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Offshoring and Home Country R&D

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Abstract

National concerns are sometimes raised against offshoring of economic activities to other countries. While most of the existing literature has focused on the effects on labor demand and productivity the effects on domestic R&D have been neglected. This is unfortunate since the decision to offshore activities also includes R&D. We use unique and rich firm level data for the Swedish manufacturing sector to analyze how offshoring impacts domestic R&D and how these effects vary with respect to target region and type of firm. The results suggest that offshoring of production alter a firm's investments in R&D in Sweden and that a negative impact on home country R&D is confined to offshoring by non-multinationals and offshoring to Europe and EU15 countries.

Key Words: Offshoring; R&D; Manufacturing sector; EU15
JEL Codes: C23; F16; F23; J23

1. Introduction

During recent years, offshoring has received increasing attention in both academic research and the public debate. Although, many economists argue that offshoring is a normal part of international trade, the debate in rich countries clearly reveals that there are worries about its consequences. These concerns are mostly connected to a fear of job losses as firms move production abroad. While low-skilled workers are obviously most vulnerable to competition from offshoring it also poses a challenge for other groups. A large share of what is being offshored by rich countries goes to other rich countries and as OECD (2005) points out, not only unskilled jobs but also ICT jobs and other tasks requiring skilled labor – perhaps even R&D – is at stake.

It is, therefore, interesting to note that existing studies on offshoring and labor demand have mainly focused on the aggregate picture where a shift in relative labor demand, from unskilled to skilled workers are typically found: the effects on R&D in the home country have largely been ignored. This is unfortunate. R&D is one of the main determinants of firm competitiveness. It is, therefore, of prior interest to ask whether offshoring leads to a relocation of R&D and if this effect varies across firms and country of destination. Moreover, for small economies, it is hard to specialize in both R&D and hi-tech production; therefore, this question may be of particular interest for a small open economy like Sweden (Eholm and Hakkala, 2007).

According to traditional theory on MNEs, one important motive for a firm to invest abroad is to take advantage of gains from division of labor as it specializes certain stages of the production process to different countries, Dunning (1993). The classical example of vertical integration is when a firm acquires the rights to a natural resource, such as a mine. A more up-to-date example of vertical integration is when Intel expanded its R&D and increased its engineering workforce 150 percent by adding 600 engineers to its research and development operations in Russia (Foremski, 2004).

The theoretical foundation of this paper is related to the literature on offshoring and labor demand models proposed by Grossman and Helpman (2002a, 2002b, 2003) and Grossman and Rossi-Hansberg (2006). One point highlighted in these papers is that offshoring is sensitive to the contract cost and that corruption can be seen as a factor that raises the contract cost. Difficulties to complete a contract with agents in a foreign country hold back offshoring, in general, and offshoring which is intensive in R&D in particular and may therefore make the sourcing firm alter the choice of target country.

Our hypothesis is that the capacity to deliver hi-tech inputs is relatively high in the US, Europe and EU region. In addition, the European integration process and the fact that the EU is a relatively homogenous and corruption clean region with well functioning institutions are likely to reduce the contract cost of intra-EU offshoring.

Looking at the empirical evidence on related issues D'Agostino et al. (2010) found complementarities in R&D offshoring of less complex technology in Brazil, Russia, India, China Singapore and Taiwan. In an exploratory cross country analysis Santangelo & Piscitello (2009) found similar results for OECD countries' R&D offshoring to BRICKST countries. Moreover, there are a number of papers focusing on the effects of offshoring on employment. Overall, the results suggest that, for rich countries, the impact of offshoring on employment is moderate and mostly confined to a reduced demand for blue collar workers and that the impact can vary across sectors. For example, Amiti and Wei (2005a, 2005b), Landefeld and Mataloni (2004) and Borga

(2005) all found small employments effects of US service offshoring and Crinò (2006), who looked at relative labor demand, found outsourcing to favor skilled US workers. Results, similar to those for the US, are also found for Sweden (Andersson and Karpaty (2007), Ekholm and Hakkala (2006)), for Germany (Falk and Kobel, 2002), and for the UK (Görg *et al*. 2007). Hence, for the advanced countries, it seems clear that the aggregate picture of offshoring is that it tends to shift labor demand from relatively unskilled to skilled workers. Less is known about how offshoring may alter home country R&D investments.

Analyzing offshoring of R&D, Gersbach and Schmutzler (2011) showed that the decision to offshore R&D and undertake an FDI are taken simultaneously and that small countries are more likely to offshore their R&D into large countries ratherthan vice versa.

In a Swedish context, three important empirical facts have previously been established (Henning and Norgren, (1992), Håkansson and Nobel (1993), Fors, (1998), Carlsson et al. (2006)). Firstly, an increasing share of R&D in Swedish MNEs is being performed by affiliates abroad.[1] Secondly, international cooperation has become a frequently chosen strategy in the development of new. Thirdly, The development of new technology in Swedish firms (own development of components and subsystem) have come to rely more on technology developed by foreign suppliers. These trends clearly indicate that Swedish firms have become more dependent upon foreign suppliers. At the same time, cooperation with foreign counterparts brings along greater possibilities for Swedish firms to take advantage of technology developed abroad. A Swedish MNE may benefit from complementarities in the R&D assets when it enters a host country market as it acquires the R&D assets of the domestic firm, or engages in collaboration with an independent supplier.

National concerns are sometimes raised against foreign MNEs outsourcing domestic production and R&D to other countries giving less national control of production and the development of new technology. However, Bandick et al. (2010) found no support to the fear that foreign acquisition leads to a loss of home R&D. In fact, they concluded that the R&D intensity increases in acquired firms.[2] In a similar vein, using survey data for Finnish manufacturing, Ali-Yrkkö and Deschryvere (2008) found complementarities between in-house expansion of R&D abroad and domestic R&D employment.

The remainder of the paper is organized as follows: Section 2 overviews the theory of offshoring and discusses measurement problems. Section 3 presents the data, empirical methodology and a descriptive analysis of the data. Results are provided in section 4 and section 5 concludes.

2. Offshoring: theory, definitions, and measurement

2.1 Theory

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[1] Håkansson & Nobel (1993) conclude that Swedish MNEs carried out 23% of their research abroad during the 1980's, while corresponding numbers for other developed countries was only 10%.

[2] In a survey of the 320 largest Swedish firms it is concluded that the geographical location of R&D-labs is only weakly correlated with the geographical location of the headquarter (HQ) and the production. A minority of the firm's claims that, as their HQ's relocate abroad, this may have effect on the R&D activity in Sweden, see Karpaty (2011).

The theory of offshoring is based on the idea that firms, under certain circumstances, benefit from a vertical defragmentation of the production process.[3] In a closed economy setting, firms may choose between in-house production and subcontracting (or outsourcing), as discussed by McLaren (2000) and Grossman and Helpman (2002b). The optimal choice depends on how strong are the motives for internalization – this, in turn, is discussed in the property-rights theories of Grossman and Hart (1986): for surveys, see Spencer, (2005), Trefler (2005) and Helpman (2006). In an open economy context, firms may choose between in-house production – in the form of foreign direct investment (FDI) or international outsourcing. International outsourcing allows the firm to avoid the fixed set-up cost that is related to FDI. However, it requires the firm to formulate a contract with a foreign subcontractor. One purpose of the contract is to protect the mother company from leakages of know-how and strategic information. Such contracts can be rather costly to formulate. Therefore, most offshoring models focus on the tension between taking the fixed FDI cost and the transactions costs needed for subcontracting. This tension is characterized by the Grossman and Helpman (2003) North-South outsourcing model. In their set-up, for a given Northern firm, the probability of international outsourcing increases with the thickness of the intermediate good market and to the extent to which the product is standardized. Other models considering the choice between FDI and outsourcing include those of Grossman and Helpman (2002a), Antras (2003) and Feenstra and Hanson (1995, 2005). One conclusion, drawn from these studies, is that sensitive tasks are not as easily outsourced to outsiders as standardized job tasks. Moreover, non-standard tasks and R&D are less likely to be offshored to countries to which the contract cost is likely to be high.

Traditionally, it is assumed that in-house R&D investments of incumbent firms are most important for the development of new or improved products, but in some industries entrant firms are very active and frequently introduce new or improved products of higher quality. In these industries the incumbent firms face the risk of being priced out of the market; see Klette & Kortum (2004).[4] An alternative strategy for head-to-head competition is to draw on complementarities and to trade technology and to cooperate in R&D; see Pisano (1990). Hence, when complementarities in R&D capabilities in the incumbent and entrant firms are high, the incumbent firm faces the alternatives to integrate or buy R&D capabilities on the market, i.e. the make-or-buy decision.[5]

The make decision. An incumbent firm may have enough financial credibility to raise capital to integrate with the entrant. Integration may help the incumbent regain its market position while still being able to exercise influence and to monitor the course of research (anti-competitive effect). An adjacent reason to internalize is the scope for productivity gains, derived from asset complementarities in R&D capabilities.[6] Integration may also help in formulating the contractual agreement that includes reassurance of property rights and restriction for the contractor's right to transfer knowledge to third parties. Moreover, Henderson & Cockburn (1996) suggests that economies of scope arise from internal and external knowledge spillovers generated in diverse portfolios of

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[3] The term "offshoring" here refers to the relocation of production of goods or services to another country. Offshoring does not separate whether the production is external or internal to the firm. We measure offshoring as imports of material inputs as a share of sales.

[4] Klette & Kortum (2004) derives theses results from an oligopolistic model with Bertrand competition.

[5] R&D capabilities or technical know-how can be retrieved through licenses, subcontracting agreements or joint ventures, Pisano (1990).

[6] Discussing FDI, Nocke and Yeaple (2008) consider the choice between greenfield investments and a merger & acquisitions. They concluded that acquisition will take place if complementarities are strong enough. Bertrand et al. (2009) extended this result and empirically tested how R&D is affected by an acquisition.

research projects.[7] Hence, when incentives for the making of a decision are strong, an M&A is a more likely an outcome than offshoring.

The buy decision. There are many reasons for a firm to outsource R&D to an outside party (Hertog and Thurik 1993). Perhaps, the most obvious reason for outsourcing R&D is to minimize both costs and risks by contracting an outside firm that benefits from scale economies in R&D.

Using external sources of R&D confers four main advantages to in-house R&D. Firstly, R&D procurement projects may be an effective way of reducing risks associated with hazardous R&D projects. Secondly, if there is economies of scale in research the contractor may sell similar prototypes or blueprints to several firms and benefit from scale economies in R&D. For example, the mobile phone companies, Apple and HTC, both purchase standardized technology from a firm that supplies several competitors with microchips.[8] Thirdly, if the incumbent firm lacks both the resources needed to internalize the entrant and necessary skills to compete with the new entrant in a specific segment, the firm may confront a "buy-or-die" decision. Fourthly, by purchasing complementary technologies the firm may be able to diversify into a segment or new market that is strategically important.[9] As is easily understood, an obvious drawback in engaging an external supplier is the loss of control of the output of the R&D generated by the external party.[10]

Drawbacks with the buy decision. If the incumbent firm chooses the buy alternative, the firm faces a transaction cost in formulating the contractual agreement that includes reassurance of property rights so that they are not transferred to third parties. This loss of control constitutes a drawback in the procurement of technology, making it difficult for the buyer/subcontracting firm to significantly deviate from its competitors and to make excessive profits by introducing significantly improved products.

3. The model, econometric considerations and data

3.1 The model

An early attempt to explain firm R&D and innovation stem from the work of Schumpeter (1943). Schumpeter empathizes the interdependence between innovation, competition and profits. In his set-up, competition is seen as a hurdle to R&D since it makes it harder to cover fixed costs in R&D and the monopoly deadweight loss is the price we have to pay to finance and to stimulate R&D. This view has been challenged by e.g. Porter (1990) who states that competition is good for growth because it forces firms to innovate in order to stay in business. To the

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7 An incumbent multi product firm may also benefit from economies of scope in marketing, designing or manufacturing multiple products within a firm (Baumol 1977).

8 Nokia continued, for a long time, to develop their own microchips while competitors like Apple and HTC purchase standard chips from Qualcomm. This is sometimes claimed to be one of the reasons for Nokia having lost market shares in recent years.

9 For example, the discussion about the relationship between GM and Opel shows that a reason for GM to hold on to Opel is the strong R&D expertise in the German HQ on small and medium sized vehicles, whereby GM's expertise is, rather, in larger motor cars. Hence, the R&D activities in the two firms are likely to be complementary, and hence, may be left in their respective countries. This may be true also for software platforms. Cit: "For Nokia, the attraction of an existing platform such as WP7 or Android is the potential to get new devices into the market faster, as opposed to starting from scratch with a platform unfamiliar to customers in key markets such as the U.S. "The Wall Street Journal, February 8, 2011.

10 In a Dutch setting, Hertog and Thurik (1993) found that firms that do internal R&D, or both internal and external R&D, are large firms, while small capital intensive firms in competitive environments are more likely to use an external supplier of R&D. Their results confirm Schumpeter's (1950) hypothesis that R&D is associated with large fixed costs. In addition, in large firms there is also scope for asset complementarities.

end that R&D can be seen as a fixed cost, theory suggests that large firms should have an advantage over smaller firms and decades of research on the relationship between firm size and R&D have established a consensus view of an elasticity of R&D with respect to firm size close to unity.[11] However, there is still no consensus view on which factors govern R&D, but financial resources, firm size and industry characteristics are frequently suggested candidates.[12]

To single out variables that determine firm R&D the knowledge production function offers a transparent route of thinking. As shown in e.g. Martínez and Labeaga (2002) firms seek to maximize the current value of their expected profit flow, where profits are a function of inputs, input prices and market conditions. The outcome of the maximization problem suggests that firm R&D, or more generally, innovative efforts can be seen as a function of market conditions, physical capital, technological opportunity, and a set of shift factors.[13] In line with this model, Hertog and Thurik (1993) model firm R&D as a function of firm size, competition, capital intensity, profitability and market conditions. These variables make up for core determinants of firm R&D, to which we add offshoring as a shift factor allowing firms to vertically split the chain of production and R&D. With this as a background, our baseline equation takes the following form:

[illegible] (1.)

where $(R\&D)_{ijt}$ is the R&D-intensity by firm *i* in industry *j*, (*offshoring*) is offshored material inputs to sales, (*size*) is firm sales, (*k*) is capital intensity, (π) is profit ratio, (raw) is domestic raw material inputs to sales, (comp) is the level of competition measured by the Boone (2008) and Boone et al. (2007) price elasticity (PE) measure[14], $(d)_j$ is an industry dummy, γ_t is a period dummy, finally ε is the error term.[15]

3.2 Econometric considerations

Not all firms have positive R&D outlays and data that contain zero valued observations. These zeros are challenging. Given that selection into R&D is not random; not adjusting the regressions for selection may lead to biased results. In order to visualize how various refinements affect the results, our point of departure is that of OLS models. With this as a basis, we can easily see the impact of various refinements, such as control for selection, heterogeneity and fixed effects.

To adjust for selection into R&D, we first apply the Heckman selection model. To this end, we need to find variables that can be used as exclusion restriction. The goal is to find variables that are closely related to the selection into R&D and variables related to the sunk cost of R&D have been suggested as candidates. [16] Here we follow Bernard and Jensen (2004) and add a measure of the skill intensity of the firms (share of workers with at

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[11] See e.g. Karpaty and Gustavsson Tingvall (2011).

[12] See e.g. Geroski (1990) and Griffiths and Webster (2010).

[13] For a survey on dynamic models of innovation, see e.g. Reinganum (1989). See also Blundell et al. (1995).

[14] The Boone price elasticity measure (*PE*) measures the elasticity of output to changes in input prices. For details, see Karpaty and Gustavsson Tingvall (2011).

[15] See Appendix for variable definitions and sources.

[16] Note that the target equation, while the selection is estimated by a probit model, can be identified because of the non-linearity alone. The non-linearity of Inverse Mils Ratio (IMR) arises from the assumption of normality. However, to ease identification it is recommended to add variables, related to the decision to enter R&D, to the selection equation.

least tertiary education) since skill intensive firms are more likely to perform R&D than other firms and both R&D and hiring and firing costs imposes sunk costs to the firm.[17] As seen in the estimations of the selection equation, skill intensity turns out as a strongly significant predictor of firm R&D.

In a heterogeneous firm set-up, Helpman Melitz and Rubenstein (2008), hereafter (HMR), recognized that the Mills ratio may not be sufficient to control for selection and firm heterogeneity. More precisely, in a Gravity model setting, HMR show how a higher order polynomial of a term "z", based on predicted probabilities from the selection equation and Mill's ratio, can control for firm heterogeneity. We will here apply both the standard Heckman approach and the HMR type of heterogeneous firms' specification. Estimating models with varying degrees of control for selection and heterogeneity gives us an indication of the robustness of the results.

A drawback with the Heckman selection model is that the distribution of the fixed effect model is unknown; instead, one may include a set of industry dummies to control for fixed effects.[18] However, a massive infusion of industry level dummies makes it hard to estimate the impact of slowly changing variables and time-invariant effects (almost all cross sectional variation is swept away by the dummies), and in addition we easily end up with an extremely large number of coefficients to estimate. Plümper and Troeger (2007) have presented an approach that appears to provide an attractive solution to the problem. They suggest the Fixed Effect Variance Decomposition (FEVD) estimator as a way to handle time invariance and slowly changing variables in a fixed effect model framework. By decomposing unit effects into one explained part (captured by dummy- and slowly changing variables) and one unexplained part (η) they make it possible to efficiently estimate and include time-invariant variables and nearly time-invariant variables in a fixed effects framework. However, several researchers have recently contested the FEVD model (Greene 2011a, 2011b., Breusch et al. 2011a, 2011b). Some critique against the FEVD estimators deals with asymptotic properties/bias; underestimated standard errors, and that the FEVD model is a special case of the Hausman-Taylor IV procedure. However, one important point, put forward in the defense of the FEVD model by Plümper and Troeger (2011) is the finite sample properties of the model, where they illustrate the advantages by an extensive set of Monte Carlo simulations. The discussion on the FEVD model is gathered in a symposium on the FEVD model in Political analysis 19(2) (2011). One important imparted lesson from the discussion is that panel data is always likely to suffer from potential omitted variable bias and that this issue needs to be considered. Nevertheless, the FEVD issue is not yet settled. We, therefore, use results from the FEVD models to analyze to what extent unobserved heterogeneity and not controlling for firm level fixed effects influences the results. This strategy also enables us to further test the robustness of our results. We would, therefore, already here like to stress that our results do not depend upon the use of a specific model specification or estimation procedure.

Here, we apply the FEVD model in a selection model framework to check the robustness of the results. A key concern, obviously, is to analyze to what extent the results are affected when we improve the control of fixed effects.[19]

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[17] Roberts and Tybout (1997) and Bernard and Jensen (2004) include lagged values of the dependent variable as proxy for fixed costs. To avoid endogeneity we leave this variable outside the model.

[18] Green, 2001.

[19] One may note that the inclusion of estimated variables such as Mills ratio and the Boone PE-measure adds uncertainty to the model. Murphy and Topel (1985) suggested a standard error correction when estimated variables are included. More recently, Hardin (2002) has shown that the sandwich estimator which is built under less restrictive assumptions and is efficient against a wide range of non-spherical distortion is asymptotically identical to the Murphy-Topel estimator and we therefore follow Hardin (2002) and apply robust standard errors.

3.2 Data

The dataset covers all manufacturing firms that operate in Sweden with at least 50 employees for the period 1997-2005. The register information used in this analysis has been obtained from three sources from Statistics Sweden (SCB) and has been merged using unique identification numbers. The financial statistics dataset (FS) and the regional labor market statistics dataset (RAMS) provides us with detailed information on all Swedish private sector firms. Examples of variables included are R&D, value added, capital stock, number of employees and their educational attainment, profits, sales and industry sector. A detailed description of the variables is found in the appendix. To capture offshoring we use data on imports of materials, collected by Statistics Sweden. Import data covers all transactions outside the EU and for intra-EU trade all firms with a total value of intra-EU transactions above 2.2 million SEK (approx. 240 000 EUR). Data on material imports are registered according to the NACE Rev 1.1. classification system and country of origin. Moreover, Statistics Sweden classifies imported materials into Major Industrial Groupings (MIG).[20] The MIG codes classifies material imports into broader classes depending on their intended use, distinguishing between production inputs, short, medium, and long term investment goods and consumption goods which allows us to identify offshore production of goods. Imports of offshored materials are then aggregated into regions, defined by Asian Development Bank (ADB). Due to different time frame for the datasets and size limitations of certain variables we limit the analysis to the period 1997-2005 and firms with at least 50 employees.

3.3 Descriptive statistics

As seen in Table A1, compared to non-offshoring firms, offshorers are, relatively large, R&D-intensive, intensive in skilled labor and display higher labor productivity than non-offshorers. This is in line with theories on the heterogonous firm (Meltiz, 2003) where offshoring requires that the firm has to overcome barriers associated with such trade. The prevalence of offshoring firms is highlighted by the fact that in the year 2000, 95 percent of employment in the manufacturing sector was recorded in offshoring firms and almost 100 percent (99.7) of firm R&D was performed in offshoring firms. Hence, out of employment, value added and R&D, we find R&D to be the variable where offshoring firms are the most overrepresented.

4. Results

Our starting point is to use OLS to analyze the impact of offshoring on firm R&D and, by refining the estimation, to analyze the sensitivity of the results. In estimation 1 in Table 1 we use firms with positive R&D only and in estimation 2 we allow firms with zero R&D expenditures to enter the analysis.

To adjust for non-random selection to R&D, in estimation 3 we estimate a Heckman selection model and in estimation 4 we further improve the control for firm heterogeneity by estimating a HMR type of the Heckman model.

As seen in Table 1, the overall impact of offshoring on R&D is negative. To some extent, this result is in line with findings by Heyman (2010) who found offshoring of Swedish firms to reduce demand for non-routine job

[20] MIG - European Community classification of products: Major Industrial Groupings (NACE rev1 aggregates).

tasks. Hence, offshoring seems to be able to challenge R&D and non-routine types of jobs. Further inspection of the results suggests that selection into R&D is not random and both the Mills ratio and estimated rho is strongly significant, suggesting that not controlling for selection may yield biased results.

[Table 1 about here]

As a final step, we analyze in Table 1 to what extent our applied 3-digit industry dummies are capable of absorbing fixed effects. That is, we aim to see if our results are robust with respect to the inclusion of firm level fixed effects. As pointed out by Plümper and Troeger (2007), estimation and the standard Fixed Effect estimator can be cumbersome with slowly changing variables and we, therefore, follow Plümper and Troeger and use the Fixed Effect Variance Decomposition (FEVD) estimator, here applied in a Heckman framework. Comparing the standard Heckman model with results from the Heckman-FEVD model we see that the results are rather similar, suggesting that further control of fixed effects beyond industry dummies at the 3-digit level do not significantly alter the results. However, considering the debate of the FEVD-model we take this as a robustness test and choose the HMR specification as our preferred estimator.

Turning our attention to the control variables we, in Table 1, see that most control variables are significant with the expected sign. The R&D-intensity seems to increase with firm size and the negative relation between profits and R&D may be due to the fact that to perform R&D, resources are allocated from production to R&D and that the benefits from R&D are not instantaneous. A less expected result is the negative relation between capital intensities. Finally, we find an inconclusive pattern between competition and R&D and that raw material intensive firms are found to be less R&D intensive than other firms.

Though the overall impact of offshoring on R&D is negative, there are reasons to expect the impact to vary with respect to region of destination. Offshoring of simple and standardized job tasks requires different skills than R&D and advanced and non-standard job tasks. Simple job tasks are likely to be targeted toward low wage countries while offshoring of advanced and sensitive activities requires, not only well educated labor but also, well functioning institutions where the respect of intellectual and material property rights are highly ranked. It is, therefore, likely that advanced activities are directed toward relatively rich regions with well function intuitions.

[Table 2 about here]

In Table 2, we allow the impact of offshoring to vary with respect to target region. Results in Table 2, suggest that the negative impact of offshoring is concentrated in offshoring to Europe and the EU15, though occasionaly, other regions may also enter with a negative sign. To the extent that offshoring increases domestic R&D, this is most likely to happen for offshoring to Africa and Latin America. Hence, the response of offshoring to different regions is highly heterogeneous.

Extensions

As noted above, wages and factor prices are key determinants of offshoring. Simple job tasks are the ones most likely to be offshored to low wage countries and advanced tasks to rich countries. To explicitly analyze the role of wage differentials, we group countries with respect to per capita income and analyze to what extent the impact of offshoring on domestic R&D varies with respect to the income level in target economies. Results within regions split by per capita income are shown in Table 3.

[Table 3 about here]

Results in Table 3 reveal a non-monotonic relation between per capita income and the impact of offshoring. The first thing to note is that we do not find any evidence that offshoring to the poorest group of countries reduces domestic R&D, while the impact of offshoring to the richest countries yields a negative impact on R&D, irrespective of estimator chosen. For other income groups, the results vary from insignificant to negative and significant depending on choice of estimator. Hence, though the pattern is not perfectly linear the results suggest that offshoring to high income countries is more likely to substitute for own R&D than offshoring to low wage countries.

According to the heterogeneous firm framework (Melitz, 2003), the impact of offshoring is also likely to vary across firms. Large firms with affiliates abroad can, with relative ease, take advantage of knowledge, at home and in other countries; in their allocation decisions. This gives support for a distinction between firms with respect to ownership. We, therefore, in Table 4 analyze whether or not the propensity to offshore R&D differs between firms with respect to ownership.

[Table 4 about here]

Results in Table 4 do not suggest any dramatic differences between domestic and foreign owned firms with respect to how local R&D responds to offshoring. However, the group “domestic firms” contain both Swedish MNEs and purely local firms. We, therefore, proceed and separate firms with respect to multinationality in Table 4. Here, we find that the negative impact of offshoring is more pronounced among non-multinationals than in multinationals. In Sweden, approximately 95% of all R&D performed in the business sector is done by multinationals. Hence, the potential “outleak” of R&D from non-multinationals is likely to be of second order. In addition, the relatively large number of small non-MNEs may be what drives the negative link between offshoring and R&D. We, therefore, proceed by weighing the regressions by firm size.

Results from employment weighted regressions presented in Table 5 reveals a pattern somewhat different from the un-weighted regressions.

[Table 5 about here]

Using firm-size weighted regressions, the most pronounced difference from the un-weighted regressions is that the overall impact of offshoring on domestic R&D goes from negative to positive. Breaking down the analysis to the regional dimension, we find that the impact of offshoring on local R&D is positive for all regions but three (North America, Europe non-EU15 and Oceania). Considering the distribution of firm R&D, these results are more likely to reflect the aggregate impact of offshoring on local R&D while the un-weighted regressions reflect the “typical firm” response. Hence, it seems clear that the response of R&D to offshoring is different in small non internationalized firms compared to large MNEs and that the economy-wide impact of offshoring on local R&D is positive, indicating that Sweden is a relatively attractive location for R&D.

5. Summary and conclusions

During recent years, offshoring has received increasing attention in the public discourse, with the fear of job losses motivating much of the debate. The fact that even relatively skill intensive jobs are at stake has often been seen as a matter of national concern. At the same time, empirical work has shown that the aggregate effects on labor demand seem to be small. However, even if the overall effects are relatively small, it is possible that the impact in some sectors may be substantial.

In this paper, we consider the extent to which increased internationalization, through offshoring and the corresponding trade flows, have affected Swedish firms R&D investments. We allowed for different impacts on the intensive and extensive margins of R&D. While not having much of an impact on the selection, we find that offshoring, generally, has a negative impact on domestic firm R&D. Taking a regional perspective we find that the most robust evidence for a negative impact of offshoring on domestic R&D is found for offshoring to Europe and EU15 countries, for other regions there is mixed evidence with a non-significant impact on domestic R&D as the most commonly found response. To the end that offshoring increases domestic R&D, this is most likely to be the case for offshoring to Latin America, Africa and OPEC countries, though, for all these regions the results are not robust with respect to choice of estimator.

To explore heterogeneity and the robustness of the results we allowed for different effects with respect to per capita income in target regions, ownership of the firm and firm size. We found that the only group of countries for which a negative impact of offshoring on domestic R&D never was found was confined to offshoring to the poorest group of countries, for middle income countries and countries with mixed evidence on home R&D, and for offshoring to the richest countries the impact of offshoring on domestic R&D was negative and significant. Hence, to some extent we found offshoring to high income countries to be associated with the highest probability of a negative impact on domestic R&D. This is not surprising, since rich countries not only have a relatively well educated labor force but also the most developed systems of IPR laws.

Looking at differences, with respect to ownership, we found that the negative impact of offshoring is more pronounced among non-multinationals than among multinationals. Given that the stock of R&D is performed by a few, very large, MNEs these results suggest that the outflow of total R&D by offshoring may be rather limited. We, therefore, proceeded by performing firm-size weighted regressions. Weighted regressions allow us to capture the economic weight of each firm. Results using firm-size weighted regressions reveals a somewhat different pattern compared to un-weighted regressions. Weighting the regressions by firm-size suggest that the overall impact of offshoring on R&D is positive and breaking down the analysis to the regional level confirms this pattern. At the regional level, offshoring to all but three regions (North America, Europe non-EU15 and Oceania) returns a positive impact on domestic R&D. That is, the negative impact of domestic R&D is, at large, confined to small firms. Given that approximately 95% of all business sector R&D is performed by (large) MNEs these results suggest that offshoring-driven outflow of R&D from Sweden not is alarming, but rather, results suggest that Sweden is a relatively attractive place for MNEs to locate their R&D while, at the same time, firms are truly heterogeneous in their response to offshoring and R&D and that understanding firm heterogeneity, therefore, is valuable.

Appendix

Table 1. Offshoring and R&D. Dependent variable, firm R&D-intensity.
Basic models. 1997-2005.

	OLS No zeros	OLS With zeros	Heckman Selection	Heckman [(A)] Target	HMR [(B)]	Heckman FEVD [(C)]
Offshoring	-0.0566 (-4.91)***	-0.0245 (-6.45)***	-0.0639 (-0.47)	-0.0462 (-3.67)***	-0.0255 (-2.69)***	-0.0487 (-6.26)***
***ln*(sales) size**	0.0008 (0.48)	0.0070 (11.20)***	0.4155 (26.95)***	-0.0125 (-10.84)***	-0.0366 (-7.30)***	-0.0067 (-6.10)***
Boone competition	0.0003 (0.55)	0.0002 (0.49)	-0.0168 (-2.29)***	0.0006 (1.07)	0.0014 (2.70)***	-0.0010 (-2.82)***
***ln*(k)**	-0.0051 (-3.13)***	-0.0005 (-0.89)	0.0502 (3.20)***	-0.0058 (-4.33)***	-0.0072 (-4.81)***	-0.0082 (-10.15)***
Profit ratio (t-1)	3.3e-06 (-1.88)*	-1.7e-06 (-1.59)	1.0e-05 (0.56)	-3.3e-06 (-2.58)***	-3.5e-06 (-2.19)**	-3.9e-06 (-5.25)***
Raw material intensity	-0.0388 (-2.38)**	-0.0164 (-2.90)***	-0.3527 (-3.72)***	-0.0266 (-3.38)***	-0.0050 (-0.37)	-0.0423 (-8.75)***
Share technicians			10.690 (31.58)***			
η fevd decomp						1(81.22)***
Z					0.0219 (9.67)***	
Z^2					-0.0005 (-7.89)***	
Z^3					3.7e-06 (6.67)***	
Mills Ratio				-0.0493 (25.74)***	-0.2169 (-10.27)***	-0.0497 (-14.79)
Rho				-0.6307 (35.31)***		
R^2	0.20	0.16		--	0.34	0.78
Obs.	4 418	12 354	12 354	4 418	4 418	4 418

Note. t-value within parenthesis ( ). *, **, ***, indicates significance on the 10, 5 and 1 percent level respectively. Firms with at least 50 employees. HMR and Heckman-FEVD models estimated using robust standard errors. Period and industry dummies at the 3-digit level included in all models. (A) p-val independent equations = 0.000.
(B) Following Helpman *et al*. (2008) we include higher order terms of z to control for firm heterogeneity where z is defined as $\hat{z}=\Phi^{-1}(\hat{p})+\hat{n}$, *p* is the predicted probability of positive R&D and *n* is Mill's ratio.
(C) Variables classified as time invariant/slowly changing include: *ln*(sales), Boone, TFP and imports of offshored materials.

Table 2. Offshoring and R&D. Dependent variable, firm R&D-intensity.
By region. 1997-2005.

	Heckman Selection	**Heckman** [(A)]	**HMR** [(B)]	**Heckman FEVD** [(C)]
1. EU15	-0.0549	-0.0492	-0.0265	-0.0216
	(-0.33)	(-3.27)***	(-2.43)**	(-2.33)**
2. Europe non-EU15	-0.1949	-0.0626	-0.0324	-0.1286
	(-0.60)	(-1.93)*	(-1.66)*	(-6.32)***
3. N. America	1.6311	-0.0407	-0.1725	-0.0507
	(1.51)	(-0.56)	(-2.30)**	(-1.17)
4. Lat. America	-5.5547	0.3408	0.4875	0.1019
	(-1.68)*	(1.03)	(3.61)***	(0.49)
5. Africa	-3.1263	0.3486	0.7503	-0.4387
	(-0.86)	(0.98)	(6.35)***	(-1.95)*
6. Oceania	-0.3337	-0.0630	0.0909	-0.0567
	(-0.06)	(-0.17)	(0.55)	(-0.25)
7. S+W Asia	-0.5066	0.0028	0.0161	-0.0663
	(-0.57)	(0.04)	(0.39)	(1.51)
8. OPEC	-7.2966	0.3183	0.7380	-1.0156
	(-0.97)	(0.58)	(3.79)***	(-3.07)***
9. Other Asia	5.3222	-0.2738	-0.5678	-0.2720
	(2.29)**	(-1.22)	(-5.07)***	(-1.95)*
***ln*(sales) size**	0.4169	-0.01258	-0.0368	-0.0055
	(26.96)***	(-10.79)***	(-7.28)***	(-4.99)***
Boone competition	-0.0171	0.0007	0.0014	-0.0011
	(-2.33)**	(1.12)	(2.77)***	(-3.12)***
***ln*(k)**	0.0502		-0.0072	-0.0065
	(3.19)***		(-4.74)***	(-8.05)***
Profit ratio (t-1)	9.7e-06	-3.3e-06	-3.5e-06	-4.2e-06
	(0.52)	(-2.56)***	(-2.17)**	(-5.52)***
Raw material intensity	-0.3465	-0.0266	-0.0053	-0.0432
	(-3.64)***	(-3.37)***	(-0.39)	(-8.90)***
Share technicians	10.645			
	(31.36)***			
η - fevd				1 (81.16)***
Z			0.0220	
			(9.76)***	
Z^2			-0.0005	
			(-7.98)***	
Z^3			3.6e-06	
			(6.73)***	
Mills Ratio		-0.0490	-0.0489	
		(25.57)***	(-14.49)***	
R^2		--	0.68	
Obs.	12 354	4 418	4 418	4 418

Note. t-value within parenthesis ( ). *, **, ***, indicates significance on the 10, 5 and 1 percent level respectively. Firms with at least 50 employees. HMR and Heckman FEVD models estimated using robust standard errors. Period and industry dummies at the 3-digit level included in all models. [(A)] p-val independent equations = 0.000.

[(B)] Following Helpman *et al*. (2008) we include higher order terms of z to control for firm heterogeneity where z is defined as $\hat{z} = \Phi^{-1}(\hat{p}) + \hat{n}$ *p* is the predicted probability of positive R&D and *n* is Mill's ratio.

[(C)] Variables classified as time invariant/slowly changing include: *ln*(sales), Boone, TFP and imports of offshored materials.

Table 3. Offshoring and R&D. Dependent variable, firm R&D-intensity.
By per capita income. 1997-2005.

Variable	**Heckman Selection**	**Heckman** $^{(A)}$ **Target**	**HMR** $^{(B)}$	**FEVD** $^{(C)}$
***ln*(sales)**	0.4157	-0.0125	-0.0366	-0.0060
size	(26.89)***	(-10.81)***	(-7.27)***	(-5.44)***
Boone	-0.0167	0.0006	0.0013	-0.0010
competition	(-2.29)**	(1.05)	(2.65)***	(2.98)***
***ln*(k)**	0.0492	-0.0057	-0.0071	-0.0060
	(3.14)***	(-4.25)***	(-4.73)***	(-7.36)***
Profit ratio	1.1e-05	-3.3e-06	-3.5e-06	-4.1e-06
(t-1)	(0.59)	(-2.58)***	(-2.21)**	(-5.51)***
Raw material	-0.3475	-0.0270	-0.0055	-0.0444
	(-3.66)***	(-3.42)***	(-0.40)	(-9.16)***
Share technicians	10.6794			
	(31.50)***			
Lowest PCI	-3.8705	0.2195	0.5145	-0.0800
	(-0.46)	(0.33)	(2.98)***	(-0.20)
Low pci	5.2851	-0.1216	-0.3509	-0.2197
	(2.14)**	(-0.70)	(-4.20)***	(-2.11)**
Md PCI	-2.3925	-0.0816	0.0430	-0.2982
	(-1.54)	(-0.58)	(0.85)	(-3.49)***
High pci	-0.3472	0.0019	0.0453	-0.0860
	(-0.68)	(0.04)	(1.91)*	(-2.53)***
Highest PCI	-0.0334	-0.0504	-0.0335	-0.0379
	(-0.22)	(-3.72)***	(-3.16)***	(-4.55)***
η - fevd				1 (81.19)***
Z			0.0218	
			(9.66)***	
Z^2			-0.0005	
			(-7.87)***	
Z^3			3.7e-06	
			(6.71)***	
Mills Ratio	-0.6304***		-0.2167	-0.0502
	(-12.81)***		(-10.25)***	(-14.92)***
R^2	--	--	0.34	0.69
Obs.	12 354	4 418	4 418	4 418

Note. t-value within parenthesis ( ). *, **, ***, indicates significance on the 10, 5 and 1 percent level respectively. Firms with at least 50 employees. HMR and Heckman FEVD models estimated using robust standard errors. Period and industry dummies at the 3-digit level included in all models. $^{(A)}$ p-val independent equations = 0.000.

$^{(B)}$ Following Helpman *et al*. (2008) we include higher order terms of z to control for firm heterogeneity where z is defined as $\hat{z} = \Phi^{-1}(\hat{p}) + \hat{n}$ *p* is the predicted probability of positive R&D and *n* is Mill's ratio.

$^{(C)}$ Variables classified as time invariant/slowly changing include: *ln*(sales), Boone, TFP and imports of offshored materials.

Table 4. Offshoring and R&D. Dependent variable, firm R&D-intensity.
Firm heterogeneity. 1997-2005.

	Offshoring	**R^2**	**Obs.**		**Offshoring**	**R^2**	**Obs.**
HMR[(A)] **Foreign**	-0.0012 (-0.07)	0.27	1 780	**HMR** [(A)] **MNE**	0.0119 (1.03)	0.31	3 366
HMR [(A)] **Domestic**	-0.0292 (-2.16)	0.42	2 625	**HMR** [(A)] **Non-MNE**	-0.1750 (-5.04)	0.54	1 038
Heckman FEVD [(B)] **Foreign**	-0.0681 (-5.74)	0.77	1 780	**Heckman FEVD** [(B)] **MNE**	0.0020 (0.21)	0.75	3 366
Heckman FEVD [(B)] **Domestic**	-0.0487 (-4.17)	0.81	2 625	**Heckman FEVD**[(B)] **Non-MNE**	-0.1116 (-9.08)	0.94	1 038

Note. t-value within parenthesis ( ). *, **, ***, indicates significance on the 10, 5 and 1 percent level respectively. Firms with at least 50 employees. HMR and Heckman FEVD models estimated using robust standard errors. Period and industry dummies at the 3-digit level included in all models.

[(A)] Following Helpman *et al*. (2008) we include higher order terms of z to control for firm heterogeneity where z is defined as $\hat{z} = \Phi^{-1}(\hat{p}) + \hat{n}$ *p* is the predicted probability of positive R&D and *n* is Mill's ratio.

[(B)] Variables classified as time invariant/slowly changing include: *ln*(sales), Boone, TFP and imports of offshored materials.

Table 5. Offshoring and R&D. Dependent variable, firm R&D-intensity.
Employment weighted regressions. 1997-2005.

	Offshoring		**Offshoring**
Heckman [(A)] **Selection**	0.0092 (0.92)	OLS No zeros	0.0051 (9.18)***
Heckman Target equation	0.0067 (12.05)	HMR[(B)]	0.0132 (24.23)***
	By Region: HMR-specification[(B)]		
Region	Offshoring	5. Africa	0.1343 (6.99)***
1. EU15	0.0364 (52.73)***	6. Oceania	-0.1035 (-11.61)***
2. Europe non-EU15	-0.1894 (-114.2)***	7. S+W Asia	0.3221 (94.64)***
3. N. America	-0.2419 (-81.34)***	8. OPEC	0.0200 (1.24)
4. Lat. America	0.7088 (40.61)***	9. Other Asia	0.0655 (5.77)***

Note. t-value within parenthesis ( ). *, **, ***, indicates significance on the 10, 5 and 1 percent level respectively. Firms with at least 50 employees. HMR and Heckman FEVD models estimated using robust standard errors. Period and industry dummies at the 3-digit level included in all models. [(A)] p-val independent equations = 0.000.

[(B)] Following Helpman *et al*. (2008) we include higher order terms of z to control for firm heterogeneity where z is defined as $\hat{z} = \Phi^{-1}(\hat{p}) + \hat{n}$ *p* is the predicted probability of positive R&D and *n* is Mill's ratio.

Table A1: Characteristics of offshoring firms relative to non offshorers, year 2000

Variable	**Offshorers/ non-offshorers**	**p-val Wilcoxon Ranksum test**
Labor productivity	1.17	0.00
Skill intensity	2.61	0.00
R&D intensity	2.23	0.00
Employment	1.94	0.00
Capital intensity	1.29	0.00

Notes: figures reported are log deviation from the average non-offshoring firm and represent differences in means for services offshorers and non services offshorers, respectively. Standard deviations in brackets. The sample is truncated at 50 employees.

Table A2. Variable definitions.

Variable	Definition
R&D-intensity	R&D outlays / sales
Material offshoring.	Import of production inputs and non-durable consumption goods.
Capital intensity	Book value, buildings and machinery per employee
Profit margin	Profit / sales
Boone price elasticity	Boone price elasticity measure, for details see Karpaty and Tingvall (2010)
Output	Total sales
Raw material intensity	Raw material inputs / sales
Share technicians	Share technicians (employees with at least technical tertiary education)

Data source: Statistics Sweden: Financial statistics, Regional labor market statistics, material import statistics and service import statistics.

Table A3. Regions and countries

Region	Countries included
1 EU 15 (excl Sweden)	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom
2 Europe Non EU- 15	Åland Islands, Albania, Andorra, Belarus, Bosnia, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Faroe Islands, Gibraltar, Hungary, Iceland, Latvia, Liechtenstein, Lithuania, Macedonia, Malta, Moldova, Monaco, Norway, Poland, Romania, Russia, San Marino, Serbia & Montenegro (formerly Yugoslavia) Slovakia (Slovak Rep), Slovenia, Svalbard & Jan Mayen Is., Switzerland, Ukraine, Vatican City State
3 North America	USA, Canada
4 Latin America	Antigua, Barbuda, Anguilla, Netherl. Antilles, Argentina, Aruba, Barbados, Bolivia, Brasilien, Bahamas, Belize, Chile, Colombia, Costa Rica, Dominica, Dominican Rep., Ecuador, French Guyana, Honduras, Jamaica, Saint Lucia, Mexico, Nicaragua, Panama, Peru, Paraguay, S:t Helena, Surinam, El Salvador, Turks-/Caicos Island, Trinidad, Tobago, Uruguay, St. Vincent
5 Africa	Burkina-Faso, Burundi, Benin, Botswana, Kongo, Democr. Rep., Central Afrika rep., Kongo, Ivory Coust, Kamerun, Kap Verde, Djibouti, Egypt, Eritrea, Etiopien, Gabon, Ghana, Gambia, Guinea, Ekvatorial, Guinea, Guinea-Bissau, Kenya, Comors, Liberia,Lesotho, Marocko, Madagaskar, Mali, Mauretanien, Mauritius, Malawi, Mocambique, Namibia, Niger, wanda, Seychellerna, Sudan, Sierra Leone, Senegal, Somalia, Sao Tome, Principe, Swaziland, Chad, Togo, Tunisia, Tanzania, Uganda, Melilla, Mayotte, South Africa, Zambia former Zaire (Kongo Democr. Repl) Zimbabwe
6 Oceania	
7 South & East Asia	Brunei Darussalam, Burma, China, Hong Kong, Djibouiti, Japan, Kambodja, South Korea, Myanmar, Mongolia, Macao, Laos, Malaysia, Philliphines, Thailand, Tunisia, Singapore, Timor-Leste, Vietnam
8 OPEC	United Arab Emirates, Algeria, Indonesia, Iraq, Iran, Nigeria, Qatar, Saudi Arabia, Venezuela
9 Other Asia	Armenia, Azerbaijan, Bangladesh, Bhutan, Georgia, Israel, India, Kyrgyzstan, Democratic People's Republic of Korea, Kazakhstan, Sri Lanka, Maldives, Nepal, Oman, Papua New Guinea, Pakistan, Syria, Tajikistan, Turkmenistan, Turkey, Uzbekistan, Yemen.

References

Ali-Yrkkö, J., and Deschryvere, M. (2008). Domestic R&D Employment Effects of Offshoring R&D Tasks: Some Empirical Evidence from Finland. ETLA discussion paper No. 1163.

Amiti, M., and Wei, S.J. (2005a). Service Offshoring, Productivity and employment: Evidence from the U.S. CEPR WP. No. 5475.

Amiti, M., and Wei, S.J. (2005b). Fear of Service Outsourcing: is it justified? Economic Policy, 20(42), 308-347.

Andersson, L., and Karpaty, P. (2007). Offshoring and Relative Labor Demand in Swedish Firms. Working Paper No. 5, 2007. Örebro University.

Antras, P. (2003). Firms, Contracts and Trade Structure. Quarterly Journal of Economics, CXVIII, 1375-1418.

Bandick, R., Görg, H., and Karpaty, P. (2010). Foreign Acquisitions, Domestic Multinationals, and R&D. CEPR Discussion Papers 8081.

Baumol, W.J. (1977). On the proper test for natural oligopoly in a multiproduct industry. American Economic Review 67(5), 809-822.

Bernard, A., and Jensen, J.B. (2004). Why some firms export. Review of Economics and Statistics, 86(2), 561-569.

Bertrand, O. (2009). Effects of foreign acquisitions on R&D activity: Evidence from firm-level data for France, Research Policy, 38, 1021 – 1031.

Blundell, R., Griffith, R. and Van Reenen, J. (1995). Dynamic Count Data Models of Technological Innovation. Economic Journal 105(429), 333 – 344.

Borga, M. (2005). Trends in Employment at U.S. Multinational Companies: Evidence from Firm-Level Data. in Susan M. Collins and Lael Brainard (eds), Offshoring White-Collar Work-The Issues and Implications. Brookings Trade Forum. Brooking Institution Press.

Breusch, T., Kompas, T., Nguyen H.T.M., and Ward, M.B. (2011a). On the Fixed-Effects Vector Decomposition. Political Analysis, 19(2): 123-134.

Breusch, T., Kompas, T., Nguyen H.T.M., and Ward, M.B. (2011b). FEVD: Just IV or just Mistaken. Political Analysis, 19(2), 165-169.

Carlsson, M. (red), (2006), The Internationalization of Corporate R&D, Leveraging the Changing Geography of Innovation, ITPS A2006:007.

Crinò, R. (2006). Service Offshoring and the Composition of White-Collar Employment: Evidence from the U.S. Mimeo, CESPRI, Università Bocconi.

D'Agostino L.M., Laursen K., and Santangelo, G. (2010). The Impact of R&D Offshoring on the Home Knowledge Production of OECD Investing Regions. DRUID Working Papers 10-19, DRUID, Copenhagen Business School, Department of Industrial Economics and Strategy/Aalborg University, Department of Business Studies.

Dunning, J.H. (1993). The Theory of Transnational Corporations. Routledge, London and New York.

Ekholm, K., and Hakkala, K. (2006). The Effect of Offshoring on Labor Demand: Evidence from Sweden. CEPR Working Paper No. 5648.

Ekholm; K. och Hakkala, K. (2007). Location of R&D and High-Tech Production by Vertically Integrated Multinationals, Economic Journal 117(518), 512-543.

Falk, M., and Koebel, B.M. (2002). Outsourcing, Imports and Labour Demand. Scandinavian Journal of Economics, 104(4), 567-586.

Feenstra C.R., and Hanson, G.H. (1999). The impact of Outsourcing and High technological Capital on wages: Estimates for the United States 1979-1990. The quarterly Journal of Economics, 114(3), 907-941.

Feenstra C.R., and Hanson, G.H. (2005). Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm. Quarterly Journal of Economics, 120(2), 729-761.

Foremski, T., (2004). Intel looks to Russia to build R&D. The Financial Times.

Fors, G. (1998). Locating R&D abroad. In The geography of Multinational Firms, P Braunerhjelm & K. Ekholm. (eds.). Kluwer Academic Publishers. London.

Geroski, P.A. (1990). Innovation, technological opportunity and market structure. Oxford Economic Papers 42(3), 586 – 602.

Gersbach H., and Schmutzler, A. (2011). Foreign Direct Investment and R&D offshoring. Oxford Economic Papers, 63(1), 134-157.

Greene, W. (2001). Estimating Econometric Models with Fixed Effects. New York University, Leonard N. Stern School of Finance Working Paper No. 01-10.

Greene, W. (2011a). Fixed Effects Vector Decomposition: A Magical Solution to the Problem of Time-Invariant Variables in Fixed Effects Models? Political Analysis, 19(2), 135-146 doi:10.1093/pan/mpq034.

Greene, W. (2011b). Reply to Rejoinder by Plümper and Troeger. Political Analysis, 19(2), 170-172. doi:10.1093/pan/mpr011.

Griffiths W., and Webster E. (2010). What governs firm-level R&D: Internal or external factors? Technovation.30 (7-8), 471-481.

Grossman, S.J., and Hart, O. (1986). The Cost and Benefits of Ownership: A Theory of Vertical and Lateral Integration. Journal of Political Economy, 94(4), 691-719.

Grossman G.M., and Helpman E. (2002a). Outsourcing in a Global Economy. NBER WP. No.8728.

Grossman G.M., and Helpman E. (2002b). Integration versus outsourcing in Industry Equilibrium. Quarterly Journal of Economics, 117(1), 85-120.

Grossman G.M., and Helpman E. (2003). Outsourcing versus FDI in Industry Equilibrium. Journal of the European Economic Association. 1(2-3) 317-327.

Grossman G.M., and Rossi-Hansberg, E. (2006). Trading Tasks: A Simple Theory of Offshoring. NBER, WP, No. 12721.

Grossman, S.J. and Hart, O.D. (1986). The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. Journal of Political Economy, 94(4), 691-719.

Görg, H., Hanley, A., and Strobl, E. (2007). Productivity Effects of International Outsourcing: Evidence from Plant Level Data. C.E.P.R. Discussion Papers No. 6361.

Henderson, R., and Cockburn, I. (1996). Scale, Scope, and Spillovers: The Determinants of Research Productivity in Drug Discovery. RAND Journal of Economics, 27(1), 32-59.

Henning, R., and Norgren, L. (1992). Formerna för teknikutvecklingens internationalisering. Ekonomisk Debatt 1992:2.

Hertog, R.G.J., and Thurik A.R. (1993). Determinants of internal and external R&D: some Dutch evidence, De Economist, 141(2), 279-289.

Håkansson, L. and Nobel, R. (1993). Foreign Research and Development in Swedish Multinationals. Research Policy, 22(5-6), 373-96.

Helpman E. (2006). Trade, FDI and the Organization of Firms. NBER, WP. No. 12091.

Helpman, E., Melitz, M., and Rubinstein, Y. (2008). Estimating trade flows: trading partners and trading volumes, Quarterly Journal of Economics, 123(2), 441-487.

Karpaty, P. (2011). Lokalisering av huvudkontor, produktion och FoU i Sverige. En undersökning av svenska företags attityder och planer, WP/PM 2011:18. Growth Analysis.

Karpaty, P., and Gustavsson Tingvall, P. (2011). Service-sector competition, innovation and R&D. Economics of Innovation and New Technology, 20(1), 63-88.

Landefeld, J.S., and Mataloni, R. (2004). Offshore Outsourcing and Multinational Companies, BEA working paper WP2004-06, July 16, 2004.

Klette T.J. and Kortum, S. (2004). Innovating Firms and Aggregate Innovation. Journal of Political Economy, 112(5), 986-1018.

Martínez-Ros, E. and J.M. Labeaga. (2002). The relationship between firm size and innovation activity: a double decision approach. The Economics of Innovation and New Technology 11(1), 35-50.

McLaren J. (2000). Globalization and Vertical Structure. American Economic Review, 90(5), 1239-1254.

Melitz, M. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity, Econometrica, 71(6) 1695-1725.

Nocke, V., and Yeaple, S. (2008). An Assignment Theory of Foreign Direct Investment. Review of Economic Studies, 75(2), 529-557.

OECD. (2005). Working Party on the Information Economy: The share of employment potentially affected by outsourcing – an empirical investigation. STI/ICCP/IE(2005)8, OECD, Paris.

Plümper, T. and Troeger, V.E. (2007). Efficient estimation of time-invariant and rarely changing variables in finite sample panel analyses with unit fixed effects. Political Analysis 15(2), 124-139.

Plümper, T., and Troeger, V.E. (2011). Fixed-Effects Vector Decomposition: Properties, Reliability, and Instruments. Political Analysis, 19(2): 147-164.

Porter, M.E. (1990). The Competitive Advantage of Nations. New York: Free Press, 1990. (Republished with a new introduction, 1998.)

Reinganum, J,F. (1989). The timing of innovation: Research, development, and diffusion. Chapter 14 In: Richard Schmalensee and Robert Willig, Editor(s), Handbook of Industrial Organization, Elsevier, 1, 849-908.

Roberts, M. J., and Tybout J.R. (1997). The Decision to Export in Colombia: An Empirical Model of Entry and Sunk Costs. The American Economic Review, 87(4), 545-564.

Schumpeter, J.A. (1943). Capitalism, Socialism and Democracy, London: Allen and Unwin. (originally published in the USA in 1942; reprinted by Routledge, London in 1994).

Schumpeter, J.A. (1950). Capitalism, Socialism and Democracy. 3rd ed. New York: Harper-Collins.

Spencer, B. (2005), International Outsourcing and Incomplete Contracts. NBER, WP. 11418.

The Wall Street Journal. 2011, February 8.

Trefler, D., (2005), "Offshoring Threats and opportunities", in, Brookings trade forum on, Offshoring White Collar Work.