm the long term growth rate.

1. Introduction

A firm in the United Kingdom that fires an employee will have to pay him 22 weeks of wages. A firm in Spain would have to pay an employee 69 weeks of wages (World Bank Doing Business Report, 2009). In this paper I show evidence that these differences in firing costs have an effect on the comparative advantage and innovation activity of a country. In recent economic literature the importance of institutions as a source of comparative advantage is emphasized (e.g. Nunn, 2007; Cuñat and Melitz, 2007). Saint-Paul (1997; 2002) argues that labour market institutions affect the pattern of trade and the innovation activity in a country. This can have important long-term consequences. The specialization of countries into certain goods can have important welfare effects. For example, specialization into high-tech goods might be associated with positive spill-over effects. In addition, innovation activity is the base of technological progress. In endogenous growth models technological progress is seen as the main driver of long-term growth. Via innovation activity firing costs can influence the long term growth rate of a country. For these reasons it is vital to have a better understanding of the effects of labour market institutions on international trade.

In this paper the focus is on a specific labour market institution, firing costs. The goal is to investigate the relation between firing costs and international trade patterns. To the best of my knowledge, the effects of firing costs on international trade is an issue that has not yet been investigated. The findings are important to understand the effects of labour market liberalization. I will present evidence that some sectors actually benefit from high firing costs in their country, because the firing costs create an comparative advantage in these sectors. It is important to realize that these sectors would most likely be negatively hit if firing costs are lowered. The results imply that labour market liberalization will have a positive effect on some industries, but a negative effect on others. Also, the existence of firing costs can have a negative effect on innovation activity, which might have serious long-term consequences. The paper builds on a theoretical framework developed by Saint-Paul (1997; 2002). The outcomes of Saint-Paul’s theoretical framework have so far not been researched empirically.

In his theoretical model Saint Paul (1997) predicts the following effects of firing costs on the pattern of trade. First, *countries with high firing costs dedicate themselves to producing mature goods, while countries with low firing costs specialize into young (immature) goods.* The theoretical model builds on the assumption that the demand of mature goods is more stable and reliable. This implies for mature industries that fewer enterprises go bankrupt. This assumption is line with empirical research on plant survival over time (Dunne at al, 1989). Enterprises in countries with high firing costs will specialize in mature goods in order to avoid paying the firing costs. Because enterprises in the countries with no firing costs do not incur costs when firing employees they have an advantage in producing younger, and thus riskier goods. Second, *countries with high firing costs produce a smaller range of goods compared to low firing costs countries.* The higher the firing costs, the more production shifts into a smaller range of more mature goods. The predictions also imply the existence of an international production cycle. New products are first produced in low firing costs countries and later, when reaching a more mature age, the production moves to high firing cost countries. In Saint-Paul (2002) the innovation of goods is explicitly modelled. This leads to the third prediction: *R&D in countries with high firing costs aims more towards imitation than in countries with low firing costs. R&D in countries with low firing costs focuses more on primary innovation than in countries with high firing costs.*

In this paper I test these three predictions empirically. The data on firing costs is widely available covering a large range of countries thanks to the *Doing Business* project of the World Bank, which publicly provides data on the ease of doing business in countries. This data is available only since a few years so it has not been used extensively in empirical analyses. A measure of the maturity of industries is not available and had to be constructed. Like in the theoretical model, I follow the results of previous empirical research that show that the age of enterprises is negatively correlated with enterprise deaths, see e.g. Dunne at al. (1989). I construct a unique measure of industry maturity using data on the percentage of enterprise deaths in an industry.

For the first part of the research (on the first prediction of Saint-Paul, 1997) I build on a factor proportion specification by Romalis (2004) to investigate whether firing costs are an important determinant of the pattern of trade. To test whether firing costs and maturity jointly determine the amount of exports in a country I use a cross-country cross-industry regression. Romalis considers several factors of production, and tests whether countries that are abundantly endowed with a particular factor capture a higher share of the US import market in industries that use that factor intensively. I expand Romalis' specification and add to it variation in firing costs and industry maturity. The first part of the empirical analysis is related to a growing amount of literature that investigates the effect of institutions on the pattern of trade (Levshenko, 2004; Nunn, 2007; Cuñat and Melitz, 2007). This research differs from Cuñat and Melitz (2007) because I only look at one specific source of labour market rigidity: firing costs. Also I construct a measure of maturity, using data on enterprise deaths per industry. For the second part of the research I create a proxy to measure the range of goods which a country exports. Following Sapir (1996) I construct a Herfindahl index and a concentration ratio, to measure the degree of specialization of exports over industries. A high Herfindahl index and a high concentration ratio indicate a high degree of specialization. Conform the predictions of Saint-Paul's model a positive relation between firing costs and the specialization measures is found. For the third part of the research I construct a measure of the average R&D intensity in the most important exporting industries. R&D intensity proxies for innovation activity. It is reasonable to assume that innovation is more expensive than imitation. With this assumption, a low R&D intensity could indicate a high amount of imitation. I find a negative relation between R&D intensity and firing costs. This indicates that countries with low firing costs spend more on innovation and probably benefit more from innovation. In addition it could indicate that high firing cost countries are more active in imitation.

The remainder of the paper is organized as follows. The following section will discuss and review the related literature. The third section shows the mathematical derivation and a numerical example of Saint-Paul's models. Next, the data used in the empirical analysis will be described. The subsequent section will discuss the methodology and results. Section six concludes.

2. Literature Overview

In this section I consider first what labour market institutions are. Next, I discuss the influence that labour market institutions can have on the pattern of trade. Then I consider various related empirical researches that study the influence of institutions on international trade. Finally, I consider the literature that relates labour market institutions to the innovation effort in a country.

2.1 A General View on Labour Market Institutions

2.1.1 Employment Protection Regulation

Most labour market institutions serve a clear purpose: to protect the rights of employees. Employment protection regulation can take the form of explicit laws and regulations, but it can also be the results of agreements between labour unions and employers. One of the most important and prominent forms of labour market regulation is the dismissal protection. Dismissal protection includes notice requirements and severance payments. For employers, the dismissal protection makes the dismissal of employees costly and they incur the so-called firing costs. Other forms of employment protection are the limited use of short-term contracts and regulation of the maximum working hours. An even wider definition of employment protection regulation would also include issues such as maternity leave, health and safety regulations, mandatory sick pay and minimum wages amongst others (Addison and Teixera, 2003).

In much of the literature the focus is placed on firing costs. Firing costs have the following advantages: they are measurable (explicitly taken up in the law) and they are conceptually easy to understand. On the other hand, one has to be careful not to ignore the quality of law enforcements. Even if the law defines an explicit amount to be paid to a worker in case of dismissal, then it still depends on the quality of law enforcement whether this amount actually has to be paid. Also the actual costs that a firm incurs can be higher than the explicit amount, for example due to legal and administrative costs. Botero et al. (2004) take account of these limitations in their effort to calculate the economic costs labour market regulation. My dataset builds on the work by Botero et al. and also takes these factors into account.

2.1.2 Flexibility of the Labour Market

The flexibility of a labour market refers to the ability of agents in the labour market (both employers and employees) to adjust to shocks and/or changing economic circumstances. We can define several types of flexibility (Michie and Sheehan, 2003). First of all, *numerical flexibility*, which refers to the ability of firms to adjust the number of people employed. Second, *functional flexibility*, which is the extent to which a firm can adjust the amount of labour used, without resorting to the external labour market. This is achieved by employing a labour force that can carry out several tasks. Third we distinguish *wage flexibility*, which is the ability of a firm to adjust the system of payments to its employees. Employment protection regulation constrains employers to hire and fire employees to their most efficient use. Therefore, it is commonly argued, correctly, that labour regulation limits the mobility and movement of labour in an economy, and leads to a more rigid labour market. However, it is also common in countries with a high level of employment protection that offsetting measures, such as work-sharing, are in place that undo the negative effect on labour market flexibility (Abraham and Houseman, 1993). Another way to think about it is that employment protection legislation negatively affects the numerical flexibility, but that the compensating measures positively affect functional flexibility. In practice it is possible to measure the level of employment protection, but it is much more difficult to measure the level of such additional measures. Therefore, a country with much employment protection is said to have a rigid labour market. It is important to keep in mind that this is a simplification that ignores additional measures. In this paper the focus is on firing costs which affects the numerical flexibility, the ability to adjust the amount of labour used.

2.1.3 Employment Regulation and Unemployment

There is no consensus on the effect that employment protection regulation has on the economy and employment levels. For example in the 1970`s many Western-European countries increased the protection of employees through job security laws. One of the arguments used by proponents of these measures was that increased protection would lead to less people being fired and thus a lower unemployment rate. However, in the 1980`s many of these measured were reversed. One of the reasons for the reversal was the fear that too strong employment protection might increase unemployment, because the measures deter hiring more than firing (Abraham and Houseman, 1993).

In the debate on the effect of labour market institutions on the economy the differences between the United States and Europe offer an interesting point of view. A popular line of reasoning blames the relatively high unemployment rate in Europe compared to the United States to its inflexible labour markets. Because firms are restricted in laying of people when times are difficult, they are reluctant to hire in ‘good times’. Thus it contributes to the structural unemployment level. On the other hand, Abraham and Houseman (1993) argue that labour protection regulation is often accompanied by measures to facilitate the use of alternatives to firing people. An example of such an alternative is work sharing. Although the effect of labour regulation is that it will slow the adjustment to a shock, the additional measures spell doubt on the strength of this effect.

Interestingly, although the effect on unemployment is controversial, Blanchard and Portugal (2001) found a strong effect on labour turnover. They compare the US, a country with a flexible labour market, and Portugal, with a rigid labour market, and found an ambiguous effect of labour market institutions on unemployment. On the one hand the duration of unemployment is three times higher in Portugal than in the United States. On the other hand the flows into unemployment are three times lower in Portugal. The net effect is that both countries have similar unemployment rates.

Given the mixed theoretical and empirical results, it is clear that the effect of labour market institutions on the economy is an area that needs further researching. Focussing on the effect on international trade offers an interesting opportunity to contribute to this debate.

2.2 Labour Market Institutions & International Trade

Saint-Paul (2002) and Cuñat and Melitz (2007) argue that labour market institutions affect the pattern of trade of a nation. Consequently, labour market institutions also influence the welfare level of a nation and the innovation activity. Literature linking labour market institutions and international trade is scarce. The empirical research in this paper can form an important contribution in this area.

2.2.1 Specialization

In Saint-Paul (1997) firing costs are an important determinant of the international pattern of trade. Goods follow a life-cycle: each period new goods are introduced and a part of existing goods disappear. Older more mature goods have a lower chance to become obsolete. The main outcome of the model is that a country with high firing costs will specialize in `mature` industries, and a country with low/no firing costs will specialize in young industries. In Section 3 the model is discussed in full detail. To the best of my knowledge this paper is the first to test the predictions of Saint-Paul empirically.

Other theoretical models in which labour market institutions are a source of comparative advantage are few and far between. Cuñat and Melitz (2007) develop a two country model in which they analyze the effect of labour market rigidities on international trade. One of the countries is characterized by a fully flexible labour market, meaning that all wages are flexible. In the other country, wages are negotiated (by a labour union). There is a 'productivity draw', where firms find out the productivity in their industry. In the flexible labour market the allocation of labour takes place after the productivity draw. Thus labour is always allocated to the most productive place. In the inflexible labour market, labour is allocated before the productivity draw and can not be changed afterwards. In case the productivity is known with certainty before the draw, for example if it would stay the same as last year, then the country with an inflexible labour market has no disadvantage in any industry. However, when there are shocks in the productivity of certain industries then the rigid labour market has a comparative disadvantage in these industries. This gives the country with a flexible labour market a comparative advantage in industries where labour is often reallocated. This country will specialize in 'volatile' industries; industries where the productivity changes often. Their empirical findings confirm their theoretical predictions. They find that indeed countries with more flexible labour market export relatively more in volatile industries.

Galdón-Sánchez (2002) uses arguments from Saint-Paul`s paper, but arrives at a different mechanism through which employment protection legislation affects specialization. If labour protection regulation affects long-term unemployment then workers acquire less on-the-job skills. Such high skills are especially necessary in `new economy` sectors, such as the IT-sector, and thus the employment protection legislation creates a comparative disadvantage in these sectors.

2.2.2 Other Models on Labour Market Institutions and International Trade

Labour market regulation can also play a role in the investment decision of multinationals. Haaland and Wooton (2006) present a model in which firing costs influence the investment decision of multinational enterprises. Using a sample of Eastern European countries they find that labour market flexibility makes a country more attractive for foreign direct investment. Haaland and Wooton argue that firms take into account exit costs before making an investment. A rigid labour market means that there are large costs to laying off personnel. A multinational firm considering a foreign direct investment will find, ceteris paribus, a flexible labour market more attractive. In the theoretical model by Davidson et al (1999) the hiring side of the labour market institutions serves as a source of comparative advantage. They look at the 'search technology' of industries, or in other words the time it takes for a labour unit and a company to find each other. They find that a country with an efficient search technology has a comparative advantage in the high-unemployment/high vacancy sector.

2.3 Empirical Research on Institutions and International Trade

The methodology of the research in this paper is related to literature on the relation between institutions and the pattern of trade of countries. The common approach is to use a factor specification model, which builds on work by Romalis (2004).

2.3.1 Factor Specification Model

In Romalis' model, factor proportions determine the structure of commodity trade. The main idea is that a country captures a large share of world production in sectors that use intensively the abundant factors of that country. For example, countries that are abundant in physical capital are expected to export goods that are capital intensive. To test this prediction Romalis uses a factor proportion model, in which trade shares are explained by an interaction of factor intensity (industry-specific) and relative factor abundance (country-specific). Cuñat and Melitz (2007) also use a specification in the sphere of Romalis to test for the effect of labour market institutions on the pattern of trade.

2.3.1 Institutional Quality

Levchenko (2004) investigates the importance of institutional quality on comparative advantage. Specifically he focuses on contracting institutions: *"the arrangements that govern relationships between private economic parties"* (Levchenko 2004). Some sectors rely more on these institutions to enforce contracts than others, for example because they can not buy their inputs at spot markets. Ceteris paribus, a country with low institutional quality is less productive in institutionally dependent sectors than a country with high institutional quality. The contracting institutions can then be a source of comparative advantage. To investigate the theoretical predictions Levchenko augments the factor proportion model of Romalis with proxies for country institutional quality and industry institutional dependency. He finds that countries with inferior institutions capture a relatively lower share of US imports in institutional imports. Nunn (2007) also tests whether the quality of a country's contracting institutions is an important determinant of comparative advantage. Specifically he focuses on sectors in which relation specific contracts are important. Weak contract enforcement affects the pattern of trade through underinvestment in relation specific investments. Nunn also employs a factor proportion specification to find that countries with strong institutional quality have a comparative advantage in sectors that require relation specific investments. These papers show that institutions can play an important role in explaining the pattern of trade of countries.

2.4 Innovation

In Saint-Paul (2002) an extension to his 1997 model is discussed that incorporates the effects of firing costs on innovation. The literature that relates innovation activity and labour market institutions stresses that the effects of labour market institutions are strongly industry dependent.

2.4.1 Firing Costs and Innovation

In Saint-Paul (2002) firing costs have an effect on the rents from innovation. In the model there are two types of innovation. Primary innovation is the development of new goods that did not exist previously. Secondary innovation is the imitation of existing goods. When a good is imitated it becomes obsolete and only the imitating good is produced. A firm producing a 'new good' in a country with firing costs runs the risk of being imitated. In that case firing costs would be incurred by the producer. When taking a decision to innovate, the firing costs are taken into account by firms. The main outcome of the model is that countries with firing costs specialize more into imitation, and countries without firing costs specialize more into primary innovation. It can even be that a firing costs country fully specializes into imitation. Section 3.1.4 discusses the model in more detail.

2.4.2 Rents from Innovation

Similar to Saint-Paul (2002) much of the literature focuses on the influence that labour market institutions have on the ability to appropriate rents from innovation. Technological advance may require significant adjustment of the labour force. In industries with low elasticity of demand this may result in significant downsizing. Institutions that make the adjustment of the labour force costly reduce the rents from innovation, and thus reduce incentive for innovation. However it is stressed that the effect of labour market institutions is specific to the technology of the industry. In industries where technology is cumulative, training is an important alternative to lay offs. On the other hand in industries where technological progress is accompanied with frequent adjustments in the labour force firms are dependent on the labour market. Labour market institutions will affect the costs of these adjustment and influence the rents from innovation and the innovation effort (Scarpetta & Tressel, 2004; Bassanini and Ernst, 2002).

However, Kleinecht (1998) notes that labour market flexibility might harm the innovation effort. A non-innovating firm has an extra competitive option. Weak firms that are in trouble have the possibility to ask their employees to accept a lower wage, or face unemployment. This reduces the chance that a innovating firm can outcompete the non-innovating firms. The Schumpeterian process of creative destruction will not work properly. Furthermore, firms that innovate generally have higher growth rates of sales and unemployment. Thus innovating firms have less need to fire people than non-innovating firms. Labour market institutions that facilitate firing people would give an advantage to non-innovating firms.

3. A Theoretical Model on Firing Cost, the Pattern of Trade and Innovation

The following section draws on Saint Paul's 1997 paper *"Is labour rigidity harming Europe's competitiveness? The effect of job protection on the pattern of trade and welfare"* and Saint Paul's 2002 paper: *"Employment protection, international specialization, and innovation."* First the mathematical model will be presented to explain the effect of firing costs on the pattern of trade and the degree of specialization. Only an intuitive explanation will be given for the effect of firing costs on innovation activity. Section 3.2 will give a numerical example to explain the effect of firing costs of the pattern of trade and the degree of specialization.

3.1 Saint Paul's Model

Imagine a two-country world, in which the two countries are similar in all aspects, save firing costs. They have the same factor endowments and share similar technology. Also they are both open to trade, transportation of goods is costless, and the labour force is of equal size. The only difference is that in one country, when a firm fires their employees they incur firing costs. This country will be referred to as *country 1*. The other county has a fully flexible labour market, without any firing costs. From now on this country will be referred to as *country 2*. The goods in production have different maturities, where maturity is defined as the amount of time that has passed since the invention of a good. The model predicts that the country with firing costs will specialize in mature goods. Mature goods are less risky than young goods, and thus firms producing mature goods have a lower chance of ever needing to pay firing costs. On the other hand, the country with no firing costs will specialize in young goods, because in case of bankruptcy a firm does not have to pay any firing costs. If the firing costs in country 2 increase, then the country will specialize even more into mature goods. The range of goods will be smaller and on average more mature than initially.

Each moment in time there are N_t goods available. Each producer only sells one good. All consumers have the same utility functions:

$$U_t = \left(\int_1^{N_t} \log c_{jt} \, dj \right) \qquad (1)$$

Maximization of utility gives the traditional iso-elastic relative demand:

$$\frac{c_j}{c_k} = \left(\frac{p_j}{p_k}\right)^{-1} \qquad (2)$$

And the aggregate price index is:

$$\log p_t = \left(\int_1^{N_t} \log p_{jt} dj\right) = 0 \qquad (3)$$

3.1.1 Prediction 1

Each moment in time, a producer faces the risk that the good he manufactures is not desired by consumers anymore. Thus at some moment the good yields no utility anymore. The chance that a good becomes obsolete is given by a *hazard function* h(s). The variable s indicates the age of the good. The hazard rate declines with the age of a good. The assumption that age and death rates are negatively related is based on empirical research (e.g Dunne et al, 1989). A good will become obsolete with a probability h(s) and subsequently the firm will have to fire its employees. The firing costs that the company will have to pay are modelled as a tax that is paid to the government. The government uses the proceeds from the tax to give a lump sum to local consumers. Thus the taxes do not have a direct effect on welfare.

In country 1, the firing costs are proportional to the wage rate. Let F denote the portion of the wage that has to be paid as firing costs (total firing costs are equal to $F*w_1$). Then the *shadow costs* of employing a worker becomes $w_1(1 + h(s)F)$. Because of the existence of firing costs, the real costs for an employer of hiring a worker thus depends on the age of the good it produces. As h(s) decreases with age, so do the shadow costs. For a producer the costs of production consists of two parts: first of all, he has to pay the wage costs w_1. In addition he takes into account the amount of firing costs he must pay in case the good becomes obsolete. Thus the costs of production are decreasing with the age of the goods.

In *country 2* a firm can adjust the size of its labour force without incurring any firing costs. Thus the cost of production only depends on the wage rate. The price of a good will be equal to the marginal costs of production. When setting the price, a producer in country 1 will take into account the probability of paying firing costs. The firing costs thus influence the price consumers have to pay. The price of a good of maturity ‘*s*’ produced in country 1 will be:

$$p(s) = w_1(1+h(s)F) \quad (4)$$

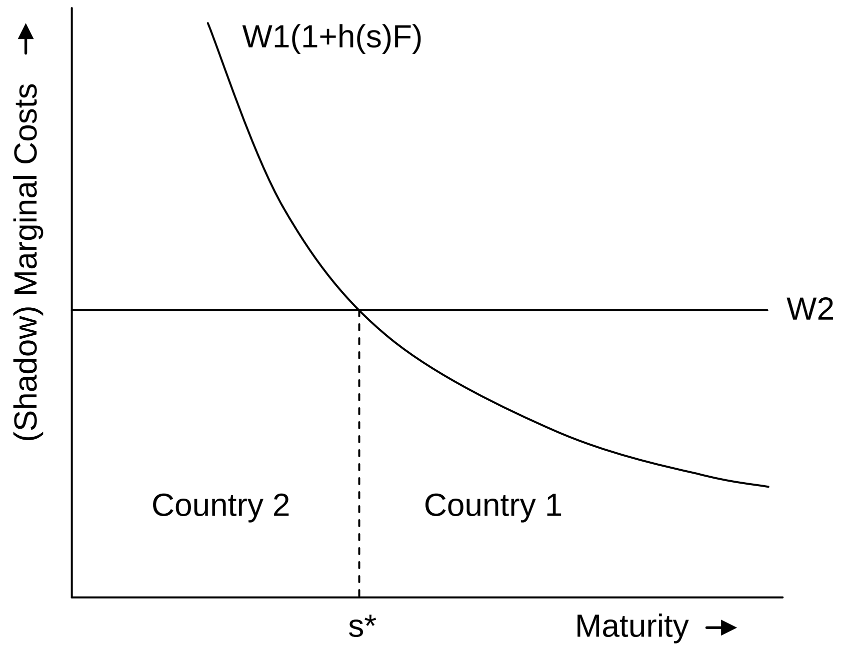
The price of a good of maturity s produced in country 2 will be:

$$p(s) = w_2 \quad (5)$$

A product will be produced in the country where it is the cheapest to be produced. There exists a good with maturity s*, for which the marginal production costs are the same in both countries. I call this good the *marginal good*. This maturity s* is found by solving the following equation:

$$w_1 = w_2\left(1 + h(s^*)F\right). \quad (6)$$

Graph 3.1: Maturity versus (shadow) marginal costs



Source: Saint Paul (1997)

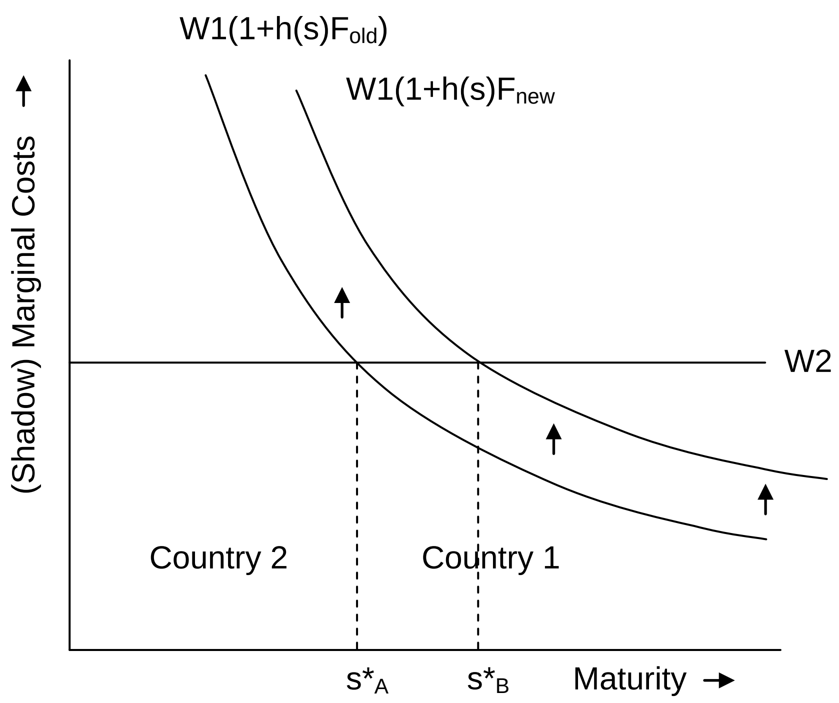
For a more graphical intuition the situation is depicted in graph 3.1. Recall that h(s) is decreasing in s. Therefore the marginal costs of employing an additional worker are decreasing with the maturity of a good. If a good is sufficiently mature, in other words s is bigger than s*, then it is cheapest to produce the good in country 1. If s is smaller than s* it is cheaper to produce in country 2. Thus country 1 will produce all goods with a maturity bigger than s* and country 2 will produce all good with a maturity lower than **s***. Thus a pattern of trade emerges, where country 1 exports goods of a maturity bigger than s*, and country 2 exports goods of maturity smaller than s*.

> **Prediction 1:** *Countries with high firing costs dedicate themselves to producing mature goods and countries with low firing costs into young (immature) goods.*

3.1.2 Prediction 2

Now we examine what happens if firing costs would change in this two country model. If firing costs increase in country 1, then the shadow costs of each good it produces will be higher. Graph 3.2 shows what happens if firing costs increase in country 1. Country 1 will not be competitive anymore in the (old) marginal good s^*_A, and this good will only be produced by country 2. In the new situation there is a new marginal good $\mathbf{s^*}_B$, for which the marginal production costs are equal in both countries. The maturity of s^*_B is higher than that of $s^*_{\mathbf{A}}$**.** In other words, an increase in firing costs moves up the maturity of the marginal good s*.

Graph 3.2: The effect of an increase in firing costs



Because country 1 only produces goods that are more mature than s*, this means that country 1 will specialize in a smaller range of goods. The following section develops the mathematics.

Given the maturity and of a good and the firing costs per country the quantity c(s) of a good that is produced is:

$$c(s) = X/\left(w_1\left(1+h(s)F\right)\right) \qquad \text{if } s > s^* \qquad (7)$$

$$c(s) = X/w_2 \qquad \text{if } s < s^* \qquad (8)$$

where X denotes an index of aggregate world demand.

The full employment conditions for each country are:

$$\frac{X}{w_2}\int_{s^*}^{+\infty}\frac{n(s)}{1+h(s)F}ds = 1 \qquad (9)$$

$$\frac{X}{w_1}\int_{0}^{s^*}n(s)ds = 1 \qquad (10)$$

Here, n(s) is the amount goods of a maturity s. The amount of goods of a certain maturity is given by the following function:

$$n(s) = ze^{-\int_0^s h(s)ds} \qquad (11)$$

Each period an amount of z unit of new products (maturity of 0) are taken into production. This amount is determined exogenously. Section 3.1.4 discusses an extension to the model in which the amount of new goods (innovations) is determined endogenously

If equations 6, 9 and 10 are combined an equation for s* can be found:

$$\int_0^{s^*}e^{-\int_0^s h(s)ds}ds = \left(1+h(s^*)F\right)\int_{s^*}^{+\infty}\frac{e^{-\int_0^s h(s)ds}}{\left(1+h(s)F\right)}ds \qquad (12)$$

Next, if F is small, the following simplification applies: 1/(1+h(s)F) ≈ 1 - h(s)F. Then we can derive a function for s*:

$$s^* \approx \hat{s} + \sigma F \tag{13}$$

Where $\hat{s}$ is the unique solution to

$$\int_0^{\hat{s}} e^{-\int_0^s h(s)ds} ds = \int_{\hat{s}}^{+\infty} e^{-\int_0^s h(s)ds} ds \tag{14}$$

and,

$$\sigma = \frac{1}{2}\left[\frac{h(\bar{s})\int_{\bar{s}}^{+\infty} e^{-\int_0^s h(u)du}}{e^{-\int_0^{\bar{s}} h(u)du}} - 1\right] > 0 \tag{15}$$

Sigma, σ, in equation 15 is always a positive number. From equation 13 it follows that the maturity of the marginal good is positively dependent on F. In other words, if firing costs are increased, the s* shift upwards and country 1 produces a smaller range of goods. Thus higher firing costs leads to more specialization in country 1.

> **Prediction 2:** *Countries with high firing costs produce a smaller range of goods compared to low firing costs countries.*

3.1.3 Effects on Welfare

Hitherto I have only explained the part of Saint-Paul's model that is most relevant for my research. Yet is interesting to consider briefly here the outcome of the model with respect to the welfare level in both countries. In order to fulfil the full-employment equilibrium in country 1, wages must decrease in that country. Wages decrease more strongly than the average amount of tax that is collected with the firing costs. Thus the welfare level in country 1 decreases. The firing costs lower the price of goods produced at home compared to abroad. For country 2 this implies that goods are on average cheaper, which increases their welfare. For country 1 goods are on average more expensive and their welfare is reduced due to the firing costs. For the mathematical derivation of the effect on the welfare level, see the original paper by Saint-Paul (1997).

3.1.4 Prediction 3

It is not illogical to assume that younger goods are more high-tech. Then the no-firing costs country will specialize into high tech goods, which generally have high R&D expenditures (Saint-Paul, 2002). Thus firing costs can influence R&D expenditures. For this reason in Saint-Paul (2002) the model is extended to include the effects on the pattern of innovation.

The set-up of the model is similar. In one country firing costs exist whereas in the other country they do not. There are two types of innovation. Primary innovation is defined as the invention of new goods. A firm obtains a patent on a newly invented good which gives them the sole right to produce the good. Secondary innovation refers to an improvement in the efficiency to produce an existing goods. A secondary innovation enables a producer to produce the original good, despite the patent of the inventor. Moreover, the primary innovator is run out of business because the secondary innovator is more cost efficient. There are decreasing returns to innovation. To simplify the model, only one imitation is possible for each product. The death rate of producers is determined by the chance of a good to become or obsolete and the risk of being imitated.

Each country has a fixed group of researchers, that devote their time to either innovation or imitation. An increase in firing costs decreases the benefits of primary innovation. Therefore it shifts the division of researchers towards imitation. In a closed economy both countries will imitate and innovate. However, because the benefits to innovation are lower, the firing costs country will imitated more and innovate less than the firing costs country. The firing costs country innovates to keep having an influx of new goods (otherwise at some moment there will be no goods). In an open economy, two equilibriums can arise: one where the firing costs country fully specializes into imitation and the no-firing costs country specializes fully into innovation. Second, the equilibrium can be such that both countries are active in both imitation and innovation. In this equilibrium the country with firing costs will always imitate more than the no-firing costs country. Similarly the country without firing costs will always innovate more than the high firing costs country.

The effect of firing costs is that a country will shift its R&D resources away from innovation towards imitation. If we assume that primary innovation is more expensive than secondary innovation, then we should see higher level of R&D expenditure in the no-firing costs country. The theoretical implications are summarized into the following prediction:

Prediction 3: *R&D in countries with high firing costs aims more towards imitation than in countries with low firing costs. R&D in countries with low firing costs focuses more on primary innovation than in countries with high firing costs.*

3.2 Numerical Example

The first two predictions from Saint-Paul can perhaps best be illustrated using a numerical example. In the numerical example I explicitly model the hazard rate. It allows for explicit changes in the size of the firing costs.

3.2.1 Assumptions of the Numerical Example

The situation is the same as above: consider a two-country world, where firing costs exist in one country, but not in the other. In country 1 there are firing costs, whereas there are no firing costs in country 2. Aside from firing costs the countries are similar in all aspects. Both countries are endowed with 500 labour units and each labour unit can produce one good. The wage rate in country 2 is normalized and set to 1. To ensure full employment equilibrium, wages in country 1 adjust in reaction to the level of the firing costs.

Each period a number of goods become obsolete. The chance for a good to become obsolete is negatively related to the age of a good. The hazard function for a good to become obsolete is defined as:

$$h(s) = \frac{0{,}25}{\sqrt{age_s}} \qquad (16)$$

The innovation rate is assumed to be constant. Each period 100 new goods are taken into production. Of the 100 goods introduced at a certain moment in time, 99,2% becomes obsolete within 100 periods.[1] Because only a small fraction survives I assume that all goods are taken out of production after the 100th period. In a long-term equilibrium there are 1000 unique goods in this world. Appendix A gives an overview of all assumptions needed to replicate the numerical example.

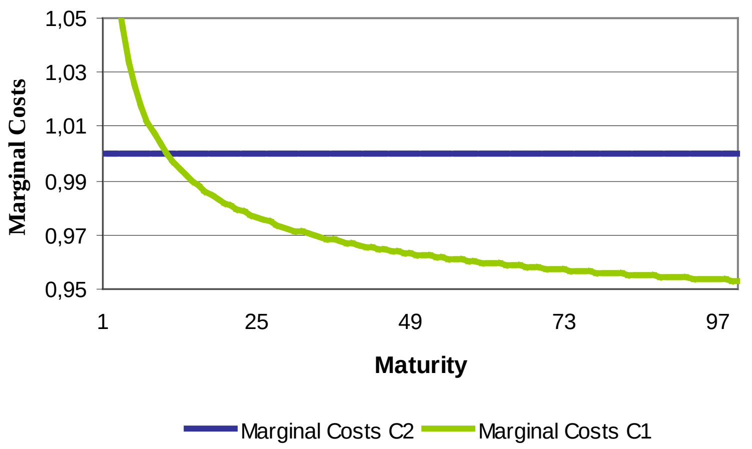
[1] For simplicity of the model I assume that fractions of goods exist. Therefore a 0,8 good can in fact be produced. Also I assume a labour unit can split its work time between two goods.

These simple assumptions are sufficient to investigate the pattern of trade in this hypothetical example. The hazard function above is used to calculate the number of different goods of a certain maturity. With equations 7 and 8 from the theoretical model above the quantity produced per good can be calculated. The price per good can be calculated with equations 4 and 5 from the theoretical model. The model itself is solved using Excel. The wage level in country 1 will adjust to ensure full employment in both countries.

3.2.2 Pattern of Trade in the Numerical Example

As an initial situation consider that the firing costs in country 1 are 1 times the wage rate. If all markets are in equilibrium, country 1 has a wage rate of 0,93 while country 2 has a wage rate of 1. Graph 3.3 shows the production costs in both countries. In country 2 the costs of production for each good is equal to 1, which is the wage rate. In country 1 the costs of production consists of the wage rate plus the possibility that firing costs will be incurred. The cost of production curve for country 1 is downward sloping because the possibility that firing costs will be incurred is negatively related to maturity. The marginal good, for which production costs are equal in both countries, has a maturity of 11 periods.[2] The production of goods with a maturity of 11 periods is shared by both countries. As graph 3.3 shows, the costs of production for goods with a maturity superior to 11 is lower in country 1, and are produced there. Similarly costs of production for goods with a maturity smaller than 11 periods are lower in country 2, and these will be produced there.

Graph 3.3 Marginal cost curve as a function of maturity



[2] There are 25,7 goods with a maturity of 11 periods. These are all 'marginal goods' for which the costs of production are the same in both country. In the scenario where firing costs are 1 times the wages rate, country 1 produces 25,0 goods with a maturity of 11 periods, while country 2 produces 0,7 goods with a maturity of 11 periods.

3.2.3 Low, Medium and High Firing Costs

Another way to illustrate the effect is to solve the model under different firing costs in country 1. The three situations are: low firing costs (0,25 times the wage), medium firing costs (1 time the wages) and high firing costs (10 times the wage). The most striking feature is that when firing costs increase from 0,25 to 10, the maturity of the marginal good shifts from 10 to 12. Thus the range of goods exported by country 1 decreases as firing costs increases. This is in line with the second prediction of Saint-Paul. This means that range of goods exported by country 1 decreases from 498 to 463. Also, table 3.1 shows that firing costs have a negative effect on wages and welfare. In the high firing costs scenario wages are only 0,58. The welfare loss is captured by the decrease in income from 496 to 428.

Table 3.1 Scenario Analysis

Endogenous Variable	**Firing Costs = 0,25**	**Firing Costs =1**	**Firing Costs = 10**
Maturity Marginal Good	10 periods	11 periods	12 periods
Wage in Country 1	0,98	0,93	0,58
Range of Goods Exported by Country 1	498	494	463
Total Income in Country 1	496	488	428

4. Data Description

To test the first two prediction of Saint-Pauls model, data is needed on a country-specific level, an industry-specific level, and data that is specific to both the country and the industry. Appendix B gives an overview of all variables used and the sources.

4.1 Country Level Data

The main country level variable of interest is the firing costs. In addition several control variables are used, such as human capital, physical capital and GDP per capita.

4.1.1 Firing Costs

The data on firing costs is from the World Bank *Doing Business Report 2009*. The Doing Business project attempts to map the country regulations that affect companies. The firing costs are measured in weeks of salary. It includes the notice requirements, severance payments and penalties due when terminating a redundant worker. The collection method is based on work by Botero at al. (2004). To calculate the firing costs certain assumptions are made about the type of company and the type of employees to make the data comparable over all countries. Given the assumptions on the worker and the business, the firing costs are calculated as the sum of the notice requirements, severance payments and penalties due, when 10% of the employees are fired for redundancy and 10% are fired for no reason. Appendix C shows the full list of assumptions made to calculate firing costs.

4.1.2 Human Capital, Physical Capital and GDP

The data on human capital level is drawn from the Barro & Lee dataset (2001). It is measured as the average years of schooling of the population aged 25 years and older. I use the most recent data available, from the year 2000. The data on physical capital levels is taken from the Penn World Table version 5.6 (in the PWT 6.0 and 6.1 versions this variable is not yet available)[3]. It is measured as the amount of physical capital per worker. Due to the fact that data availability is low, physical capital is one of the main limiting factors regarding the amount of countries included in the analysis. For physical capital, I also use the most recent data available, which stems from the year 1992. The data on the GDP per capita is taken from the World Development Indicators and stems from 2007.

[3] Although a note must be made that Cunat and Melitz (2007) do have access to the capital per worker data from PWT 6.0 and PWT 6.1. This explains why they can include much more countries in their analysis.

Table 4.1 Descriptive Statistics: Country Level Variables

Descriptive	Human Capital	Physical Capital	GDP per Capita	Firing Costs
Mean	8,64	24.123	26.066	39,45
Median	9,02	23.313	29.435	26,00
Standard Deviation	2,16	13.615	13.829	31,97
Skewness	-0,29	-0,03	0,14	0,49
Kurtosis	2,17	1,64	2,10	1,96

4.2 Industry Level Data

For the empirical analysis a measure of the maturity of industries is needed, as well as data on the factor intensities used in production. The industry specific data is organized according to 4-digit NAICS (North American Industry Classification System) and covers 80 industries.

4.2.1 Maturity

There is no dataset with information on the maturity of industries. As far as I know there is no research that tries to use a proxy to measure the maturity of an industry. Therefore, relying on theoretical research I create a variable to measure maturity using data on the death rate of enterprises per industry. Several theoretical models link the age of a firm to a hazard rate of exit. Jovanovic (1982) and Hopenhayn (1992) develop a model where the hazard rate of failure is a decreasing function of age. As a firm matures it learns more about its productive capabilities and it is able to make a better decision to stay in the market or to exit. Looking specifically at goods, it is also likely that older, more mature goods have a lower chance to become obsolete for at least two reason. First, consumers learn over time whether a good is really useful or not. Second, it takes a while before standards are established (Saint-Paul, 1997). Think for example of the dvd-sector, where survival of blue-ray or other types depends on whether they become a common accepted standard. Empirical research by Dunne et al. (1989) confirms the negative relation between firm age and death rates. Based on the results of these papers, I use the percentage of firms that do not survive as a base to measure the maturity of an industry.

The ‘death rate’ per industry is estimated as the amount of enterprise deaths during a year divided by the amount of enterprises at the start of the year. The death rate is negatively related to maturity. Thus a relatively high death rate implies that the industry is relatively young. Next, I define the maturity of an industry as:

$$Maturity = \frac{100 - \%enterprise\_deaths}{\%enterprise\_deaths} \qquad (17)$$

The data on enterprise deaths is taken from the US Census Bureau from the SUSB (Statistics of US Business) data. I assume that the ranking of maturities are similar over different countries. This is a strong, but necessary assumption. There is only a limited amount of data available on enterprise deaths from other sources. For example in the OECD STAN database data on many sectors for many countries is not disclosed, making any analysis very limited. Therefore I use data from the US Census Bureau. In addition the US Census data has the advantage that it covers much more industries. To justify the use of US Census data, I performed Spearman Rank Correlation tests on the STAN data. Except for the smallest country, New Zealand, the ranking of industries in order of maturity in all countries shows a significant correlation with the maturity in the USA. The results of the Spearman Rank Correlation tests are shown in appendix C. Also, the US Census data covers more years, which allows us to average it over the last 5 years. I average in order to eliminate distortions due to yearly fluctuations. Appendix E shows the 10 most and the 10 least mature industries.

4.2.2 Factor Intensities

The measures for factor intensities are not available for a large range of countries and industries. In line with previous research I assume that the ranking of the measures do not vary across countries (Cuñat and Melitz, 2007). Therefore I use data from U.S. industries to measure the physical capital and skill intensity. The data on capital and skill intensity are taken from the NBER CES Manufacturing database. The data is available in 4 digit NAICS. In previous research different measures of skill and capital intensity are used. In practice they are highly correlated and yield very similar results (Cuñat & Melitz, 2007). I follow Cuñat and Melitz, and define capital intensity as the amount of capital per worker in an industry. Skill intensity is measured as the amount of production wages divided by total wages paid.

Table 4.2 Descriptive Statistics: Industry level variables

Descriptive	Maturity	Skill Intensity	Capital Intensity
Mean	11,26	0,39	176,66
Median	11,34	0,38	125,91
Standard deviation	2,55	0,13	163,60
Skewness	0,03	0,88	2,76
Kurtosis	3,18	3,72	12,65

4.3 Country-Industry Level Data

The two country-industry specific data used in the empirical research are export and R&D intensity. For the first two parts of the research export data is used from World Trade Flow dataset (Feenstra, 2005). For the third part of the research export data from the OECD STAN Database is used. The R&D intensity is also only used in the third part of the research.

4.3.1 World Trade Flow Dataset

The data on exports is obtained from the World Trade Flow dataset from Feenstra (2005). The export data measures the amount of exports per country per industry to the rest of the world. It is classified according to 4 digit SITC rev2 (Standard International Trade Classification). For the empirical analysis I use industry data classified according to NAICS. The export data is converted into 4 digit NAICS with Feenstra's conversion table. After the conversion and exclusion of non-manufacturing industries 80 industries are left. In order to eliminate yearly fluctuations in the distribution of exports I average the exports over the last 5 years. This approach is in line with that by Cuñat and Melitz (2007). To calculate these averages the most recent available data is used, for the years 1995-1999. The countries that have many 0 export industries are excluded from the dataset. If in a country many industries have 0 export it can be due to country specific reasons, unrelated to physical capital endowments, human capital endowments or labour market characteristics. Also several countries are counted together in the Feenstra dataset. For example Belgium and Luxembourg exports are lumped together. Because this might create a bias I also exclude these countries. The final dataset for the first two predictions consists of 32 countries.

4.3.2 STAN Indicator Dataset

Data on exports for the third part of my research is obtained from the OECD STAN Database for Structural Analysis. This data is used instead of the World Trade Flow data because it uses the same concordance as the R&D intensity data. The data on exports is from 2002 until 2006. Similar to the data above, the exports per industry are averaged over these 5 years to avoid the effect of yearly fluctuations in the distribution of exports. The dataset covers 22 countries and 18 manufacturing industries. The industries are categorized according to ISIC rev. 3.

Table 4.3 Descriptive Statistics: Industry-Country specific data

Descriptive	WTF Export Data	OECD Export Data
Mean	1299	1496108
Median	169	11272
Standard deviation	4277	1329978
Skewness	8,77	17,43
Kurtosis	107,77	336,76

4.3.3 R&D Intensity

R&D intensity is defined as the ratio of Business R&D expenses per industry to total exports per industry. The data on R&D intensity is obtained from the OECD STAN Indicators 2009. Also the R&D intensity per industry is averaged over 5 years (2002-2006). Data is collected for 22 countries and 18 manufacturing industries and the industries are categorized according to ISIC rev. 3. It is important to note that R&D intensity only measures the input to innovation activity and not the output. Also, it only captures the formal part of R&D expenditures, while in many industries informal innovation effort is also important. The data on R&D intensity is only used in the third part of my research.

Table 4.4 Descriptive Statistics: Average R&D Intensity per Country (in %)

Country	Average over all Industries	Median	Standard Deviation	Average Top Tercile
Austria	2,54	1,53	3,31	2,22
Belgium	2,67	0,72	3,56	1,44
Canada	2,39	0,60	3,88	1,18
Czech Republic	0,60	0,26	0,80	0,63
Denmark	2,95	0,62	4,16	4,94
Finland	2,89	1,51	3,52	3,28
France	2,79	1,44	3,09	2,92
Germany	2,58	0,99	3,06	3,94
Greece	2,10	0,18	4,92	0,36
Hungary	0,33	0,10	0,73	0,74
Iceland	2,36	0,25	4,72	5,81
Italy	1,05	0,31	1,55	0,68
Japan	4,48	2,04	6,06	6,04
Korea	1,24	0,61	1,52	2,36
Netherlands	4,00	0,75	11,86	10,08
Norway	2,48	1,19	2,81	1,32
Poland	0,23	0,11	0,24	0,23
Portugal	0,39	0,13	0,49	0,61
Spain	1,10	0,43	1,16	0,85
Sweden	4,10	1,15	4,78	6,11
United Kingdom	2,56	1,02	3,12	3,49
United States	3,85	0,83	5,36	9,09

5. Empirical Research

The empirical research is divided into three parts, corresponding to the three predictions of Saint-Paul. The first part describes the analysis of the effect of firing costs on the pattern of trade. The second part examines the prediction that countries with relatively high firing costs will specialize into a smaller range of goods. The third part focuses on the relation between firing costs and innovation activity in the most important export sectors.

5.1 First Prediction of Saint Paul’s Model

The first prediction from the model by Saint-Paul states how firing costs affect the comparative advantage of a country. Countries with relatively high firing costs specialize in more mature goods and countries with low firing costs specialize in young goods.

5.1.1 Methodology

To estimate the impact of firing costs on the comparative advantage I use a factor proportion specification. I will also take into account a country’s physical and human capital abundance and their effect on the pattern on trade. In order to test the effect of firing costs on the pattern of trade I consider the following regression:

$$\begin{aligned} \text{Ln}(\text{exports}_{ic}) = \; & \beta_1 (\text{Firing Costs}_c) + \beta_2 \; [\text{Firing\_Costs}_c * \text{Maturity}_i] + \\ & \beta_3 \; [\ln(\text{Capital Intensity}_i) * \ln(\text{Capital abundance}_c)] + \\ & \beta_4 \; [\ln(\text{Skill Intensity}_i) * \ln(\text{Skill abundance}_c)] \end{aligned} \qquad (18)$$

Romalis (2004) applies this functional form to the area of trade to test the importance of factor endowments on the pattern of trade. Romalis uses as an independent variable the value of imports into the US per country and industry. However there is also good data available on the amount of exports per industry from one country to the rest of the world, published by Feenstra et al. (2005). Therefore I follow the approach of Nunn (2007) and Cuñat and Melitz (2007), and take as an independent variable the natural logarithm of the value of exports per country per industry to the rest of the world.

Saint Paul’s model predicts that countries with high firing costs specialize in mature goods and countries with low firing costs specialize in young goods. Therefore I expect the coefficient β_1 to be negative and β_2 to be positive. Jointly, this implies that for young industries the effect of firing costs is negative. A positive coefficient of the interaction term firing costs*maturity would indicate that for more mature industries the effect of firing costs can be positive. Moreover traditional trade literature expects capital abundant countries to export capital intensive goods while human capital abundant countries are expected to export skill intensive goods. Thus the coefficients β_2 and β_3 are expected to be positive.

5.1.2 Results

Table 5.1 shows the empirical results for the regression specified in equation 18. The first specification is a variation that only includes the variables firing costs and the interaction term firing costs*maturity. The second specification includes all variables as described in equation 18. The third contains additional control variables, such as the level of GDP per capita and the level of capital per worker and the average amount of schooling.

I find evidence that countries with high firing costs specialize in mature industries and countries with low firing costs specialize in young industries. Table 5.1 shows the result from the regressions. The first specification, which only includes firing costs and the interaction term firing costs*maturity, shows that firing costs alone indeed have a negative influence on the exports of an industry. The interaction term firing costs*maturity is positive and reverses the negative influence of firing costs when the industry is sufficiently mature. Both coefficients are highly significant. These results indeed confirm the expectations from the model of Saint-Paul. The R-squared of the first specification is 29%.

The second specification includes further standard control variables similar to other empirical studies (e.g. Cuñat & Melitz, 2007)). It includes the interaction term between physical capital abundance and capital intensity and the interaction term human capital abundance and skill intensity. Including these interaction terms increases the significance of the specification considerably. The signs of the interaction terms are in line with results from previous trade literature (e.g Romalis, 2004). For further comparison with other empirical research in Appendix F the standardized coefficients and standard errors are reported. The size of the coefficients reported in appendix F are also in line with previous research. The positive coefficient on physical capital abundance*capital intensity implies that countries that have a high level of physical capital specialize in industries that use physical capital intensively. Similarly the positive coefficient on human capital abundance*skill intensity implies that countries with a high level of human capital specialize in industries that use human capital intensively. The coefficient for firing cost decreases slightly whereas the coefficient of firing costs*maturity stays the same. The coefficients are significant at a level of 1% and 5% respectively. The third specification includes additional control variables. The previous presented results are robust to the inclusion of these control variables. Again the coefficient on firing costs slightly decreases while the coefficient on firing costs*maturity does not change much. Both coefficients remain statistically significant at a 1% and 5% significance level respectively. The R-squared increases to 43% due to the inclusion of the control variables.

Hence these results suggest that firing costs have a negative influence on young industries. As the maturity of an industry is higher there is a tipping point where the influence of firing costs on an industry is positive. This cut-off point is skewed quite far to the mature industries. Over the three specification the results indicate that for the 83-94% youngest industries the effect of firing costs on exports is negative, but that for the 6-17% most mature industries the effect is positive.

Table 5.1 Regression results prediction 1

Independent variable: natural log of exports in industry i from country c to the rest of the world

Specification	1	2	3
Variable	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Firing Costs	-0,044 (0,010)***	-0,037 (0,009) ***	-0,031(0,010)***
Firing Costs * Maturity	0,002 (0,0009)*	0,002 (0,0008) **	0,002 (0,0008)**
Ln[Physical Capital Abundance] * ln[Capital Intensity]		0,152 (0,015) ***	0,168 (0,067)**
Ln[Human Capital Abundance] * ln[Skill Intensity]		0,213 (0,060) ***	1,816 (0,403)***
GDP per capita			1,254 (0,083)***
Physical Capital Abundance			-1,538 (0,348)***
Human Capital Abundance			-6,498 (1,475) ***
R-squared	0,287	0,378	0,433
F-statistic	1,228	1,815	2,199

Note1: Sector fixed dummies included.

Note2: * significant at 10%, **significant at 5%, *** significant at 1%.

5.2 Second Prediction of Saint Paul's Model

According to the second prediction, the higher the firing costs, the smaller the range of goods a country produces. Thus I expect that countries with high firing costs have high degree of specialization.

5.2.1 Methodology

To test the second prediction of Saint-Paul, I use the same dataset as in section 5.1. In Saint-Paul's model the level of specialization is defined as the number of goods that a country exports. Thus a practical definition of specialization is required. I draw on measures that are commonly used in economics to determine the level of competition in a sector. The first measure is a Herfindahl index, calculated by summing the squared export share of each industry[4]. Sapir (1996) uses the Herfindahl index to compare the degree of specialization between France, Germany, Italy and the United States. The advantage of the Herfindahl index is that it takes into account all industries in which a country exports. The second measure is the four-industry concentration ratio. The concentration ratio is calculated by summing the market share of the four largest export industries in each country. The concentration ratio has the advantage that if focuses only on the 4 most important exporting industries.

To analyze the relationship between firing costs and specialization I run the following regression:

$$\textit{Concentration Ratio} = \beta_0 + \beta_1 * \textit{Firing Costs} + \beta_2 * \textit{GDP} + \beta_3 * \textit{Physical Capital} + \beta_4 * \textit{Human Capital}. \qquad (19)$$

The model of Saint-Paul predicts a positive relation between firing costs and the concentration ratio. Thus I expect the β_1 to be positive. The other variables serve as control variables. GDP proxies for the economic size of a country. It is possible that economic size has an influence on the level of specification. A smaller economic power may not be able to produce in a wide range of industries. Similarly physical capital abundant or skill abundant countries will specialize into industries that use that factor intensively, which can have an influence on the concentration ratio.

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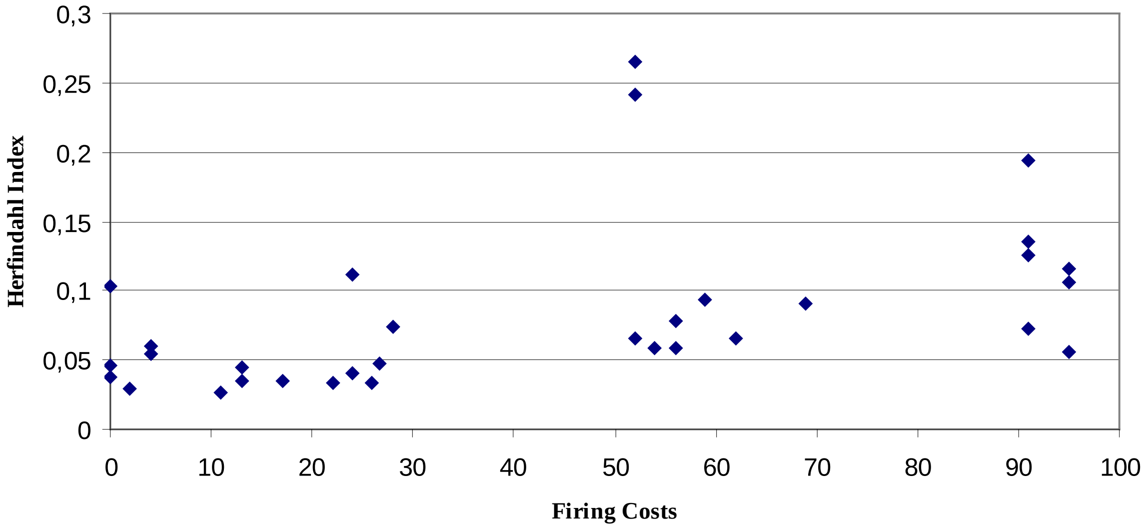
4 HH-exports$_c$= $\sum s_i^2$, where s_i is the export share of industry *i* in country *c* relative to total exports in country *c*.

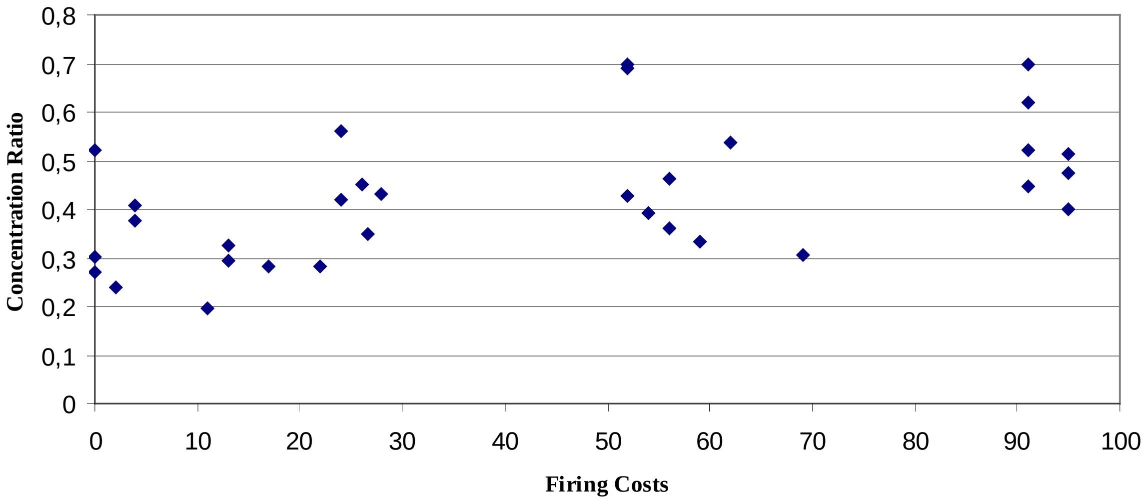
5.2.2 Results

The expectation is that countries with relatively high firing costs have a relatively high Herfindahl index, which indicates a high degree of specialization. Graph 5.1 shows a scatter diagram plotting the Herfindahl index versus the firing costs. The graph presents evidence of a positive relation between the Herfindahl index and firing costs in a country. Graph 5.2 plots the four-industry concentration ratio versus firing costs. The pattern is similar, but more pronounced than the Herfindahl index. There is a clear positive relation between the concentration ratio and firing costs.

Graph 5.1 Scatter diagram: the Herfindahl index versus firing costs



Graph 5.2 Scatter diagram: the concentration ratio versus firing costs



The graphical representation suggest that the concentration ratio performs better than the Herfindahl index. To quantify the effects on the concentration ratio I run a regression of firing costs on the concentration ratios. Table 5.2 shows the results from this regression. In the first specification the coefficient of firing costs is positive and significant. Ceteris paribus, an increase in firing costs by one week increases the concentration ratios by 0,21%. The coefficient is significant at a level of 5%. The second specification controls for the GDP per capita, capital per worker and human capital level. Human capital is the only other variable that has a statistically significant influence on the concentration ratio. Including the control variables does not change the sign of the firing costs coefficient. The coefficient of firing costs stays almost the same (value of 0,20). The significance slightly deteriorates, but the coefficient stays significant at a level of 5%. Using the Herfindahl index similar results are obtained, except that the coefficient on firing costs is not significant at a level of 10% (although it is at a level of 15%).

To summarize the second part of the research, a positive relation is found between the degree of specialization and firing costs in a country. This is in line with the second prediction of the theoretical model.

Table 5.2: Regression results prediction 2

Independent variable: Concentration Percentage of 4 biggest export industries.

Specification:	1	2
Variable	Coefficient (Standard Error)	Coefficient (Standard Error)
Firing Costs	0,209***	0,198**
	(0,062)	(0,083)
GDP		-0,00033
		(0,00026)
Physical Capital		-0,00034
		(0,00026)
Human Capital		0,348)**
		(0,145
C	3,351	21,420
	(3,343)	(12,389)
R-squared	0,277	0,460
F-Statistic	5,542	7,882

Note: * significant at 10%, **significant at 5%, *** significant at 1%.

5.3 The third Prediction of Saint Paul’s Model

The third prediction of the two Saint-Paul papers states that countries with high firing costs specialize into industries where the focus is more on imitation. The purpose of this part is to show that there is a relation between firing costs and innovation intensity in the major exporting industries.

5.3.1 Methodology

In this part of this research I use a different dataset. Specifically I use data on R&D intensity and exports from the OECD STAN database. The dataset consists of 22 OECD countries. For each country I sorted the industries according to the size of exports. Then per country the industries were divided into terciles on the basis of the magnitude of exports. For the top tercile, which consists of the main export industries, I calculate the average R&D intensity. A priori a negative relation between R&D intensity and firing costs is expected. In order to quantify the relationship I estimate the following regression:

$$\textit{Average R\&D intensity (top tercile)}_{c} = \beta_0 + \beta_1 * \textit{Firing Costs}_{c}. \qquad (20)$$

5.3.2 Results

A negative relation between firing costs and the average R&D intensity of the main exporting industries is depicted in Graph 5.3. The correlation between the average R&D intensity and firing costs is -31%. The negative correlation coefficient is not driven by the four observations with firing costs bigger than 50 weeks. The results are robust to exclusion of these countries. In fact the correlation coefficient is -36% when they are excluded.

Graph 5.3: Scatter diagram: R&D intensity versus firing costs

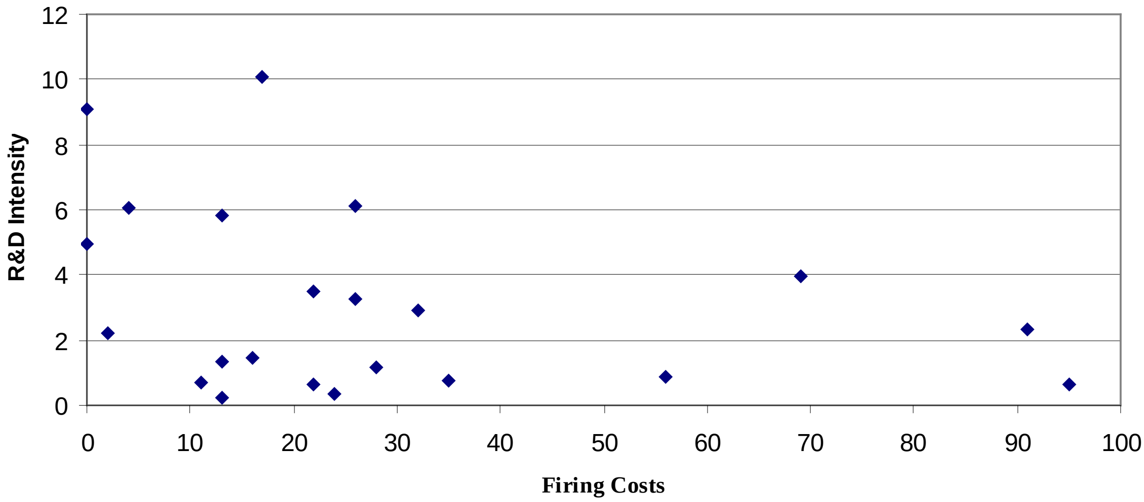


Table 5.3 shows the results of the regression analysis. The coefficient for firing costs is negative and significant at a level of 10%. An increase in firing costs with 10 weeks corresponds to a decrease in R&D intensity of 0,32 percent point. Compared to an average R&D intensity of 3,1 % for the main exporting industries this is an economically significant effect. These results are consistent with the third prediction of the theoretical model. However, the results are not robust to inclusion of other variables such as human capital, physical capital and GDP per capital[5]. The sign of the firing costs coefficients stays negative, but becomes insignificant. An explanation could be that the statistical power of the specification is too low with only 22 observations. Perhaps with a larger data sample the results could be confirmed with a higher degree of confidence.

Table 5.3 Regressions results prediction 3

Dependent variable: Average R&D intensity of top tercile exporting industries

Variable	Coefficient (Standard Deviation)
Firing Costs	-0.032776*
	(0.016391)
C	4.021848
	(0.926958)
R-squared	0.095945
F-Statistic	2.122537

Note: * significant at 10%, **significant at 5%, *** significant at 1%.

[5] Because the results are insignificant they are not reported in this paper.

6. Conclusion

The goal of this paper is to research the relation between firing costs and international trade. Specifically, I investigate three predictions from the theoretical models of Saint-Paul (1997; 2002). The results of the paper are in line with the Saint-Paul's predictions. First of all, I find that firing costs are a source of comparative advantage. Countries with high firing costs specialize in relatively mature industries compared to countries with low firing costs. Industries that are sufficiently mature actually profit from the firing costs. Second, I find that countries with high firing costs also have a higher degree of specialization than countries with low firing costs. This is in line with the prediction that countries with high firing costs export a smaller range of goods. Third, I find a negative relation between firing costs and innovation activity. Specifically I find that the average R&D intensity of the top 30% export industries is negatively correlated to firing costs. The results of the third part of the research are not robust to the inclusion of additional control variables. Research with a larger dataset could confirm the findings for the third part with a higher degree of confidence.

The results of this paper form an important contribution to the literature on the effects of labour market institutions on the economy. It is the first paper to confirm the predictions from the theoretical models by Saint-Paul. It shows that labour market institutions do not only influence the employment level or employment turnover. In the first place it shows that labour market institutions influence the pattern of trade. For policy makers it is important to keep in mind that not all industries will be affected similarly by trade liberalization. Reducing firing costs will reduce the comparative advantage of mature industries. The specialization pattern induced by firing costs also influences the innovation activity. There is a negative relation between the R&D intensity of the main exporting industries and firing costs. Low R&D intensity may imply that there is little innovation in these industries. Thus countries with high firing costs will have less benefit from innovation spill-overs from their main exporting industries. There may be other serious long-term consequences. Take R&D activity as a base for technological progress. In endogenous growth models technological progress is the main driver of economic growth. Then high firing costs might slow growth in the long-run.

This paper stresses the importance of firing costs for the pattern of trade and innovation. The relation between firing costs and the pattern of trade has been researched more extensively in this paper and with a larger degree of confidence. Given the large potential influence on welfare and economic growth it would be interesting to delve more into the relation between firing costs and innovation activity in future research.

Appendix

A. Assumptions in the numerical example:

Assumptions:

- Hazard rate:	$h(s) = \dfrac{0{,}25}{\sqrt{age_s}}$
- Labour:	500 labour units
- Wage rate country 2:	Normalized to 1
- Amount of new goods per periods:	100 goods

- 1 labour unit produces 1 good per period
- Full employment equilibrium in both countries
- Fractions of goods exist and can be produced
- Labour units can split their work time on two different goods

Endogenously determined variables:

- Marginal good s*
- Wage rate country 1
- Welfare level in both countries

B. Variables used in analysis

Variables	Definition	Data source
Country variables:		
Firing costs	Firing costs (weeks)	Doing Business Project
Physical capital abundance	Physical capital per country	Penn World Tables v. 5.6
Human capital abundance	Years of schooling of population >25	Barro & Lee
GDP	Gross Domestic Product ($, current prices)	World Development Indicators
Herfindahl index	Sum of squared export share	Feenstra
Four industry concentration index	Percentage of four largest industries in total exports	Feenstra
Industry variables		
Maturity	(1- enterprise deaths) / enterprise deaths	US Census Bureau
Skill intensity	Production wages / total wages	NBER CES
Capital intensity	Capital per worker	NBER CES
Country-industry variables		
Exports	Exports in industry i from country c to rest of the world ($)	Feenstra
Exports	Exports in industry I from country c to rest of the world (country currency)	OECD STAN database
R&D intensity	Business R&D expenditures as a percentage of production	OECD STAN database

C. Assumptions on the worker and the business

The worker:
Is a 42-year-old, nonexecutive, full-time, male employee.
Has worked at the same company for 20 years.
Earns a salary plus benefits equal to the economy's average wage during the entire period of his employment.
Is a lawful citizen who belongs to the same race and religion as the majority of the economy's population.
Resides in the economy's largest business city.
Is not a member of a labour union, unless membership is mandatory.
The business:
Is a limited liability company.
Operates in the economy's largest business city.
Is 100% domestically owned.
Operates in the manufacturing sector.
Has 201 employees.
Is subject to collective bargaining agreements in economies where such agreements cover more than half the manufacturing sector and apply even to firms not party to them.
Abides by every law and regulation but does not grant workers more benefits than mandated by law, regulation or (if applicable) collective bargaining agreement.

Taken from: http://www.doingbusiness.org/MethodologySurveys/EmployingWorkers

D. Spearman Rank Order Correlation Tests

Country	rho(s)	T	p-value(1 sided)	p-value(2 sided)
Czech	0.8909	5.88	0.000118	0.000235
Fin	0.6273	2.42	0.019306	0.038611
It	0.8909	5.88	0.000118	0.000235
NL	0.5818	2.15	0.030019	0.060037
NZ	0.3273	1.04	0.162736	0.325471
Sp	0.6727	2.73	0.011613	0.023225
EST	0.8	4.00	0.001555	0.00311

E. Maturity of Industries

10 most mature industries

NAICS	Industry
3273	Cement and Concrete Product Manufacturing
3321	Forging and Stamping
3251	Basic Chemical Manufacturing
3112	Grain and Oilseed Milling
3336	Engine, Turbine, and Power Transmission Equipment Manufacturing
3324	Boiler, Tank, and Shipping Container Manufacturing
3111	Animal Food Manufacturing
3365	Railroad Rolling Stock Manufacturing
3262	Rubber Product Manufacturing
3241	Petroleum and Coal Products Manufacturing

10 youngest (least mature) industries

NAICS	Industry
3311	Iron and Steel Mills and Ferroalloy Manufacturing
3133	Textile and Fabric Finishing and Fabric Coating Mills
3369	Other Transportation Equipment Manufacturing
3118	Bakeries and Tortilla Manufacturing
3169	Other Leather and Allied Product Manufacturing
3341	Computer and Peripheral Equipment Manufacturing
3346	Manufacturing and Reproducing Magnetic and Optical Media
3159	Apparel Accessories and Other Apparel Manufacturing
3151	Apparel Knitting Mills
3152	Cut and Sew Apparel Manufacturing

F: Panel Regression as in table 5.1, but with standardized coefficients

Independent variable: natural log of exports in industry I from country c to the rest of the world			
Specification	1	2	3
Variable	Coefficient (Standard Error)	Coefficient (Standard Error)	Coefficient (Standard Error)
Firing Costs	-0,816 (0,186)***	-0,690 (0,176)***	-0,578 (0,168)***
Firing Costs * Maturity	0,373 (0,200)*	0,384 (0,186)**	0,388 (0,178)**
ln[Physical Capital Abundance] * ln[Capital Intensity]		1,211 (0,114)***	1,341 (0,533)**
ln[Human Capital Abundance] * ln[Skill Intensity]		0,265 (0,070)***	2,260 (0,502)***
GDP per capita			1,405 (0,093)***
Physical Capital Abundance			-1,190 (0,269)***
Human Capital Abundance			-1,885 (0,428)***
R-squared	0,287	0,378	0,433
F-statistic	1,228	1,815	2,199

Note1: Standardized beta coefficients and standard errors reported. The coefficients represent the effect on ln[exports] of a one standard deviation change of the independent variable.
Note2: Sector fixed dummies included.
Note3: * significant at 10%, ** significant at 5%, *** significant at 1%.

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