Stockholm School of Economics
Department of Economics
Course 659
Bachelor Thesis in Economics

Asymmetric Effects of Corruption on Offshoring:

A Firm-level Study of Swedish Offshoring 1997-2005

Abstract: This paper investigates the effect of corruption on Swedish firms' choice of country for their offshoring. In the offshoring literature, corruption is expected to have a deterrent effect on firms' choice of location and the effect is expected to differ depending on firm characteristics such as firm size and R&D-intensity. To test this we create a set of Swedish firm level data for the period 1997-2005, different country specific variables and Transparency International's Corruption Perceptions Index. We find a threshold level of corruption below which corruption plays no role. Above this threshold corruption has a deterrent effect on offshoring. Larger firms are more susceptible to corruption which can be explained by recent theory on corruption's influence on firms' choice of organizational form. The relation between R&D-intensity and corruption susceptibility is small and results are inconclusive.

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Acknowledgements: We would like to express our gratitude towards Patrik Gustavsson Tingvall, our tutor, for his valuable help and support throughout our work with this thesis and for being an all-around great guy. The authors would also like to thank each other for good cooperation.

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1. Introduction

As international openness increases and information technology develops the international organization of production changes. We are facing a world where not only blue collar workers lose their jobs to low cost countries, but computer programmers, radiologists and accountants as well. During the last decades, offshoring has been a hot topic in the public and policy debate. Domestic firms moving production abroad, workers losing their jobs and cities losing their main employer have all been commonplace in the headlines. Offshoring is no longer a matter only for low skilled jobs in manufacturing, but increases steadily also in the service sector. Many economists see offshoring as a natural extension of international trade theory; others predict a major transformation of the developed countries. Mankiw and Swagel (2006) describe the political uproar following the Economic Report of the President in February 2004, a report that came to have a significant impact on the presidential election campaigns that year, but claim that the effects of offshoring are misunderstood. On the other hand, Alan S. Blinder (2006) describes service sector offshoring as the next industrial revolution and believes that major consequences of offshoring are overlooked. The same debate is lively in Swedish media and public concerns about Swedish jobs moving abroad are plenty, as shown by the Swedish Institute for Growth Policy Studies (Jonsson, 2006).

The debate as well as the research on offshoring, have so far largely focused on how offshoring affects the labour market and productivity, how firms and individuals are affected by the new patterns of trade and international division of production. Reserach on offshoring is hard, as data is limited and the phenomenon as such is hard to define. Consequently, most of the research has been conducted on aggregated data on country or industry level. Much less has been written about the factors influencing the individual firm's behaviour concerning offshoring. What are the factors affecting a firm's decision to offshore or not and what factors are important when deciding where to locate their offshoring? With this paper, we want to shed light on the latter question: what factors firms take into account when choosing location for their offshoring, and more specifically, what role corruption plays in this decision.

In order to investigate this question we use a gravity model setting to explain trade patterns between different countries, controlling for differences assumed to influence firms' choice of

location on both firm and national level. The data used is on firm level, using Swedish firms' import of intermediate goods as proxy for offshoring.

1.2 Structure

The paper is structured as follows: In section 2 we will go through relevant literature to get a basic understanding of the phenomenon of offshoring, including definitions and measurement and the theoretical implications of earlier research. Section 3 presents the theoretical implications of the literature. In section 4 we present the gravity model, its foundations and variables as well as specifying he model we will use. Thereupon we present the data in section 5 before going through some econometric issues in section 6. Section 7 is the analysis, divided into the basic model, the threshold level of corruption, firm size, R&D-intensity and some robustness tests. Finally we conclude in section 8. Sections 9 and 10 are references and appendix respectively.

2. Literature Review

2.1 Vertical Specialization and International Trade

During the last decades, the patterns of international trade have changed. For long, trade was largely a matter of finished goods or raw materials. To a large extent, the common view of trade is still heavily influenced by these patterns; basic textbooks in international trade typically use examples such as cheese and wine, cars and shoes. However, as transportation becomes easier, due to technological progress and increased free trade, the patterns of trade change.

In The Wealth of Nations (1776), Adam Smith argued that the key factor in the search for efficient productivity was high specialization by task. As a worker concentrates his skills on one single task his efficiency improves, as his work is combined with the work of others, specializing in their single tasks, the total output per worker increases. Obviously, this requires synchronization and communication and as long as transportation is slow and communication over distance is hard and cumbersome, task specialization requires proximity, encouraging agglomeration.

In his famous essay "The Nature of the Firm" from 1937, Coase raised the question why firms exist, if, as economists often argue, a market is the most effective device in order to allocate scarce resources. The answer, he claimed, was that in an environment with imperfect information and transaction costs, it may be more efficient to coordinate production through a formal organization, such as a firm, than through the market mechanism. The higher the transaction costs, the more production will take place inside the firm. In other words, the degree of vertical specialization depends on transaction costs.

Over time, transaction costs have decreased. This is partially due to technological progress in the transportation of goods, e.g. shipping and flight cargo but the most dramatical change has been seen in the development of the information technology. The IT-revolution has implied sharply decreasing costs in communication and transmitting of information, making coordination and synchronization over distance easier. As a result, the value adding chain becomes more and more dispersed, and proximity loses its importance. A t-shirt may be designed in France, produced in Turkey with cotton harvested in India, marketed by a U.S. firm and sold in Sweden. In the case of a more complex product, the fragmentation of the production process may be far more

complicated and geographically dispersed. The decreased importance of proximity is not limited to manufacturing: Accounting, security analysis and even surgical operations are activities now possible to exercise over long distances. Grossman and Rossi-Hansberg make a thorough description of the rise of offshoring, or trade in tasks in their article *The Rise of Offshoring: It's Not Wine for Cloth Anymore* (2006a).

Another reason for the dispersion of the value chain is the increased openness in the world. The fall of the Berlin wall and the communist bloc, China's gradual and partial transformation into a market economy and the rise of countries like India and Brazil, have created a host of new opportunities for international specialization. As an example, China's export was about four times bigger in 2003 than it was in 1993 (Spencer, 2005).

Roodhooft and Warlop (1999) write that firms are expected to concentrate their effort on activities for which they have a comparative advantage over competitors, and outsource remaining activities to external actors, i.e. firms have to make a choice between in-house production and outsourcing. Their comparative advantage and thus the choice between in-house production and outsourcing, is affected by two factors: production costs and transaction costs. As transaction costs decrease in relation to production costs, the vertical specialization is expected to increase and firms will concentrate its resources on the one part of the value chain at which they have a comparative advantage. This is true both on a domestic and on an international level in an open economy context, where firms may locate parts of their production abroad. This phenomenon is referred to as offshoring.

When studying the phenomenon of offshoring and previous research on the matter, two questions of definition arise: What is offshoring? And how to measure it?

2.2 Definition and Measurement

Ekholm and Hakkala (2006) define offshoring as the *transition* when companies start importing goods and services from suppliers abroad or from affiliates abroad, instead of producing them themselves or buying them from local suppliers in the home country.

Amiti and Wei (2004) use the term *international outsourcing* and define it as:

> the procuring of service or material inputs by a firm from a source in a foreign country. This term includes both intrafirm international outsourcing (by which the foreign provider of the input is still owned by the firm) and arm's-length international outsourcing (by which the foreign provider of the input is independent from the firm using the input).

Karpaty et al. (not publ.) cite a definition they claim to have found in Baghwati, Panagariya and Srinivasan (2004), "the purchases of services abroad with the supplier and buyer remaining in their respective locations, including trade with either a foreign affiliate or an external overseas supplier." We fail to verify this exact formulation, but if "services" is replaced with "goods", we come very close to the definition we will use. Finally, Mankiw and Swagel (2006), call the very same phenomenon *offshore outsourcing*.

In this paper, we will stick to the shortest, *offshoring*, thus referring to the import of goods and services that were formerly produced domestically, regardless of the legal relation between the importer and the exporter.

As Hagsten et al. (not publ.) point out, detailed firm level data on offshoring, and changes in offshoring, will probably never be available. Instead a number of proxies for offshoring have been proposed. In the same paper, Hagsten et al. use the import of goods and services as a measure of offshoring. Borga (2005) measures offshoring as parent companies' "*share of imports in their purchased inputs*" from their foreign affiliates and for the analysis focuses on changes in the offshoring behaviour. Feenstra and Hanson (1996 and 1999) measure outsourcing as "the share of imported intermediate inputs in the total purchase of non-energy materials."

Following Hagsten et al., we will use import of intermediate goods as proxy for offshoring.

2.3 Effects on Labour Demand and Productivity

Much of the literature regarding offshoring focuses on its effects on labour demand and productivity. Among the pioneers were Feenstra and Hanson, who studied how offshoring affects demand for skilled and unskilled labour (1996 and 1999). Their idea was to measure to what extent workers at home have been replaced by import of intermediate goods and found that foreign outsourcing (in our terms offshoring) could account for a large part of the increase in relative demand for skilled labour in the US manufacturing industry during the 1980's. In a related study, Karolina Ekholm and Katariina Hakkala (2006) use Swedish data to conclude that

offshoring to low income countries tends to decrease the demand for workers with an intermediate level of education while offshoring to high income countries does not affect the composition of labour demand. Somewhat surprisingly they do not find any effect on low skilled workers. Braconier and Ekholm (2000) find that the effect of offshoring on labour demand in Swedish multinational firms is low, if not non-existing, and if there is a wage competition from other countries, this is mainly from other high income countries.

Criscuolo and Leaver (2006) find that offshoring increases productivity, a conclusion also drawn in studies by e.g. Morrison Paul and Yasar (2009), investigating Turkish textile and apparel manufacturing plants, and by Grossman and Rossi-Hansberg (2006a), using a theoretical approach. A widely quoted report performed by the international consultancy firm McKinsey (2003), also stresses the productivity gain obtained from offshoring, claiming that both the offshoring country and the country receiving the offshoring gain from the transaction.

Another part of the literature on offshoring concentrates on the different organizational forms. Grossman and Helpman (2004) describe the two primary forms vertical specialization on an international level may take:

> Firms may procure specialized components or services from arms-length providers under contractual arrangements, or they may undertake the various production and assembly activities within the boundaries of a single firm by engaging in foreign direct investment (FDI)."

Consequently, the choice between in-house production and outsourcing is not necessarily linked to the decision of the location of production. In-house production as well as outsourcing may take place both domestically and abroad, and offshoring may take place both inside and outside the boundaries of the firm.

Grossman and Helpman discuss several implications related to the choice of organizational form and location. The principal-agent problem is assumed to be higher as the vertical specialization increases. A principal running a vertically integrated firm can easier control and monitor a manager's effort than a principal outsourcing the production on arm's length basis. However, Grossman and Helpman acknowledge that the organizational form is not the only factor influencing the controllability; proximity matters as well. They assume that the principal can control a larger fraction of the manager's tasks when geographically close to the firms

headquarter, but as the distance between the firms headquarter and the affiliate increases, the principal's ability to control the manager goes down.

Another important difference between the two forms originates from the assumption that the principal bears the costs of labour, capital and material inputs in a vertically integrated firm. In an outsourcing relationship, these costs are, at least to a larger extent, borne by the agent (Grossman and Helpman, 2004). As initial costs usually are higher for FDI, outsourcing is in general a more plausible alternative for smaller firms.

In their paper from 2003, Grossman and Helpman examine several determinants of organizational form. They list four factors promoting outsourcing in favour of FDI: a high productivity advantage of firms that specialize in production, a large industry size, a contractual environment with high completeness of contracts and a low relative wage in the country exporting the component.

Eiichi Tomiura (2005) performs a wide-ranging study on more than 100 000 Japanese manufacturing firms, examining foreign outsourcing (in our terms offshoring) focusing on what firm characteristics are associated with offshoring. He finds that firm size is relevant in the sense that large firms are more likely to choose foreign outsourcing instead of domestic solution. But the level of outsourcing relative to firm size does not increase with firm size, once the offshoring decision is taken. Tomiura further finds that human capital intensity is correlated with a higher degree of offshoring. He suggests that this could be both a result of offshoring of less human capital intensive tasks, or that a higher degree of managerial or technological capability is needed to engage in foreign countries. Firms with higher productivity, firms producing more labour intensive goods and more R&D-intensive firms tend to be more engaged in offshoring. R&D-intensive firms are also engaged in domestic outsourcing to a higher degree. That firm size matters is also in accordance with Lööf (2008). Studying Swedish firms, he claims that the import intensity is much higher in large firms. Among the largest 10% of Swedish firms, 89% are importers and the value of their imports correspond to 12% of their total sales. For the smallest 90% of the firms, only 25% are importers and the value of the imports correspond to only 3% of sales.

2.4 The Role of Corruption

Papers such as Anderson and Marcouiller (2002) present the idea that economic predation at the border due to corrupt institutions acts as a hidden tax on trade, implying higher costs and thus lower incentives for a firm to engage in an offshoring relation in the country. Another obstacle to international vertical specialization is contract incompleteness and imperfect contract enforcement. According to Antràs (2003), firms tend to import capital-intensive goods within the boundaries of the firm while labour-intensive goods tend to be imported on arm's-length distance. One explanation to these patterns is presented by Nunn (2005), focusing on the importance of relation-specificity as a determinant of comparative advantage. A supplier undertakes a relation-specific investment if specializing production so as to meet the need of one particular buyer, thereby excluding the possibility to sell to other buyers. If contracts are imperfectly enforced, underinvestment will occur in relationship-specific investments since relation-specificity creates a potential for holdup. That is, once the production is completed the buyer has an incentive to lower the price, as there are no other potential buyers. As the seller anticipates this, he will underinvest in the production process. Obviously the relation is bilateral; the product is specialized for the buyer and without the existence of any other sellers, it is tempting for the seller to increase the price. Because underinvestment raises the cost of producing the inputs, countries with good contract enforcement have a relative advantage in the production of relationship-specific goods. Subsequently, the higher the importance of the relationship-specificity, the higher the comparative advantage of a good contractual environment. These results hold even when controlling for countries' endowment of capital and skilled workforce (Nunn, 2005).

It is tempting to believe that the quest for low wages is the main factor behind outsourcing and offshoring. However, this is not all that obvious. In an often quoted survey on offshoring in the consumer goods and retail sectors, performed by Accenture in 2004, low cost is certainly one important factor, but regarded as less important than the expertise/capability of the provider and the flexibility of the provider. Another fact pointing in the same direction is that the largest part of offshoring is between high income countries as stated by Antràs above.

Grossman and Helpman (2004) show that price differences between countries are not enough to generate offshoring. A low-wage country's cost advantage may be offset by factors such as

lacking infrastructure, poor legal environment or lack of skilled labour. But of course, price is an important factor. As shown by Swenson (2004), an increase in a country's own costs, or a decrease in the competitor countries' costs, have a contractionary effect on US firms' overseas assembly activities in the country. This holds for all countries but the magnitude of the effect is larger for developing countries, implying that cost is a more important factor when offshoring to developing countries.

As this paper's main concern is the role of corruption and institutional quality in firms' choice of location of its offshoring activities, it is closely related to a study performed by Hakkala et al. (2008). In their paper, they use Swedish firm-level data to study the effect of corruption on FDI. On an aggregate level, they show that corruption reduces the probability that a Swedish firm will make an FDI in a given country, but not the level of investment once the investment decision is taken. However, their results indicate that the effects are asymmetric: Horizontal investments, aimed at selling on the market where the affiliate is situated, are affected to a larger extent than vertical investments, aimed at exporting back to Sweden or to a third country.

Hakkala et al divide FDI into three categories: depending on the targeted market:

> Local sales (primarily driven by horizontal motives), sales back to Sweden (primarily driven by vertical motives), and sales to third countries (primarily driven by export-platform motives).

Examining the effect of corruption on offshoring, we are interested in their results for vertical FDI, i.e. the second category, sales back to Sweden. In contrast to the other two categories, the authors fail to establish a negative effect of corruption on FDI aimed at selling back to Sweden. The results of their regression indicate that high corruption increases FDI, although the result is statistically insignificant. However, there might be reasons to believe that the effect of corruption is asymmetric not only in terms of horizontal/vertical investments, but also in terms of firm characteristics. Hakkala et al. quote Svensson (2003), who uses quantitative information on bribe payments of Ugandan firms to show that public officials act as price discriminators. Firms' "ability to pay" and their "refusal power" influence the amount of bribes demanded, so that large firms are less negatively affected by corruption because of their higher bargaining power but also that highly profitable firms may face higher graft demands as their ability to pay is higher.

Finally, research and development- (R&D) intensive firms may be more attractive to the foreign country giving the firm a stronger bargaining position.

3. Theoretical Implications

This paper is closely related to Hakkala et al. (2008), who investigate the effect of corruption on Swedish firms' FDI. However, they do not study the effect of corruption on Swedish firms' total offshoring, which includes both FDI and foreign outsourcing. Since the debate to a large extent has focused on firms moving production abroad, no matter the organizational form, we choose to focus on total offshoring. Having reviewed the literature, we believe our paper to be the first to investigate the effect of corruption on Swedish firms' choice of location for its offshoring activities. Neither have we found any similar studies, on firm level data, in any other country.

With this paper, we want to shed light on corruption as one of the factors influencing *where* Swedish firms decide to locate their offshoring. Further, we want to study if there are asymmetries in this effect in terms of firm characteristics, as suggested by Svensson (2003) and Hakkala et al. (2008).

Following earlier research we assume corruption to affect firms' offshoring activities in several ways. Corruption is assumed to alter a firm's choice of organizational form. This alteration may not always be an option and certainly, the alternatives may not be equally interesting. For various reasons, a firm may prefer FDI to outsourcing, or vice versa, thus choosing one country rather than another for its offshoring activity, because of the level of corruption.

Corruption is assumed to increase costs through different kinds of bribes demanded by civil servants in bureaucratic procedures, such as applying for licenses, permits etc, thus working as a hidden tax on trade. If corruption increases costs, we can assume that corruption decreases a firm's desire to invest in a given country.

Corruption is a part of the contractual environment; in a country with a perfectly functioning rule of law, there is no room for corruption. A poor contractual enforcement may in turn deter foreign investment, both in the form of FDI and outsourcing.

Finally, we can assume an asymmetric effect of corruption on offshoring in terms of firm characteristics, including what kind of task is being offshored. As relation-specificity increases, the deterrent effect of lax contract enforcement, and thereby corruption, increases. An R&D-intensive firm may be more attractive to the foreign country, thus strengthening its bargaining

power and making it less susceptible to corruption. Likewise, firm size may affect a firms' bargaining power making it less susceptible.

3.1 Hypotheses:

H1: Swedish firms are more likely to engage in an offshoring activity in a country with a low level of corruption.

H2: Firm characteristics, such as firm size and R&D-intensity, influence a firm's susceptibility to corruption when choosing location for its offshoring activities.

4. The Model

4.1 The Gravity Model of Trade

As basis for the regression we will use a standard gravity model, first proposed by Tinbergen (1962) in the appendix of his book on international economic policy, *Shaping the World Economy*. It builds on Isaac Newton's old model for the gravity between two bodies, depending on their mass and the distance between them, in its original form:

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2}$$

where the attractive force between the two bodies *i* and *j* (F) is dependent on the masses of the two bodies (M), the distance between them (D) and a gravitational constant (G). Applied to economic trade patterns, this gives us a model where trade between the two countries is dependent on the economic size of the countries, mostly measured as GDP, and the distance between them, measured between the economic centers of the two countries. The constant G can for purposes of research, be replaced with any variable of interest, such as a free trade-agreement or, in our case, a measure of corruption.

The intuition behind the Gravity Model is simply that a big part of trade between two countries can be explained by their economic size and how far they are located from each other. In practice, this leads to our model including the two variables GDP and distance.

For his analysis, Tinbergen ranks the main factors that determine the trade flow between any pair of countries as follows:

> the amount of exports a country is able to supply depends on its economic size (i.e., its GNP);
> the amount that can be sold to a particular country will vary with the size of that country's market (i.e., the GNP of the importing country); and
> the volume of trade will depend on transportation costs (these are assumed to correspond roughly with the geographic distance between the two countries).

The gravity model has however not been completely uncontroversial, because of its "somewhat dubious theoretical heritage" (Deardorff, 1984). While the Gravity Model of Trade always has had a strong empirical foundation, it was criticized for a lack of theoretical base following its introduction. Since then, a body of theories has emerged, not always in concordance with each other, but always supporting the gravity model. Bergstrand (1985) uses a general equilibrium world trade model to derive a gravity model of trade. In his 1989 paper, Bergstrand adds to this model factor-endowment differences, which makes the gravity model fit with both the Heckscher-Ohlin model of inter-industry trade and the Helpman-Krugman-Markusen model of intra-industry trade. Another example is Feenstra et al (1998), who on their hand suggest a theory for the model to explain international trade in homogenous goods. Evenett and Keller (1998) further test how the gravity model corresponds with the Heckscher-Ohlin model and also add the Increasing Returns trade theory, finding support for the latter and also for the Heckscher-Ohlin model with imperfect specialization across countries, but less with assumptions of perfect specialization. Being acquainted with the above theories is however not necessary for understanding our approach.

Furthermore, Baldwin and Taglioni (2006) name a number of "high profile papers" that have used a gravity model, additionally adding to its credit, an example being McCallum (1995).

In light of the above, it feels safe to conclude this section by quoting Rose (2000): for "[a]ll one needs to know is that the gravity model stands proudly on both theoretical and empirical legs."

4.2 Model Specification

To study the impact of corruption on the import of intermediate goods by Swedish firms we start off using the following model:

$$offshoring_{ij} = \beta_0 + \beta_1 corruption_2 + \beta'_2 x_i + \beta'_3 x_j + \gamma_t + v_{ij} + \varepsilon_{ij}$$

with offshoring by firm *i* to country *j* on the left hand side of the equation. On the right hand side x_i is a vector of firm specific variables, x_j is a vector of country specific variables, γ_t is a period dummy, and ε is the usual error term. v_{ij} captures time invariant fixed effects which will be discussed in more detail in the econometric section. Corruption is a country specific variable assumed to influence the offshoring by a firm to a given country.

4.3 Explanatory Variables

GDP: Earlier papers often use GNP instead of GDP as measure for size. The reason for this was that GNP data were easier available (Frankel 1997), but the results with the two different measures have been similar. We will stick to GDP as has become praxis.

In their 2005 paper, Grossmann and Helpman discuss *thickness of market* as an important factor for a firm's chances of finding an abroad supplier. They simply define the thickness concept as the number of relevant suppliers in the country. In addition to measuring a country's economic size, GDP also works as a proxy for this thickness, although admittedly a crude one.

Finally, it can be added that we will be using GDP in its logarithmic form. This is also customary in the literature we have reviewed, since Tinbergen's introduction of the gravity model in the 60's. As we start off from the gravity model, where the GDP of country *i* is constant as it is always the GDP of Sweden, country specific effects will include GDP of the exporting country and distance between Sweden and the exporting country.

Distance: Frankel's (1997) book on regional trading blocs contains a comprehensive review of the gravity model. Among other things, it states that the reason for having distance in its logarithmic form is to allow for a diminishing average cost of transportation over long distances. Ryrfeldt and Sundblad (2006) list a number of factors affecting trade that are captured by the distance proxy:

> Transport costs. The cost of physically shipping the products.
>
> Time elapsed during shipment. Rather, the risks included in the shipping that may damage the product in any sense.
>
> Synchronization costs. Costs of a Just-In Time system not functioning properly or the cost of having to store goods in a warehouse before they are used.
> Communication costs. (Im)possibilities of personal contact and transmitting of information.
>
> Transaction costs. Costs of searching for new trade opportunities and the establishment of trade partnerships.
>
> "Cultural distance". Costs caused by cultural misunderstandings or other cultural clashes in trade.

In our model we will use a distance measure which is weighted so as to take internal distances and population dispersion into account. E.g. the weighted distance between Sweden and Russia is relatively larger than the geographical distance to compensate for the distances within Russia. More detailed information is to be found in Notes on CEPII's distance measures by Mayer and Zignago (2006).

Dummy variables: Most of the papers cited above, employing the gravity model, are using various dummies indicating adjacency of countries and a few also contain a dummy for same spoken language (e.g., Frankel 1997 and Bergstrand 1985 and 1989). From the very beginning of the gravity model of trade, it has also contained a dummy for free-trade agreements between the countries being studied (in fact, to study this dummy was the very purpose when Tinnbergen introduced the model in 1962). In our dataset, this effect is to a large extent captured by the region dummies, region 1 being EU 15, region 2 being the rest of Europe, i.e. the countries that Sweden had the most extensive openness of trade to.

In a very widely cited paper, Baldwin and Taglioni (2006) award the gold (correlation bias in the gravitational constant when omitting certain variables), silver (wrongly averaged bilateral trade) and bronze (wrongly US price index deflation) medals when it comes to mistakes using the gravity model. These derivations are on a rather high level of econometrics; here it is sufficient to state that by using a fixed effects estimator and including time dummies, we happily avoid the gold and bronze medals of mistakes. With all firms being situated in Sweden and only measuring their import, the silver medal is not applicable to our problem at all.

5. Data

Our sample consists of unbalanced panel data on Swedish firms' imports divided on country of origin, between 1997 and 2005. The firm-data come from three register-based data sets from Statistics Sweden (SCB). Variables such as value added, number of employees, total wages, ownership, profits, capital stock, sales and industry sector are from the financial statistics data set (FS), with detailed information, such as R&D-intensity, on all Swedish private sector firms with at least 50 employees. Labour data, such as demographics and educational level are available from the regional labour market statistics data set (RAMS), aggregated to the firm level. Firms are classified by sector according to SNI92 (Statistics Sweden) on a two digit level.

The individual observation is a single firm's import from a single country a single year. Swedish firms with no imports are not in the sample, neither are firm-country pairs without imports. We divide imports into six broad categories according to MIG (Major Industrial Groupings): durable consumption goods, non durable consumption goods, investment goods, energy goods, other intermediate goods and other goods, where intermediate goods is the category of interest and used as proxy for offshoring. We will thus have a number of zeroes in our sample being the firm-country pairs with import in one or more of the other categories but not in intermediate goods[1]. In other words, if firm A imports investment goods from country 1, but no intermediate goods, it will appear as a zero in our sample. If the same firm does not import anything at all from country 1, the firm-country pair will not exist at all in our sample. Theoretically, it would be possible to create a dataset where we construct all these possible firm-country pairs, as observations with zero value. However, such a dataset would contain too many observations to handle (about 100000 firms times 200 countries times 10 years). Besides, as the vast majority of firms do not import at all or only from a very limited number of countries, the number of zero observations would be very high, making the decision not to offshore completely dominate the choice between countries. Consequently, we limit our study to firm-country pairs with import of

[1] For further discussions about handling the problem with zero observations see Helpman, Melitz and Rubinstein (2005) and Westerlund and Wilhelmsson (2006).

intermediate goods. Thus, we will not use the zero values in our sample (we use the logarithmic value of import of intermediate goods, thereby excluding zero observations). These zero observations describe a firms choice not to offshore to a country from which it imports something else than intermediate goods. In other words, the decision not to offshore to a certain country is not in the dataset. This limitation has one important implication: we cannot study the decision whether to offshore or not, as firms not offshoring at all are not in the sample. That is, our study concerns the choice of location and level of offshoring, after the decision to offshore has already been taken. In total, we get a sample of about one million observations.

For measuring corruption, the variable of interest in our study, we use the *Corruption Perceptions Index* (CPI), which is the best known tool of *Transparency International*. Its methodology for the relevant years is discussed at length in Graf Lambsdorff (2005); here we will limit ourselves to saying that it is a composite index based on the perceptions of different countries by businesspeople and analysts, where a 10 indicates the lowest possible level of corruption and 0 the highest corruption level. For pedagogical reasons we have chosen to invert the index so that a high score on the corruption index indicates a high level of corruption. That is, in our regressions, 10 indicates an extremely corrupted country while 0 indicates perfectly functioning rule of law. Moreover, this reversion facilitates comparison with similar papers such as Hakkala et al (2008).

There has been some criticism on CPI as a measure for analyzing differences within countries over time, because the methodology for measuring it might change somewhat from year to year (Graf Lambsdorff 2005). This should not be a problem for us, because using the fixed effects vector decomposition, we only compare between countries for each year, treating corruption as time-invariant in the regression.

6. Econometric Details: Fixed Effects

When using the gravity model we want to control for fixed effects mainly on country level. However, estimating a fixed effects model eliminates other time-invariant variables from the regression. Since certain time invariant effects, such as distance, are key elements of the gravity model, this is not a plausible solution. Baldwin and Taglioni (2006) discuss this problem, concluding that both nation dummies and nation pair dummies are non-satisfying as "no time-invariant parameters such as distance elasticity can be estimated."

One possible solution to the issue at hand is proposed by Plümper and Troeger (2004a). They summarize by saying that in panel data, we have a complication if we can assume that "units are heterogeneous (unobserved time-invariant effects exists), this unobserved heterogeneity is correlated with some of the regressors (hence: doing nothing leads to biased estimates) and that some of the variables included are time-invariant or have very little within variance."

They present a method entitled *fixed effect vector decomposition* (fevd) which is easily performed in STATA. In short, fevd consists of three steps:

(1) estimation of the unit fixed effects by the baseline panel fixed effects

model excluding the time-invariant right hand side variables;

(2) regression of the fixed effects vector on the time invariant explanatory

variables of the original model (by OLS);

(3) estimation of a pooled OLS model by including all explanatory time variant

variables, the time-invariant variables and the unexplained part of

the fixed effects vector. This stage is required to control for

multicollinearity and to adjust the degrees of freedom.

The complication addressed by Plümper and Troeger is present in our data: we can assume that unit effects exist, on country as well as firm level; that unit effects are correlated with some of

the regressors; and both time invariant variables and almost time invariant variables exist. If a variable should be considered as time varying or time invariant depends on the ratio of it's between variation and within variation. If this ratio is high, i.e. if the cross sectional variation is large and the variation over time is small, treating the variable as time invariant in an fevd model gives more efficient and probably less biased point estimates. As a rule of thumb, a variable should be considered time invariant if its ratio is above 1.5. In our data, most of the variables have ratios above 1.5 (Appendix C). However, the country level variables' ratios are notably higher than those of the firm level variables, therefore we will treat the former group as time invariant and the latter as time variant. Our focus is thus on differences in corruption between countries rather than differences in corruption over time in one given country.

Time invariant variables can be divided into two categories: the first is variables being invariant per definition. In our data the distance between countries or regional belonging are good examples. The other category is variables which are invariant in the period analyzed. For example, Denmark has not always been a member of the EU; however, Denmark is a member of the EU during the entire time period we study. Consequently, this second category of time invariant variables can be made time variable by adding more time periods.

Identifying the effect of a variable that is almost time-invariant is difficult. Almost time-invariant variables include variables that by nature seldom change e.g. political institutions or membership in trade agreements, and also variables that do change continuously, but the changes are small. In our case this includes variables such as GDP, corruption level and several development measures such gross enrolment in tertiary education and energy consumption. Although these variables do change over time, the cross-sectional variance tends to be substantially larger than the variance over time.

7. Analysis

7.1 The Basic Model

Our basic model (Table 1), including all firms in the dataset, shows a positive relation between corruption and how much a firm offshores to a given country. This is somewhat surprising as previous literature rather suggest a deterrent effect of corruption on offshoring. However, some of the results of Hakkala et al. (2008) point in the same direction. Studying Swedish firms' FDI, they find that corruption decreases total sales from the affiliate, but when dividing total sales into sales on the local market, sales back to Sweden and sales to third countries, they find that corruption actually tend to increase exports back to Sweden. As FDI is one important part of our offshoring measure, it is reasonable that our result in this case could be in line with theirs. The positive relation could also be explained by the omission of wage level, which might be correlated with corruption. However, we believe we control for this using control variables as gross enrolment in tertiary education, energy consumption and agriculture's share of GDP. Nevertheless, the positive sign on corruption is counterintuitive and deserves further investigation.

The effects of corruption in the basic model are, although statistically significant, quite small. For a decrease in corruption level of one step on the 0-10 scale (approximately corresponding to the difference between Spain (3.5) and Great Britain (2.3) or Albania (6.6) and Turkey (5.4) the model would predict a decrease in Swedish offshoring by 3.6%. A rather large leap on the scale, from e.g. Moldova (7.1) to France (3.1) would be predicted to decrease offshoring by 14.4 %. Although that figure could be regarded as quite substantial in itself, it seems fairly moderate compared to the difference in institutional quality between France and Moldova.

7.2 Effects Depending on Level of Corruption

Studying the corruption index we find that a large group of countries usually referred to as having a low level of corruption, have quite dispersed corruption values. The distances in the index (all values for 2005) between Denmark (0.5), U.S.A. (2.4) and Hungary (5.0) are fairly large, although we doubt that the difference in corruption between these countries would affect a Swedish firm's investment choice to any large degree. On the other half of the index, the more

corrupted countries, we may suspect corruption to have a larger impact. The differences in corruption between Somalia (7.9), Ukraine (7.4) and Lithuania (5.2) are more likely to affect Swedish firms.

Therefore we allow for a threshold level, below which corruption level could be of less importance, splitting the sample into two parts: countries with a high level of corruption (above 5) and low level of corruption (lower than or equal to 5). Performing the same regressions on the two groups (table 1), we get a positive coefficient on the less corrupt half, where we expected the smallest effect of corruption. The coefficient is however barely significant on the 5 % level and rather small (0.007). The coefficient for the more corrupt half is negative, much larger (-0.037) and statistically significant on the 5 % level, having a p-value of 0.015. These results support the idea of a threshold level on corruption; the effect is more than four times larger and more significant in the group of more corrupt countries. The number of observations differs substantially between the two groups. For the less corrupt countries we have 312706 observations and for the more corrupt countries only 59903. This difference in observations is certainly natural as less corrupt countries are heavily overrepresented in Europe and among Sweden's major trading partners. The difference in observations is probably the reason for why the coefficient in the total sample is positive, the small positive coefficient on the half below the threshold offsets the negative coefficient on the other half.

Table 1. Asymmetric effect depending on corruption level

	Basic Model	**Corruption <=5**	**Corruption > 5**
Dependent Variable	*log(Import intermediate goods)*		
Corruption	0.036***	0.007*	-0.037**
	(0.002)	(0.004)	(0.015)
Observations	372609	312706	59903
Adjusted R-squared	0.759	0.765	0.727

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Standard errors reported in parentheses. Control variables and dummies for year, industry and regions are included. See Appendix A for full table.

7.3 Effects Depending on Firm Size

In their study on Swedish firms' FDI, Hakkala et al. quote Svensson's study from 2003 and suggest that firm characteristics may play a role in firms' susceptibility to corruption. They find that large firms and R&D-intensive firms are less adversely affected by corruption. Consequently, we may suspect asymmetric effects of corruption on differences in these characteristics. To study the effect of firm size, we first split the sample in to groups depending on firm size. We run a regression on the two groups, small and large firms, and secondly we use an interaction term between corruption and firm size.

For firms larger and smaller than 63[2] employees, we find that corruption has a negative sign in the large firm sample and a positive sign in the small firm sample, both coefficients being significant on any reasonable level (see table 2). Regressing only the firms in the 90 percentile (more than 262 employees) the sign is still negative and the coefficient more than doubled in magnitude compared to the firms above 63 employees, indicating a higher susceptibility to corruption for large firms. We then use an interaction term between corruption and firm size. As expected from the earlier regressions, we get a negative sign on the interaction term, confirming that the bigger the firm, the more deterrent is the effect of corruption on the firm's offshoring.

[2] 63 is the firm size of the median observation, i.e. ordering the firm-country observations in firm size order, 63 is the median value.

Table 2. Asymmetric effects of corruption depending on firm size

	Size <= 63	**Size > 63**	**Size > 262**	**Interaction**
Dependent Variable	*log(Import intermediate goods)*			**Term**
Corruption	0.069***	-0.043***	-0.112***	0.093***
	(0.003)	(0.005)	(0.007)	(0.003)
Corruption x log(Size)				-0.016***
				(0.000)
Observations	263610	108999	44015	372609
Adjusted R-squared	0.758	0.751	0.761	0.759

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Standard errors reported in parentheses. Control variables and dummies for year, industry and regions are included. See Appendix A for full table.

Interestingly, these results are contradictory to the conclusions of Hakkala et al. who found that large firms are less adversely affected by corruption than small firms. However, it is not self-evident that our results on the effect of firm size should be expected to be in line with the results of Hakkala et al. as they limit their study to FDI. When studying the whole spectrum of offshoring, the effect of corruption depending on firm size could be different. Literature on offshoring, such as Grossman and Helpman (2003), Helpman (2006) and Antràs (2003), imply that organizational form depends on contractual environment, or corruption level, in a country. They suggest that FDI is preferred in a corrupt environment while outsourcing is the preferred choice in a less corrupt country with high institutional quality. As Hakkala et al. study only FDI, we might expect the positive effect of corruption on FDI in their study to stem from the fact that FDI could act as a substitute for outsourcing when corruption is high. If that is the case, FDI could in fact increase with the level of corruption at the same time as total offshoring decreases, given that the negative effect of corruption on outsourcing, the other part of offshoring, is large enough.

Literature suggests that the principal bears the costs of labour, capital and material inputs to a higher degree in a vertically integrated firm. That is, initial costs are higher for FDI than for outsourcing. These costs may be tougher to bear for a small firm, leading small firms to favour

outsourcing to FDI. If outsourcing is more adversely affected by corruption, small firms may abstain from offshoring to corrupt countries at all. In our data, smaller firms to a larger extent offshore to countries on the less corrupt half of the countries, i.e. the half where corruption plays an insignificant role. This might be an explanation to why larger firms are more susceptible to corruption; as they have the possibility to replace outsourcing with FDI, they have the possibility to act in countries where corruption influences their behaviour. But as the decrease of total offshoring due to corruption is just partially offset by the potential increase in FDI, larger firms seem more affected by corruption than smaller firms. It is possible that this effect would have been reversed if we had been able to include observations on all firm-country pairs with no offshoring, as the smaller firms' decisions not to offshore at all to a given country then would have been present.

7.4 Effects Depending on R&D-intensity

R&D-intensity is another firm characteristic expected to affect a firm's susceptibility to corruption. Following Svensson (2003), an R&D-intensive firm may be more attractive to the foreign country, increasing its resistance to pay bribes. On the other hand, as complexity in the production process increases, so does relation-specificity. As presented in our literature review, relation-specificity increases the importance of a high-quality contractual environment. If we assume that R&D-intensity is positively correlated with relation-specificity,[3] this part of the literature would rather imply an increased negative effect of corruption as R&D-intensity in the firm gets higher. All in all, it is not obvious what result to expect.

In our data we have figures for R&D-intensity for all firms with more than fifty employees. All firms with less than 50 employees are reported to have zero R&D-intensity. To avoid bias we have to drop all these firms in our regressions concerning R&D-intensity, which will obviously limit our conclusions on this.

Using an interaction term between R&D-intensity and corruption on all firms for which R&D-intensity is available, the coefficient on the interaction term is positive, but small and completely

[3] Nunn (2005) presents the industries with the highest degree of relation-specificity, including industries regarded as R&D-intensive, such as automobile, aircraft, computer and electronic equipment manufacturing industries. The least relation-specific industries include industries with primary inputs, e.g. flour milling, oilseed processing and poultry processing, none of which are R&D-intensive industries.

statistically insignificant. So in the most basic form, we find no special effect on R&D-intensive firms at all (table 3).

Some evidence for the opposite appears if we only include firms that actually have any R&D reported. Column 2 in table 3 shows the basic regression for firms with an R&D-intensity above 0. The significant and strong coefficient (-0.152), indicates that corruption is certainly negative for R&D-intensive firms' offshoring. Our estimate suggests that a one point increase in corruption would imply a 15 percent decrease in offshoring from R&D-intensive firms, which is large also in economic terms. This result is in favour of Nunn's (2005) relation-specificity theory. As the sample of R&D-intensive firms only includes larger firms, the negative sign on the coefficient is expected as it is in line with the coefficient on corruption presented in table 2, including only large firms, but the coefficient is much stronger fo R&D-intensive firms.

Running the regression on firms with an R&D-intensity above zero including an interaction term between R&D and corruption (table 3) we find that the interaction term is positive, but small, while corruption in itself is negative. It is hard to draw any clear-cut conclusions from this. The relation-specificity theory suggested by Nunn (2005) could be an explanation to the large negative coefficient on corruption: for R&D-intensive firms, corruption has a deterrent effect. However, it fails to explain the positive sign on the interaction term. The interaction term could instead be explained by Svensson's theories about R&D-intensive firms having a stronger bargaining position and thus being less susceptible to corruption. Obviously, this theory fails to explain that firms with R&D-intensity above zero seems to be more affected by corruption than firms with no R&D at all.

Table 3. Interaction between corruption and R&D-intensity

	Size > 50	**R&D-intensity > 0**	**R&D-intensity > 0**
Dependent Variable	*log(Import intermediate goods)*		
Corruption	0.037***	-0.152***	-0.153***
	(0.004)	(0.009)	(0.009)
Corruption x R&D-Intensity	0.004		0.017***
	(0.004)		(0.004)
Observations	123281	34221	34221
Adjusted R-squared	0 .749	0.774	0.774

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Star errors reported in parentheses. Control variables and dummies for year, industry and regions included. See Appendix A for full table.

Finally, we would like to examine the effect of corruption on R&D-intense firms' offshoring decisions for the full range of firms (i.e. also those with less than 50 employees). To do this, we use *share of employees with at least three years natural science/technological tertiary education* (R&D-educ-intensity), as a proxy for R&D-intensity and create an interaction term with corruption, allowing us to use the basic model with the entire dataset. Running the basic regression with the new interaction term, we find the interaction term, R&D-educ-intensity×corruption, positive and significant, giving further support to the idea that R&D-intensive firms are less susceptible to corruption (table 4).

To check the robustness of the results presented in table 3, we repeat the regressions with small and large firms replacing R&D-intensity with R&D-educ-intensity. We find the two regressions to point in the same direction, with corruption being negative. The coefficient is smaller for the proxy, but significant on all levels.

To conclude, we find that corruption has a negative effect also on R&D-intensive firms' offshoring decisions. However, the more R&D-intensive a firm is, the smaller is the negative effect.

Table 4. Interaction between corruption and R&D-educ-intensity

	Basic Model	**Size <= 63**	**Size > 63**
Dependent Variable	log (Import intermediate goods)		
Corruption	0.031***	0.067***	-0.060***
	(0.002)	(0.003)	(0.005)
Corruption x R&D-educ-intensity	0.115***	0.072***	0.300***
	(0.006)	(0.007)	(0.019)
Observations	372609	263610	108999
Adjusted R-squared	0.759	0.758	0 .751

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Standard errors reported in parentheses. Control variables and dummies for year, industry and regions are included. See Appendix A for full table.

7.5 Causality

From our tests, we cannot say anything about causality. That Swedish firms' offshoring activities in themselves should influence a country's corruption level is unlikely but if Swedish firms follow other firms' in the world economy there might be a reversed causality, i.e. Swedish offshoring influencing corruption level. Hakkala et al. (2008) test for this using a dummy for protestant country and a variable for European settler mortality as instrumental variables. They find support for the result that corruption has a negative impact on FDI. Although our study is not using exactly the same data, it is not unreasonable to believe that this causality holds also for our results.

7.6 Robustness Tests

In order to test the robustness of our results, we run a few of the regressions analyzed above, replacing corruption with other variables of institutional quality assumed to be correlated with corruption. The variables are taken from the World Bank's Government Perfomance Indicators. In contrast to corruption, they are defined so that high values indicate good institutional quality. In other words, we assume a negative correlation between corruption and the measures, e.g. a country with low corruption is assumed to have a high value of government efficiency. The variables are (correlation with corruption reported after each) *government efficiency* (-0.50),

political stability (-0.73), *regulatory quality* (-0.48) *and rule of law* (-0.52), all obtained from the World Bank. The results of the regressions can be seen in table 5.

Table 5. Other institutional quality variables

	Basic model	**High institutional quality**	**Low institutional quality**
Dependent Variable	log(Import intermediate goods)		
Corruption	0.036***	0.007***	-0.069***
Government efficiency	-0.022***	0.104***	0.171**
Political stability	-0.404***	-0.677***	0.114**
Regulatory quality	0.127***	0.155***	-1.100***
Rule of law	-0.073	-0.091***	0.358***

Note: High (low) institutional quality refers to countries with a better (worse) value than the middle number of the respective scale. For corruption this corresponds to below (above) 5, for the others above (below) 0.

Comparing those values to the values of corruption, we find support for our conclusions. The coefficients are strongly significant and negative for *government efficiency, political stability and rule of law,* while *regulatory quality* is positive. The former three suggest that just like in our basic model with corruption, high institutional quality seems to have a small negative effect on Swedish firms' offshoring, including all firms in the data.

Repeating some of the conditioned regressions, we find that for observations above a middle value of each measure (0, these indices go from -3 to 3), there is support for our findings in five out of eight cases, judging from the signs of the coefficients. This is too inconclusive to be seen as neither confirming nor rejecting our finding that less corruption is good for the more corrupt part, while negative for the less corrupt part. But considering that they are different measures and based on perceptions, we will not draw any further conclusions out of this.

We have also tested for heteroskedasticity in the unobservable error-term, using the Breusch-Pagan test as in Wooldridge (2008). Our test statistic ($F = 88.26 \rightarrow$ p-value of 0.00), indicates a rejection of the assumption of homoskedasticity. However, heteroskedasticity only affects the standard errors and not the estimates. Therefore we have also tried our basic regression using

robust standard errors. The p-values change slightly, but not enough to change the significance of our estimates which are still significant on the one percent level (p-value 0.000).

8. Conclusion

The aim of our thesis is to test the hypotheses that the level of corruption in a country affects Swedish firms' choice of offshoring location and that this effect is depending on firm characteristics. We find this question interesting as Swedish firms' offshoring is increasing and lively debated, while the factors influencing offshoring are discussed less. Research on firm level is particularly scarce and we believe our thesis to be the first using Swedish firm level data to study the role of corruption on offshoring. To test our hypotheses we constructed a dataset consisting of Swedish firm level data, several country variables and Transparency International's Corruption Perceptions Index to measure corruption and institutional quality. In total this gave us about one million observations. To analyze data we use a gravity model setting with imports of intermediate goods as proxy for offshoring.

Following theory, we expected an overall negative effect of corruption on offshoring. We also expected firm characteristics to influence the magnitude of the effect. More precisely, we expected larger firms to be less adversely affected by corruption than smaller firms. For R&D-intensity, our expectations were less obvious. Theory could be said to argue in both directions, i.e. that R&D-intensive firms should be more affected as well as less affected.

Our tests indicate that the effect of corruption on the decision of location for offshoring activities is asymmetric in several aspects. Firstly, there is a threshold level of corruption below which the effect is insignificant. Above this threshold, increased corruption has a deterrent effect on offshoring which is statistically significant. The coefficient is rather small but as we control for several development factors supposed to influence offshoring the result may not be negligible.

Secondly, larger firms are more adversely affected by corruption than smaller firms. This is contrary to the findings of Hakkala et al. (2008). This difference may be due to the fact that Hakkala et al. study only FDI while our study includes all kinds of offshoring. The differences in the results may be explained by theory on the effect of corruption on firms' choice of organizational form suggesting that FDI is a substitute for outsourcing in countries with a high level of corruption.

Thirdly, we investigate if differences in R&D-intensity may have an impact on firms' susceptibility to corruption. We find statistical support for the idea that R&D-intensive firms, although negatively affected by corruption, are less susceptible to corruption the more R&D-intensive they are. However, the effects are small and partly ambiguous. This ambiguity in our results is also reflected in theory, suggesting several non-coherent effects of corruption in relation to R&D-intensity.

Studying offshoring is complicated as exact data is not available. Our proxy, imports of intermediate goods, is admittedly a crude one and a better proxy would be of high interest. Likewise it would be interesting to integrate firm-country data taking a zero value, thereby being able to investigate also the decision not to offshore to a certain country. The possibility of reverse causality might be another point of interest for further research.

Our study indicates that there is a difference in corruption susceptibility between total offshoring and FDI. Investigating outsourcing alone, not including FDI would be an interesting extension to our study and enable a comparison between our results for offshoring in total and Hakkala et al.'s result for FDI.

Finally, it is not impossible that firms evaluate corruption differently, based on the corruption level in the country they originate from. For example, Swedish firms might have more difficulties adapting to a corrupt environment, and are perhaps also more reluctant to pay bribes, than a firm from a country where corruption is more common. Investigating offshoring from a more corrupt country than Sweden (CPI 0.4) might therefore offer new insights.

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10. Appendix

Appendix A

Table 1. Asymmetric effect depending on corruption level

	Basic Model	**Corruption <=5**	**Corruption > 5**
Dependent Variable	*log(Import intermediate goods)*		
Corruption	0.036***	0.007*	-0.037**
	(0.002)	(0.004)	(0.015)
log(GDP)	0.244***	0.305***	0.337***
	(0.002)	(0.004)	(0.007)
log(weighted distance)	-0.428***	-0.425***	-0.480***
	(0.007)	(0.010)	(0.024)
R&D to GDP	0.350***	0.341***	-0.230***
	(0.005)	0.006	(0.026)
Agriculture	-0.017***	0.111***	0.022***
	(0.001)	(0.003)	(0.003)
Tertiary education	0.006***	0.006***	0.005***
	(0.000)	(0.000)	(0.000)
Energy	-0.000***	-0.000***	0.000***
	(0.000)	(0.000)	(0.000)
log(Labour)	0.437***	0.456***	0.298***
	(0.001)	(0.002)	(0.004)
Capital intensity	0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)
Profit margin	0.002	0.002	0.003
	(0.002)	(0.002)	(0.005)
Export quote	0.086***	0.106***	-0.013
	(0.011)	(0.012)	(0.027)
edu_h3	-0.001***	0.000	-0.003***
	(0.000)	(0.000)	(0.000)
Constant	-6.155***	-7.939***	-8.244***
	(-0.077)	(0.096)	(0.268)
Year dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Observations	372609	312706	59903
Adjusted R-squared	0.759	0.765	0.727

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Standard errors reported in parentheses.

Table 2. Asymmetric effects of corruption depending on firm size

	Size <= 63	**Size > 63**	**Size > 262**	**Interaction**
Dependent Variable	*log(Import intermediate goods)*			**Term**
Corruption	0.069***	-0.043***	-0.112***	0.093***
	(0.003)	(0.005)	(0.007)	(0.003)
Corruption x log(Size)				-0.016***
				(0.000)
log(GDP)	0.153	0.411***	0.507***	0.241***
	(0.003)	(0.005)	(0.008)	(0.002)
log(weighted distance)	-0.231***	-0.861***	-1.088***	-0.426***
	(0.008)	(0.015)	(0.023)	(0.007)
R&D to GDP	0.389***	0.232***	0.109***	0.346***
	(0.006)	(0.010)	(0.017)	(0.005)
Agriculture	0-.031***	-0.005*	-0.008*	-0.020***
	(0.001)	(0.003)	(0.004)	(0.001)
Tertiary education	0.007***	0.005***	0.002***	0.006***
	(0.000)	(0.000)	(0.001)	(0.000)
Energy	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
log(Size)	0.373	0.669***	0.731***	0.475***
	(0.002)	(0.004)	(0.009)	(0.002)
Capital intensity	0.000**	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Profit margin	0.007***	0.004	0.095***	0.002
	(0.002)	(0.004)	(0.020)	(0.002)
Export ratio	0.100***	0.104***	0.136***	0.086***
	(0.021)	(0.016)	(0.027)	(0.010)
Skilled labour	0.000	-0.007***	-0.006***	-0.001***
	(0.000)	(0.001)	(0.001)	(0.000)
Constant	-4.650***	-9.529***	-10.63***	-6.232***
	(0.088)	(0.153)	(0.250)	(0.077)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes	Yes
Observations	263610	108999	44015	372609
Adjusted R-squared	0.758	0.751	0.761	0.759

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Standard errors reported in parentheses.

Table 3. Interaction between corruption and R&D-intensity

	Size > 50	**R&D-intensity > 0**	**R&D-intensity > 0**
Dependent Variable	log(Import intermediate goods)		
Corruption	-0.037***	-0.152***	-0.153***
	(0.004)	(0.009)	(0.009)
Corruption x log(Labour)			
Corruption x R&D-Intensity	0.004		0.017***
	(0.004)		(0.004)
log(GDP)	0.391***	0.525***	0.525***
	(0.005)	(0.009)	(0.009)
log(weighted distance)	-0.817***	-0.967***	-0.968***
	(0.014)	(0.026)	(0.026)
R&D to GDP	0.253***	0.175***	0.174***
	(0.010)	(0.019)	(0.019)
Agriculture	-*.004	0.006	0.006
	(-0.002)	(0.004)	(0.004)
Tertiary education	0.005***	0.006***	0.006***
	(0.000)	(0.001)	(0.001)
Energy	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
log(Labour)	0.632***	0.690***	0.693***
	(0.004)	(0.007)	(0.007)
Capital intensity	0.000**	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Profit margin	0.008*	-0.014***	0.005
	(0.004)	(.004)	(0.005)
Export quote	0.091***	0.385***	0.387***
	(0.015)	(0.031)	(0.031)
edu_h3	-0.007***	-0.014***	-0.014***
	(0.000)	(0.001)	(0.001)
Constant	-9.063***	-12.07***	-12.083***
	(0.142)	(0.275)	(0.275)
Year dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Observations	123281	34221	34221
Adjusted R-squared	0 .749	0.774	0.774

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Standard errors reported in parentheses.

Table 4. Interaction between corruption and R&D-educ-intensity

	Basic Model	**Size <= 63**	**Size > 63**
Dependent Variable	*log (Import intermediate goods)*		
Corruption	0.031***	0.067***	-0.060***
	(0.002)	(0.003)	(0.005)
Corruption x R&D-Intensity	0.115***	0.072***	0.300***
	(0.006)	(0.007)	(0.019)
log(GDP)	0.246***	0.154***	0.416***
	(0.002)	(0.003)	(0.005)
log(weighted distance)	-0.432***	-0.232***	-0.874***
	(0.007)	(0.008)	(0.015)
R&D to GDP	0.346***	0.388***	0.226***
	(0.005)	(0.006)	(0.010)
Agriculture	-0.017***	-0.031***	-0.006**
	(0.001)	(0.001)	(0.003)
Tertiary education	0.006***	0.007***	0.005***
	(0.000)	(0.000)	(0.000)
Energy	-0.000***	-0.000***	-0.000
	(0.000)	(0.000)	0.000
log(Labour)	0.446***	0.377***	0.686***
	(0.002)	(0.002)	(0.004)
Capital intensity	0.000***	0.000*	0.000***
	(0.000)	(0.000)	(0.000)
Profit margin	0.001	0.005***	0.004
	(0.002)	(0.002)	(0.004)
Export ratio	0.086***	0.099***	0.103***
	(0.011)	(0.021)	(0.016)
edu_h3	-0.001***	-0.000	-0.010***
	(0.000)	(0.000)	(0.001)
Constant	-6.196***	-4.648***	-9.617***
	(0.077)	(0.088)	(0.153)
Year dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Region dummies	Yes	Yes	Yes
Observations	372609	263610	108999
Adjusted R-squared	0.759	0.758	0 .751

Note: *** significant at 1 % level, ** significant at 5 % level and * significant at 10 % level. Standard errors reported in parentheses.

Appendix B

Variable Name	Definition	Source
Import intermediate goods	(1/1000000)*(outvaror_smal/price indexed intermediate goods)	Statistics Sweden
capital intensity	Machinery and inventory/price indexed production	Statistics Sweden
size	ln(mean number of employees over the year)	Statistics Sweden
profit margin	Gross result/sales	Statistics Sweden
export ratio	Total exports/total sales	Statistics Sweden
Skilled labour	Share of employees with at least 3 years tertiary education	Statistics Sweden
R&D-educ-intensity	Share of employees with at least 3 years of natural sciences/technological tertiary education	Statistics Sweden
R&D-intensity	R&D intensity	Statistics Sweden
Weighted distance	ln(weighted distance between largest cities)	CEPII
GDP	ln(GDP) GDP in USD 2000	World Bank
R&D to GDP	Expenditure on R&D as share of GDP	World Bank
Agriculture	Agriculture's share of value added as % of GDP	World Bank
Tertiary education	Gross enrollment rate (%), tertiary education	World Bank
Energy consumption	Energy consumption, kg of oil equivalent, constant 2000 PPP 1000$	World Bank
corruption	Corruption Perception Index	Transparency International
Government efficiency	Governance Indicator	World Bank
Political stability	Governance Indicator	World Bank
Regulatory quality	Governance indicator	World Bank
Region[4]		
Year	1997-2005	
SNI92	Industry sector, 2-digit level	Statistics Sweden

[4] EU 15, Europe except EU 15, North America, Latin America, Africa, Oceania, South and East Asia, Other Asia

Appendix C

Country variables	between variance	within variance	Ratio
Log(GDP)	1,702722	0,0602393	28,26597
corruption	2,041643	0,2425862	8,416155
R&D to GDP	0,8075958	0,1169493	6,905521
Agriculture	4,553587	0,5173914	8,801049
Tertiary education	18,44296	4,474052	4,122205
Energy consumption	2070,721	164,9212	12,55582
Firm variables			
Capital intensity	1,281643	0,4980921	2,573104
size	1,83155	0,2694711	6,796833
Profit margin	1,531589	0,871754	1,756905
Export ratio	0,2520241	0,1065465	2,365391
Skilled labour	17,1134	5,500322	3,111345