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Imports, Productivity and the Origin Markets

- the role of knowledge-intensive economies

Hans Lööf [1] and Martin Andersson[2]

([1]CESIS and KTH Division of Economics, [2]JIBS and CESIS)

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Hans Lööf[⊕] and Martin Andersson[∅]

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Abstract

This paper investigates whether domestic firms' productivity is an increasing function of imports from the most knowledge intensive economies in the world, i.e. the G7 countries. Using Swedish firm-level data, we confirm an instantaneous causality going from imports to productivity. We also show that productivity is increasing in the G7-fraction of total imports. Our results highlight the importance of import flows from R&D and knowledge intensive economies for productivity and are consistent with imports being a vehicle for technology diffusion. Tests of the sensitivity of the results suggest that G7 imports are particularly important for firms in high-technology sectors and for firms belonging to multinationals and domestic corporations.

Keywords: Technology diffusion, productivity, imports, panel data, GMM

JEL codes: C81, F14, L10, L60, O333

[⊕]Department of Transport and Economics, and Centre of Excellence for Science and Innovation Studies (CESIS), Royal Institute of Technology Stockholm. Mail: hansl@infra.kth.se

[∅]Jönköping International Business School, Jönköping, and Centre of Excellence for Science and Innovation Studies (CESIS), Royal Institute of Technology, Stockholm. Mail: martin.andersson@ihh.hj.se

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1. INTRODUCTION

Examining long-run productivity growth Eaton and Kortum (1996) conclude that productivity is an increasing function of a country's ability to adapt more productive technologies and that research performed abroad is highly important for aggregate growth. Their analysis suggests that even a large economy like the United States obtains over 40 percent of its growth from foreign innovation. An extensive literature shows that international trade is an important mechanism through which foreign innovation and technology flow across borders (Keller 2004). International trade contributes to the flow of ideas across borders because a major part of imports are new products (Acharya and Keller 2008, Broda and Weinstein 2006). However, the findings of a positive association between national productivity and international technological diffusion by Eaton and Kortum (1997), Coe and Helpman (1995), Coe, Helpman and Hoffmeister (1997) and others have been difficult to verify at the micro level (Kneller 2007).

This paper contributes to the still rare literature that tries to quantify the relative importance of international technology diffusion for productivity at the level of individual firms. We augment a basic Cobb-Douglas production function with variables describing the level of imports for each and every firm and test whether imports affect a firm's labor productivity. The analysis encompasses all manufacturing firms in Sweden with 10 or more employees over an eight-year period. The main contribution of the paper is that it analyzes the role of imports for productivity at the level of individual firms and explicitly tests if the distribution of imports across different origin countries matter.

There are several arguments in favor of a causality going from imports to productivity at the level of individual firms. Imports can be described as inputs in a firm's production process. By importing an individual firm can exploit global specialization and employ inputs from the forefront of knowledge and technology. In addition, it can be argued that an import strategy allows the firm to focus resources and specialize on activities where it has particular strengths. Kasahara and Rodrigue (2008) find for instance that plants switching from being a non-importer to an importer of foreign intermediate goods can immediately improve their productivity. Moreover, Andersson, Lööf and Johansson (2008) show that firms that both export and import (i.e. two-way traders) are more productive than firms that only export or only import. This is interpreted as that two-way traders are deeply engaged in the international division of labor and employ inputs based on frontier knowledge and technology in their production process. In principle, there are two basic ways in which imports can raise a firm's productivity: (i) lower costs associated with materials and other inputs (a division of labor argument) and (ii) a learning effect through technology diffusion of high-quality capital goods with high knowledge- and technology content (cf. Acharya and Keller 2008). While the first effect is most likely associated with imports in general and imports from low-cost countries in particular, the second effect is expected to primarily pertain to imports from R&D-intensive advanced economies.

We are particularly interested in imports as a vehicle for technology diffusion and we focus on the effect of imports from G7 countries on firms' productivity. These countries account for about 80 percent of global R&D and encompass the largest producers of new technology and knowledge in the world. If imports are a vehicle for technology and knowledge diffusion we should observe that the effect of imports from R&D intensive countries is particularly strong. Recent analyses give strong support for such an hypothesis. Acharya and Keller (2007) find for example that the combined effect of R&D investments in countries close to the world's technology frontier is on average about three times as large as that of domestic R&D. The countries considered are all included in G7.[1] In addition, our data show that the value per kilogram (a rough indicator of the quality of trade flows) of the import flows from G7 by firms in the same industry is higher than the average for the firms' import flows from all countries. The fraction of imports from G7 is also particularly high for high-technology industries. Hence, the assumption that import flows from G7 have a higher knowledge-content and are of higher quality, such that the potential for technology and knowledge diffusion is higher for G7 import flows, is indeed warranted.[2]

We analyze whether the labor productivity of a firm is an increasing function of the G7-fraction in total imports.[3] Thus, for a given level of imports we ask if the distribution of imports from different countries matter. Using a dynamic GMM estimator, we first confirm an instantaneous causality from import to productivity. We then show that productivity is an increasing function of the G7-fraction in total import. Thus, firms that import a higher fraction from countries that account for the majority of global R&D and are close to the world's technology frontier have higher productivity. This is consistent with imports being a vehicle for technology diffusion. Tests of the sensitivity of the results suggest that G7 imports are particularly important for firms in high-technology sectors and as well as firms belonging to multinationals and domestic corporations, which are typically more knowledge intensive than independent firms.

The remainder of the paper is organized in the following fashion: Section 2 presents the theoretical framework and provides a brief review of the pertinent previous literature. Section 3 presents the data, defines variables and puts special emphasis on the distribution of imports across firms, both as regards to their export-status, the corporate ownership structure and the classification of their production specialization. Section 4 discusses the empirical methodology and section 5 presents the results of the analysis. Section 6 concludes.

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[1] They are the US, Japan, Germany, France, the UK and Canada.

[2] Andersson and Lööf (2008b) also show that trade with G7 countries correlate significantly with the probability that a firm is innovative, as indicated by patent applications.

[3] In the model we also control for the fraction of imports from EU15, Scandinavia and the rest of the world.

2. IMPORTS, PRODUCTIVITY AND TECHNOLOGY DIFFUSION

Eaton and Kortum (1999) present a widely recognized general equilibrium model incorporating international technology diffusion. Two pertinent general implications of this model are:

- Foreign R&D raises domestic total factor productivity (TFP)

- Because R&D depreciates, foreign R&D has a greater effect on domestic TFP the faster foreign technologies diffuse to the domestic economy

How does foreign R&D raise domestic TFP? One mechanism is trade in intermediate goods. Keller (2004) outlines a simplified model based on Grossman and Helpman (1991) and Rivera-Batiz and Romer (1991) of how imports of intermediate goods affect domestic productivity. The basic idea is akin to Romer (1990) such that new intermediate goods are outcomes from investments in R&D. A domestic firm can then access foreign R&D by importing the intermediate goods produced in the foreign country. Let the production function of a representative firm be a standard Cobb-Douglas:

$$(1) \qquad y = AL^{\alpha} I^{1-\alpha}, \quad I \equiv \left(\sum_{i \in n^e} z_i^{1-\alpha}\right)^{\frac{1}{1-\alpha}}$$

where A is a constant and L is labor. I is a sub-production function and represents a composite index of intermediate goods, z. n^e is the number of intermediate capital goods employed by the firm and may be a subset of all intermediate goods in the world economy. If the intermediate goods are symmetric, the stock of capital can be written as $k = n^e z$ and the right-hand-side of (1) can be expressed as $(n^e)^{\frac{\alpha}{1-\alpha}} k$. This means that (1) can be rewritten to read:

$$(2) \qquad y = AL^{\alpha} k^{1-\alpha} \left(n^e\right)^{\alpha}$$

TFP is then given by:

$$(3) \qquad \ln TFP \equiv \ln y - \ln(l^{\alpha} k^{1-\alpha}) = \ln A + \alpha \ln n^e$$

Equation (3) states that the total factor productivity of a firm is increasing in the number of capital goods employed in production. The relationship to technology stems from the basic assumption in Romer (1990): each capital good is based on a unique design, developed in an R&D process. The intermediate goods n^e in (3) can be produced by the firm itself, supplied by domestic firms or be imported from foreign countries. By importing capital goods, then, a firm can indirectly access technologies developed in foreign countries. Hence, (3) provides a theoretical foundation for a positive relationship between imports and productivity.

In the literature on international technology diffusion, empirical counterparts to Equation (3) have been estimated for countries and industries.[4] As in the seminal study by Coe and Helpman (1995), domestic productivity is typically modeled as a function of domestic and foreign R&D. Foreign R&D is assumed to be accessed through imports of capital goods and R&D stocks in other countries are weighed by import shares. A recent example is Keller (2002) who demonstrates that trade in differentiated intermediate goods is an important mechanism by which technology diffuses. He finds that as much as 20 percent of the productivity of a domestic industry can be attributed to foreign R&D, accessed through imports of intermediate goods. In a similar fashion, Madsen (2008) analyzes the role of the international patent stock for the productivity in 16 OECD countries over a period of 120 years. He finds that the cross-border flow of knowledge and ideas is important for TFP growth and that international trade is a significant vehicle for such flows. He also documents that convergence in TFP among countries can be attributed to international patents and the flow of knowledge through imports, suggesting that imports of products embodying knowledge is an important mechanism for catching-up to the world technology frontier.

Evidence at the firm-level is however rare and most studies of the type cited above are based on macro-level data. Although research on the relationship between productivity and international trade through the lens of individual firms has increased dramatically since the seminal paper by Bernard and Jensen (1995), the role of imports is often not analyzed explicitly. It is instead the relationship between exports and productivity at the level of individual firm that has received the greatest attention. The empirical literature suggests that the empirically verified ‘exporter productivity premium’ is primarily explained by self-selection due to sunk costs of entry and heterogeneity in the underlying characteristics of firms, such that the causality goes from productivity to exports.[5]

With respect to imports, however, there are evident arguments in favor of a causality going from imports to productivity at the level of individual firms. There are two basic ways in which imports can

[4] A recent survey is provided by Keller (2004).

[5] Evidence of learning-by-exporting, suggesting a causality going from exports to productivity, is weak. Kneller (2007) provides a nice discussion of the various ways in which exporting may raise a firm’s productivity. Andersson and Lööf (2008b) find a causality going from the export status of a firm to productivity for firms that persistently export a significant fraction of their sales but not for other types of export firms.

raise a firm's productivity: (i) lower costs associated with materials and other inputs (a division of labor argument) and (ii) a learning effect through technology diffusion of high-quality capital goods with high knowledge- and technology content. By importing an individual firm can exploit global specialization and employ inputs from the forefront of knowledge and technology. An import strategy can also allow the firm to focus resources and specialize on activities where it has particular strengths. Viewing imports as an exogenous decision reflecting a firm's internationalization strategy, we would clearly expect that imports lead to effects on productivity.

There are a few studies which analyze the relationship between imports and productivity at the level of individual firms. Andersson, Lööf and Johansson (2008) show that firms that both export and import (i.e. two-way traders) are more productive than firms that only export or only import. Firms that only import also have a productivity advantage over firms that are not engaged in international trade at all. Similar results are obtained by Muuls and Pisu (2007), Castellani, Serti and Tomasi (2008) as well as Serti and Tomasi (2008). Kasahara and Rodrigue (2008) find that plants switching from being a non-importer to an importer of foreign intermediate goods can immediately improve their productivity. Halpern, Koren and Szeidl (2006) maintain that imports can affect a firm's productivity because (i) they can be imperfect substitutes to domestic inputs and (ii) can have higher quality. They find that imports lead to significant productivity gains, of which two thirds are attributed to the imperfect substitutes argument and the remainder to the quality argument.

Surprisingly few of existing studies discuss heterogeneity in the way import flows influence a firm's productivity among origin markets. Equally, few adhere to the literature on international technology diffusion and imports. The study by Serti and Tomasi (2008) constitutes an exception, which shows that the relationship between imports and productivity at the level of the individual firm varies amongst different groups of origin markets. They do not, however, pay particular attention to any specific group of origin countries.

The literature on international technology diffusion which estimates variants of Equation (3) or similar shows convincingly that the effect of import on productivity depends on characteristics of the origin country, specifically its R&D and knowledge intensity. Imports from countries that invest significantly in new technology and knowledge are more likely to be associated with learning effects in the form of technology and knowledge diffusion. As stated in the introduction we focus in the subsequent analysis on imports from G7countries, which account for about 80 percent of global R&D and encompass the largest producers of new technology and knowledge in the world. Estimates by Acharya and Keller (2007) suggests that the combined effect of R&D investments in countries close to the world's technology frontier (six G7 countries) is on average about three times as large as that of domestic R&D.[6] In a previous paper, Andersson and Lööf (2008a), we find that firms that have significant trade with G7 countries are much more likely to be innovative, as indicated by patent applications. This finding is consistent with that trade with R&D intensive countries is conducive for innovation and productivity, e.g. through knowledge flows mediated by imports.[7]

If G7 imports are particularly conducive for knowledge and technology diffusion we should observe that not only imports in general, but also the distribution of imports among markets matter for the productivity. Specifically, firms that import a larger fraction from the R&D and knowledge intensive G7 economies should, all else equal, have higher productivity. Our empirical analysis is based precisely on this conjecture.

3. DATA, VARIABLES AND DESCRIPTIVES

The data source used is this study covers the eight-year period 1997-2004. The basic data set consist of about 130 000 observations on all manufacturing firms in Sweden with one or more employees. We restrict the data to firms with at least 10 employees because the quality of the balance sheet information is better for large firms we have about 40 000 observations. Based on a unique identification number of each firm have data material which describes Swedish firms' export and import activities on a yearly basis between 1997 and 2004 have been matched with economic characteristics of the firms. The matched data material is described in more detail in Andersson, Lööf and Johansson (2008). In the analysis we will primarily conduct estimations when the data are restricted to firms with 10 or more employees that can be observed all eight years. This is necessary since we wish to discriminate between temporary and persistent presence on foreign markets in our analysis of the sensitive of the results (cf. Andersson and Lööf 2008b).

Table 1 presents basic descriptive of key variables in our empirical analysis. It shows that the median manufacturing firm in Sweden with 10 or more employees has 23 ordinary employees and 1 employee with university education three years or more. In the following we label the latter as "skilled labor." Since the mean values for ordinary and skilled labor are 85 and 11, respectively, we conclude that the distribution of firms is skewed with many small firms and few large firms.

The table also reports data for labor productivity. The distinction between *ordinary labor(L)* and *skilled labor(H)* raises the question of how labor productivity should be measured. The standard measure

[6] In a related paper Acharya and Keller (2008) find that it is primarily technology intensive imports that are likely to generate learning effects at the macro-level.

[7] In Andersson and Lööf (2008a) we estimate the likelihood that an individual firm apply for a patent to the Swedish Patent Office (PRV). Controlling for an ample set of characteristics of the firm, we find that firms with a higher fraction of G7 exports and imports are significantly more likely to be innovative.

is total value added (Q) over total employment (E). An alternative argument was launched by Griliches and Mairesse (1984), and it considers the effect on the productivity of ordinary labor, i.e., its effect on $q = Q / L$. We measure labor productivity in this way. This approach considers the distinction between the production of knowledge and the returns to its use. At each point in time *(H)* reflects the capacity to expand future knowledge and *(H)* is assumed to be associated with a firm's R&D efforts. The size of *(H)* will also reflect the knowledge stock of a firm and its capacity to absorb external knowledge, in particularly for firms serving an international market.

Our additional economic variables are those commonly used in the literature. Apart from the one of the two key variables, labor productivity, they include physical capital, measured as investments in machinery and equipment and capital structure, supposed to capture the financial strengthens of the observed firm. We define *(CS)* as total debt over total debt and equity. Thus, the higher the capital structure, the more indebted the firm. Moreover, it can be assumed that higher interest expenditures due to increased leverage, will leave less room for investment expenditures. In this case the contemporaneous effect on productivity will be negative.

The second key variable is import. We consider both total import value and fraction of imports from the world market separated into five categories: Scandinavia, Poland-Baltic, G7, EU15-contries other than countries belonging to Scandinavia and G7, and rest of the world. The most important origins of imports for the Swedish manufacturing firms is the neighboring Scandinavian countries.[8]

Table 2 shows that the relative importance of imports from the five markets we consider in the study for different firm categories. The upper part of Table 2 shows that non-exporting firms and temporary exporters import mainly from the neighboring countries, while the majority of import origins for persistent exporters are G7, EU15 and rest of the world. The middle part of the table report that non-affiliate firms and companies with only domestic affiliates – uninational firms- typically import from neighboring countries. The most important import markets for foreign and domestically owned multinationals in Sweden are G7. Looking at the different broad sector aggregates, it is evident that firms producing resource and scale intensive products tend to mainly import from Scandinavian countries. As can be expected firms in high-technology rely more heavily on intermediate products from G7. Firms focusing on differentiated products and labor intensive product imports in average 2/3 of their intermediate products from Scandinavia or from G7.

A basic assumption underlying our analysis is that import flows from G7 have a higher knowledge-content and are of higher quality. Table 3 reports the ratio between the average export value per volume

[8] It should be noted that we include both Finland and Iceland here, although Scandinavia only consists of Sweden, Norway and Denmark.

unit (kg) for import flows from G7 and the average export value per kilogram of total import flows. Such a ratio is rough indicator of how the quality of import flows from G7 compares to total import flows. If G7 imports in general are of higher quality we expect that the ratio exceeds one. We see from the table that for all five broad sector aggregates, the import flows from G7 are characterized by higher export value per kg compared to the total import flows. The ratio is closest to one for high-technology sectors, which can be explained by the high share of G7 imports in total imports for this sector aggregate.

4. EMPIRICAL MODEL AND ESTIMATION STRATEGY

The general model that we use for our empirical analysis is a standard Cobb-Douglas production function augmented with import variables. The basic model can be expressed as:

$$Q_{it} = K_{it}^{\beta_K} L_{it}^{\beta_V} H_{it}^{\beta_H} X_{it}^{\beta_X} e_{it} \tag{4}$$

where the subscript *i=1,2,…N* refers to a cross-sectional unit, subscript *t=1,2…,T* refers to a point in time, Q_{it} is the value-added of firm i at time t , K_{it} is the capital input, L_{it} is the ordinary labor input, H_{it} is skilled labor, X_{it} is other observed factors that influence Q and e_{it} is technological chocks.

By dividing Q with ordinary labor, our preferred productivity measure (see Section 3), we can express (4) as:

$$q_{it} \equiv \frac{Q_{it}}{L_{it}} = K_{it}^{\beta_K} L_{it}^{(\beta_V - 1)} H_{it}^{\beta_H} X_{it}^{\beta_X} e_{it} \tag{5}$$

Taking natural logs on both sides transforms equation (5) to

$$\ln q_{it} = \beta_K \ln K_{it} + (\beta_L - 1)\ln L_{it} + \beta_H \ln H_{it} + \beta_X \ln X_{it} + \ln e_{it} \tag{6}$$

In a simplified notation, equation (6) can be reformulated as follows

$$\tilde{q}_{it} = \beta_K \tilde{K}_{it} + (\beta_L - 1)\tilde{l}_{it} + \beta_H \tilde{h}_{it} + \beta_X \tilde{x}_{it} + \tilde{e}_{it} \tag{7}$$

where ~ indicates logarithm. It should be noted that equation (4) does not include any direct R&D-investments. As maintained in the previous section, we believe that *h*, knowledge-intensive labor, can be considered as a good proxy for a firm’s innovative capacity. The majority of R&D-expenditures are wages to skilled engineers and other well educated personnel

The error term in the equation (7) consists of two variables: η_i is an unobserved firm-specific time-invariant effect which allows for heterogeneity in the means of q_{it} series across firms, and ν_{it} is the traditional error term. η_{it} are assumed to be independent across firms. For i=1, 2,…, N and t=2,..,,N the error terms are assumed to have the standard component structure

$$E[\eta_i] = 0, \quad E[\nu_{it}] = 0, \quad E[\eta_i \nu_{it}] = 0 \tag{8}$$

Since increased productivity is associated with adjustment costs and other inertia factors, it can be expected that output is delayed in time by a process of adjustment of factors such as investments, labor and knowledge. Contemporaneous productivity of a firm is also close related its productivity in previous periods. Both kinds of argument motivate a lag structure of the model. Let us therefore consider equation (7) as a dynamic model specified with the variables presented in Section 3 in a time-series cross-section context where t refers to a point in time and i refers to a cross sectional observation:

$$\begin{aligned} \tilde{q}_{it} &= \alpha\tilde{q}_{i(t-n)} + \beta_K \tilde{K}_{i(t-n)} + (\beta_L - 1)\tilde{L}_{i(t-n)} + \beta_H \tilde{H}_{i(t-n)} \\ &\quad + \beta_M \tilde{M}_{i(t-n)} + \beta_{CS} CS_{i(t-n)} + YEAR'\varphi + IND'\gamma + \eta_i + \nu_{it} \end{aligned} \tag{9}$$

where q_{it} is log value added per ordinary employee, k_{it} is log capital investments, l_{it} is log ordinary labor, h_{it} is log skilled labor, M_{it} is log import value or import fraction from Scandinavia, Poland-Baltic, G7, EU15 other than Scandinavia, Poland-Baltic and rest of the world. CS_{it} is capital structure, *YEAR* is a vector with eight year dummies and *IND* is a vector with 13 industry dummies. Of the error components, ηi, is an unobserved time-invariant firm specific effect and ν_{it} is the traditional error term.

In order to better assess the relative importance of technology spillovers, we will explore an alternative specification where the import fraction (*M*) is interacted with (i) export status, (ii) corporate ownership structure and (iii) sector indicators.

Two complications in obtaining consistent parameters in our dynamic extended production function (9) is that $y_{i\ t-1}$ is endogenous to the fixed effects in the error term and that η_i includes all fixed omitted variables. One effect of the “dynamic panel bias” due to endogeneity is that the coefficient estimate for the lagged dependent variable will be inflated by power that actually belongs to the fixed effects.

Beginning with Balestra and Nerlove (1966), Anderson and Hsiao (1982) and Holtz-Eakin, Newey and Rosen (1988) various instrumental solutions to the endogeneity problem have been suggested in the literature. Currently, the state of this art is the use of fully efficient GMM-estimators that allow for heteroskedasticity across firms, and serial correlation over time (see Arellano and Bond 1991). The basic idea of the GMM approach is to take the first-difference on a dynamic model specification in order to remove unobservable and time-invariant firm-specific effects, and then instrument the right-hand-side variables in the first-differenced equations using levels of the series lagged two periods or more, under the assumption that the time-varying disturbances in the original level equations are not serially correlated.

Instead of differencing Arellano and Bover (1995) proposed a forward orthogonal deviations transform that can be incorporated in a system of two equations, the original equation as well as the transformed. We will use this two-step system GMM estimator (Arellano and Bover 1995, Blundell and Bond 1998) as the main estimator. It has a set of attractive advantages over alternative estimators that can deal with endogeneity problems. First, it can include time-invariant regressors. Second, it can make the Windmeijer (2005) finite-sample correction to the reported standard errors in two-sample estimation, without which these standard errors tend to be severely downward biased. Third, by making the assumption that the first differences of instruments are uncorrelated with the fixed effects more instruments can be used which can dramatically improve efficiency. Finally, this estimator allows for finer control over the instrument matrix than alternatives methods.

One disadvantage with the System GMM (and difference GMM as well) is that it is complicated and can easily generate invalid estimates (Roodman 2006). The test statistics for autocorrelation, overidentification and exogeneity of instruments are therefore important information. In our study, we will also report fixed-effects estimates as a rough check of the validity of our system GMM estimator.

5. RESULTS

This Section presents results that shed further light on the importance of imports on productivity and asks whether productivity is more sensitive to imports from the G7 countries than from other markets.. The analysis encompasses all manufacturing firms in Sweden with one or more employees and the focus is firms with 10 or more employees observed annually over an eight-year period.

We begin with a basic model, three different sample sizes, and fixed effects estimates in Table 4. Table 5 reports two-step system GMM results for the sample consisting of firms with 10 or more employees observed over the whole period 1997-2004. In Table 6 GMM results are presented for the interaction between import fraction and firms characteristics. In contrast to the estimates of import fractions for the different markets presented in Tables 4-6, Appendix I reports the elasticity of labor productivity with respect to total imports from Scandinavia, Poland-Baltic, G7, EU15-small and rest of the world. The main focus is on estimations based on the subsample restricted to firms with 10 or more employees observed the whole period 1997-2004. Eight year dummies and 13 industry dummies are included in the regressions.

5.1 Fixed effects estimates

Table 4 presents fixed effects production function estimates on a specification when all right-hand side variables are lagged two years. We suspect that the lagged value of lagged labor productivity is affected by "dynamic panel data bias" and that the direction of this bias is downward. This information will, however, be useful for a first robustness check of the GMM-results reported in Table 5. If the two-step system GMM instruments are weak, the lagged productivity variable will be downward biased also in this regression with a coefficient estimate in the same size-region as the within estimate (0.01-0.09).

Turning now to the import variables, columns 1-2 show the results for all manufacturing firms in Sweden with at least one employee. The elasticity of (log) labor productivity with respect to (log) import value is positive and highly significant, even with proper control for differences in physical capital ordinary labor, skill and capital structure across firms and over the period 1997-2004. See column 1. In column 2 we find that firm productivity is sensitive only to the import fraction from the G7 countries and the Poland-Baltic area.

Columns 3-4 reports the production function estimates when the sample is downward censored to 10 employees. The information here is that labor productivity is an increasing function of imports and this can be explained completely by intermediate products from the seven countries that account for the majority of world-R&D.

The two last columns of Table 4 shows the regression results for our preferred sample which is created based on the following criteria: (i) observed over the whole period 1997-2004, (ii) ten employees or more. The first criterion allows us to classify the firms into different groups depending on persistent, temporary or non presence on international markets. We imposed the second in order to guarantee the quality on the import data. The results presented in columns 5-6 confirms the importance of imports in general and imports from the G7-countries in particular. There is also some weak evidence that imports from neighboring countries (Scandinavia and Poland-Baltic) are important.

In summary, the results in Table 4 provide initial support for the hypothesis that imports in general have a positive effect on productivity and that the distribution of imports across origin markets matter. A high fraction of G7 imports seems to be particularly important for productivity. This is consistent with technological spillovers from knowledge intensive economies through imported new goods being associated with not only productivity at the aggregate level, but also among individual firms. We will now investigate whether this conclusion can be confirmed by more rigorous statistical methods.

5.2 GMM estimates

Table 5 displays GMM-estimates for different specifications of the lag structure of equation (9). The sample used is firms with 10 employees and observed over the whole eight-year period. The first row of Table 5 shows that the GMM estimates for the lagged labor productivity are within the range 0.29-0.44, which is evidently lager than the within-groups estimates. Weak instruments would bias the first-differenced estimator in the direction of within groups but we find no such information. A more careful test statistics is provided in the bottom of the table. First, we see that the AR-statistics report no or only minor (1 lag) problems with autocorrelation. Second, the validity of the lagged levels dated t-1, t-2 and t-3 is instrument in our two-step is clearly accepted by the Sargan test of overidentifying restrictions. Third, the Difference-Sargan statistics accept the validity of the additional GMM-instruments used in the level equation at the 1% level only in the 3-lags specification, reported in columns 5-6. We will therefore limit our discussion to these estimates.

Based on our theoretical framework and the within-group estimates, we expect an effect going from G7 imports to labor productivity. We also expect a positive and significant coefficient associated with the changes on total imports. The GMM-estimates provide strong evidence for both effects. The point estimate for log imports is highly significant. Looking at the sensitivity of import fractions from different markets, column 6 shows that the estimators are highly significant for Scandinavia and G7. However, the size of the estimate is five times larger for G7 compare to Scandinavia. No significant effect on productivity is reported for the import fraction from the three other markets.

The estimates associated with the covariates are all highly significant and have the expected sign and size for the instantaneous effect on labor productivity: physical capital and human capital (skill) are both positive and closely to 0.03. As expected, the point estimate for ordinary labor is negative. Furthermore, contemporaneous changes in debt levels (and hence leverage ratios) are inversely related to productivity.

While Table 5 provides regression results of the relative importance of different import markets for a given level of imports, Appendix 1 shows estimates for the absolute import value from the five markets considered. The test statistics informs both the 2-lags and the 3-lags are accepted, and the estimated coefficients are highly significant for all regions except Poland-Baltic. The point estimates are all positive and somewhat larger for G7. However, the difference is not statistically significant.

5.3 Sensitivity test

Are G7 imports likely to matter equally for all types of firms and sectors? In general one would expect that imports from R&D and knowledge intensive economies is most important for firms active in high-technology sectors in which advanced capital goods and technology are used intensively in production. In a similar fashion there could be differences among firms pertaining to the importance of G7 imports. Table 6 presents regression results describing the relationship between the fraction of G7-imports and productivity when the sensitivity of three categories of firm characteristics is considered. The model is two-step system GMM and it is specified with 3 years lag.

First, we ask whether a particular export-status during the observed period influence the importance of knowledge spillovers from G7. Table 2 reported that G7 is the most important import market for persistent exporters serving mainly the foreign markets, while firms focusing on the domestic markets tend to import from neighboring countries. Somewhat unexpected, however, column 1 reports that temporary exporters and persistent exporters selling mainly to domestic customers are more sensitive to variation in the relative G7-imports than other firms. A likely reason for this is that most firms that are persistent exporters and export a large fraction of their sales import a significant fraction of the total imports from G7 (see Table 2), such that an effect from G7 imports is difficult to identify among these firms.

Column 2 considers G7 imports and corporate ownership structure. The import fraction correlates positively with productivity for foreign MNEs, domestically owned MNE and Swedish companies with only domestic affiliates. In contrast, no significant impact from G7 import can be established for small independent firms.

In column 3, we have dropped the 13 industry dummies and investigate the association between knowledge from countries accounting for 80 percent of all R&D in the world and the knowledge intensity in products produced by Swedish manufacturing firms. An association was suggested by the descriptive statistics reported in Table 2. This is confirmed by the regression results shown in column 3. The point elasticity is highly significant for high technology products and for differentiated products. The size of the estimate however is nearly three times lager for high technology products. At 5 percent level of significance, labor productivity is an increasing function of the G7 import also among firms specialized on resource intensive products.

6. CONCLUSIONS AND SUGGESTION FOR FURTHER RESEARCH

This paper provides additional evidence of the effects of imports on firms’ productivity and asks whether productivity is more sensitive to imports from the G7 countries than from other markets. These countries account for about 80 percent of global R&D and encompass the largest producers of new technology and knowledge in the world. If imports are a vehicle for technology and knowledge diffusion we should observe that the effect of imports from R&D intensive countries is particularly strong. This basic hypothesis finds support in recent studies. Acharya and Keller (2007) find for example that the combined effect of R&D investments in countries close to the world's technology frontier is on average about three times as large as that of domestic R&D. The countries considered are all included in G7.

We estimate an extended Cobb-Douglas production function using an 8 year panel of manufacturing firms in Sweden. Using a robust two-step GMM-estimator we find the following results, conditional on an extensive set of firm characteristics:

- there is an instantaneous causality going from imports to labor productivity

- productivity is increasing in the G7-fraction of total import

The findings show that there is a causality going from imports in general to productivity. Importantly, they also show that characteristics of the origin countries matter. Our findings on the role of G7 countries illustrate the importance of import flows from R&D and knowledge intensive economies for productivity and are consistent with imports being a vehicle for technology diffusion. The analysis thus provides firm-level evidence of imports as a means of international technology diffusion.

Moreover, our sensitivity analyses showed that G7 imports are particularly important for firms in high-technology sectors as well as firms belonging to multinationals and domestic corporations. These firms are typically more knowledge intensive than independent firms.

The research in this paper can be extended in several ways. In this paper we treated G7 countries as a common group. A natural extension would be to include data on actual R&D stocks in different countries and test for the role of foreign R&D for the productivity of individual firms. Another interesting extension would be to try to separate import flows between firms in different countries belonging to the same MNE from other flows. It is well established that a significant share of trade flows are between affiliates of MNEs. The extent to which estimated international technology diffusion depend on diffusion between firms and plants affiliated to MNEs is to our knowledge not clarified in the literature. Finally, another extension is to conduct a more rigorous analysis of differences regarding the role of imports for productivity among different product groups and sectors.

REFERENCES

Acharya R.C. and Keller, W. (2007), Technology Transfer through Imports, NBER Working Paper

Acharya, R.C., Keller, W. (2008). Estimating the productivity selection and technology spillover effects of imports. NBER Working paper series, No 14079.

Anderson, T. and Hsiao, C. (1982) Formulation and Estimation of Dynamic Models Using Panel Data. Journal of Econometrics, 18, pp 67-82.

Andersson, M and Lööf H (2008a). A Portrait of the Innovative Firm as a Small Patenting Entrepreneur, CESIS WP 127, Royal Institute of Technology

Andersson, M. and Lööf, H. (2008b). Learning-by-Exporting Revisited – the role of persistence and intensity, CESIS WP, Royal Institute of Technology

Andersson, M., Lööf, H., Johansson, S. (2008). Productivity and International Trade – evidence from a small open economy. Review of World Economics, 144 (4). *Forthcoming.*

Arellano. M., Bond, S. (1991). Some test of specification for panel data: Monte Carlo evidence and application to employment equations. The Review of Economic Studies, 58, pp 277-97.

Arelleno, M., Bover, O. (1995). Another Look at Instrumental Variable Estimation of Error Component Models. Journal of Econometrics, 68, pp 29-51.

Balestra, P., M. Nerlove (1966). Pooling Cross Section and Times series data in the estimation of a Dynamic Model: the Demand for Natural Gas. Econometrica, 24, pp 585-612.

Bernard, A.B and J.B Jensen (1995). Exporters, Jobs and Wages in US Manufacturing 1976-1987. Brookings Paper on Economic Activity: 67-119

Blundell, R.S., Bond, S. (1998). Initial Conditions and Moment Restrictions in Dynamic Panel data Models. Journal of Econometrics, 87, pp 115-43.

Broda, C., Weinstein, D. (2006) Globalization and The Gains from Variety. *Quarterly Journal of Economics* 121:541-585.

Castellani, D., Serti, F and Tomasi, C (2008), Firms in International Trade: importers and exporters heterogeneity in Italian manufacturing , LEM WP 2008/04

Coe, D. and Helpman, E. (1995). International R&D Spillovers. European Economic Review, 39:5, pp 859-887

Coe, D, Helpman, E. and Hoffmeister, A.W (1997). North-South R&D Spillovers, Economic Journal 107: 134-149

Eaton, J and S. Kortum (1999). International Technology Diffusion: Theory and Measurement. International Economic Review 40: 537-570

Eaton, J., Kortum, S. (1997). Engines of growth: Domestic and foreign sources of innovation. Japan and the World Economy, vol. 9:2, pp 235-259.

Griliches, Z., Mairesse, J. (1984). Productivity and R&D at the firm level, in Z. Griliches (ed.), *R&D Patents and Productivity*, Chicago, University of Chicago Press, pp 339-375.

Grossman, G. and E. Helpman (1991). *Innovation and Growth in the Global Economy*. Cambridge: MIT Press

Halpern, L., Koren, M. and Szeidl, A (2006). Imports and Productivity, Mimeograph

Holtz-Eakin, D., Newey, W., Rosen, H.S. (1988). Estimating Vector Autoregressions with Panel Data. Econometrica, 56: 1371-95.

Kasahara, H and J. Rodrigue (2008). Does the use of Imported Intermediaries Increase Productivity? – plant-level evidence. Journal of Development Economics.87: 106-118

Keller, W. (2002). Trade and the Transmission of Technology. Journal of Economic Growth, 7, pp 5-24.

Keller, W. (2004). International Technology Diffusion. Journal of Economic Literature XLII, pp 752-782.

Kneller, R (2007). Exporters and International Knowledge Transfers: evidence from UK firms, GEP Research Paper 2007/07

Madsen, J.B (2008). Economic Growth, TFP Convergence and World Export of Ideas: a century of evidence. Scandinavian Journal of Economics, 110(1): 145-167

Muuls, M and Pisu, M (2007), Imports and Exports at the Level of the Firms: evidence from Belgium, CEP Discussion Paper No. 801

Rivera-Batiz, L and P. Romer (1991). International trade with endogenous technological change. European Economic Review 35: 971-1001

Romer, P. (1990). Endogenous Technological Change. Journal of Political Economy 98: 71-102

Roodman. D, (2006). How to Do xtabond: An Introduction to “Difference” and”System” GMM an Stata. CGDEV Working Paper No 103.

Serti, F and Tomasi, C (2008), Firm Heterogeneity: do destinations of exports and origins matter?, LEM WP 2008/14

Windmeijer, F. (2005) A finite sample correction for the variance of linear efficient two-step GMM estimators. Journal of Econometrics, 126, pp 25-51.

Table 1. Key economic variables.

	Mean	Std dev	Median
Employment, (*E*)	96	499	24
- Ordinary labor[a] (*L*)	85	411	23
- Skilled labor[b] (*H*)	11	130	1
Labor productivity, log (*lp*)	3.91	0.44	3.88
Physical capital, log (*K*)	5.67	2.07	5.59
Capital Structure[c] (*CS)*	0.67	0.21	0.71
Import value, log (*M*)	2.63	4.38	2.93
Import as a fraction of sales	0.08	0.16	0.1
Imports from Scandinavia[d]	0.37	0.39	0.17
Imports from Poland-Baltic[d]	0.06	0.20	0.00
Imports from G7[d]	0.34	0.35	0.21
Imports from EU15 other than Scandinavia and G7[d]	0.08	0.18	0
Imports from rest of the world[d]	0.15	0.28	0.1

38, 929 observations 1997-2004

Notes

(a) Number of employees with university education less than 3 years as a fraction of total employment.

(b) Number of employees with university education 3 years or more as a fraction of total employment. (c) Total debt/(total debt+equity)

(d) As a fraction of total imports. Only firms with imports.

Table 2. Distribution of imports

Import as a fraction of sales, distributed after markets for different firm characteristics. Mean values.

Firm definition	Scand	Pol/Balt	G7	EU15	ROW	Imp/sales Total
Non-exporters	0.07	0.01	0.04	0.01	0.02	0.15
Temporary exporters	0.21	0.03	0.12	0.02	0.08	0.46
Persistent exporters<50	0.32	0.06	0.28	0.08	0.12	0.86
Persistent exporters≥50	0.25	0.06	0.42	0.09	0.14	0.96
Non-affiliate	0.20	0.04	0.14	0.03	0.08	0.49
Domestic Uninational	0.25	0.04	0.18	0.04	0.10	0.61
Domestic multinational	0.26	0.07	0.34	0.09	0.13	0.89
Foreign multinational	0.31	0.03	0.40	0.11	0.09	0.94
Labor intensive prod	0.22	0.05	0.17	0.05	0.09	0.58
Differentiated prod	0.24	0.04	0.30	0.05	0.12	0.75
High technology prod	0.16	0.03	0.46	0.05	0.20	0.90
Resource intensive prod	0.28	0.05	0.12	0.04	0.07	0.56
Scale intensive prod	0.26	0.03	0.08	0.04	0.08	0.49

Notes

The table reports that persistent exporters, multinational firms and producers of high technology products are more import intensive than other firms. G7 is the most important import market for persistent exporters serving foreign markets foreign and domestic multinationals, and for producers of high technology and differentiated products.

Table 3. Relative value of imports per volume unit (kg) from G7

	Ratio	Weighted average G7 share of total imports
Labor intensive	1.48	0.40
Differentiated products	1.16	0.58
High technology	1.04	0.64
Resource intensive	1.81	0.30
Scale intensive	1.71	0.55

Notes

The table shows the relative value of imports per volume unit (kg) from G7 countries compared to the value per kg of all imports.

Tab 4 Fixed effects (“Within)

Dependent variable: log value added per employee

	(1)	(2)	(3)	(4)	(5)	(6)
Ln LP $_{t-1}$	0.060	0.056	0.011	0.014	0.083	0.091
	(0.000)	(0.000)	(0.576)		(0.01)	(0.24)
M-tot	0.010		0.006		0.006	
	(0.000)		(0.001)		(0.000)	
M-scand		0.002		0.009		0.014
		(0.774)		(0.256)		(0.085)
M-polbalt		0.028		-0.003		0.001
		(0.019)		(0.833)		(0.016)
M-g7		0.026		0.030		0.034
		(0.013)		(0.000)		(0.001)
M-EU15other		-0.002		-0.013		-0.009
		(0.993)		(0.616)		(0.730)
M-row		0.004		0.000		0.003
		(0.723)		(0.982)		(0.746)
Ln K	0.056	0.036	0.023	0.024	0.013	0.016
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ln Ord Lab	0.061	0.450	-0.052	-0.025	-0.062	-0.093
	(0.014)	(0.000)	(0.008)	(0.713)	(0.001)	(0.142)
Ln Skill Lab	-0.083	-0.054	0.018	0.019	0.021	0.023
	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cap struc	-0.273	0.349	-0.445	-0.438	-0.454	0.437
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
No of obs	119 101	119 101	34 740	34 740	26 984	26 984

Notes

Columns 1, 3 and 5 report the elasticity of log labor productivity with respect to log import, controlling for capital labor, knowledge, capital structure, industry and year.

Columns 2, 4 and 6 report the elasticity of log labor productivity with respect to import fraction from different destination regions, controlling for capital labor, knowledge, capital structure, industry and year.

p-values are reported in parentheses. Only instantaneous effects are reported.

(1) (2) All manufacturing firms in Sweden with 1 or more employees

(3) (4) All manufacturing firms in Sweden with 10 or more employees

(5) (6) All manufacturing firms in Sweden with 10 or more employees and observed over the whole period 1997-2004.

All the right-hand side variables are lagged two years, but with the exception of lagged labor productivity only the instantaneous coefficients are reported.

Ln LP is log labor productivity, M-tot is log import value, M-scand, M-polbalt, M-g7, M-EU15other, M-row is import fractions from different markets, Ln K is log investments in machinery and other equipment, Ln Ord Lab is log ordinary labor, Ln Skill Lab is log employment with at least three years university education, Cap struc is debt/(dept+equity).

Eight year dummies and 13 industry dummies are included in the regressions.

Table 5. Two-step System GMM

Dependent variable: Log value added per employee.

	1 lag (1)	1 lag (2)	2 lags (3)	2 lags (4)	3 lags (5)	3 lags (6)
LP $_{t-1}$	0.285 (0.000)	0.387 (0.000)	0.369 (0.000)	0.368 (0.000)	0.442 (0.000)	0.432 (0.000)
IM-tot	0.010 (0.000)		0.007 (0.000)		0.006 (0.006)	
IM-scand		0.011 (0.041)		0.014 (0.033)		0.007 (0.006)
IM-polbalt		0.015 (0.227)		0.012 (0.368)		0.011 (0.434)
IM-g7		0.046 (0.000)		0.032 (0.000)		0.036 (0.000)
IM-EU15other		0.052 (0.001)		0.022 (0.341)		0.010 (0.657)
IM-row		0.012 (0.127)		0.008 (0.354)		-0.001 (0.952)
Ln K	0.031 (0.000)	0.046 (0.000)	0.030 (0.000)	0.033 (0.000)	0.027 (0.000)	0.030 (0.000)
Ln Ord Lab	-0.080 (0.001)	-0.085 (0.000)	-0.134 (0.000)	0.143 (0.000)	-0.127 (0.001)	-0.123 (0.000)
Ln Skill Lab	0.037 (0.000)	0.047 (0.000=	0.029 (0.000)	0.043 (0.000)	0.028 (0.005)	0.038 (0.003)
CS	-0.461 (0.000)	-0.250 (0.000)	0.392 (0.000)	-0.320 (0.017)	-0.381 (0.000)	-0.428 (0.006)
AR(1) in first diff	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) in first diff	0.139	0.050	0.954	0.590	0.484	0.544
Hansen test of overid	0.000	0.000	0.000	0.000	0.004	0.023
Diff-GMM	0.000	0.004	0.004	0.047	0.120	0.173
No of obs	32 550	32 550	26984	26 984	21 800	21 800

Notes

Columns 1, 3 and 5 report the elasticity of log labor productivity with respect to log import, controlling for capital labor, knowledge, capital structure, industry and year.

Columns 2, 4 and 6 report the elasticity of log labor productivity with respect to import fraction from different destination regions, controlling for capital labor, knowledge, capital structure, industry and year.

p-values are reported in parentheses

All manufacturing firms in Sweden with 10 or more employees and observed over the whole period 1997-2004.

All the right-hand side variables are lagged one year, two years or three years, but only the instantaneous coefficients are reported.

Ln LP is log labor productivity, M-tot is log import value, M-scand, M-polbalt, M-g7, M-EU15other, M-row is import fractions from different markets, Ln K is log investments in machinery and other equipment, Ln Ord Lab is log ordinary labor, Ln Skill Lab is log employment with at least three years university education, Cap struc is debt/(dept+equity). Eight year dummies and 13 industry dummies are included in the regressions.

Table 6. Two-step System GMM, 3 years lag

Dependent variable: Log value added per employee.

	(1)	(2)	(3)
LP $_{t-1}$	0.422 (0.000)	0.387 (0.000)	0.369 (0.000)
IM-g7 Non export	0.015 (0.596)		
IM-g7 Temp export	0.041 (0.003)		
IM-g7 Persist export<50	0.028 (0.030)		
IM-g7 Persist export≥50	0.043 (0.200)		
IM-g7 Non-affiliation		0.041 (0.236)	
IM-g7 Unininational		0.031 (0.013)	
IM-g7 Domestic MNE		0.026 (0.039)	
IM-g7 Foreign MNE		0.044 (0.024	
IM-g7 Labor intensive prod			0.008 (0.587)
IM-g Differentiated prod			0.052 (0.003)
IM-g7 High technology prod			0.133 (0.001)
IM-g7 Resource intensive prod			0.068 (0.017)
IM-g7 Scale intensive prod			0.028 (0.090)
AR(1) in first diff	0.000	0.000	0.000
AR(2) in first diff	0.584	0.903	0.814
Hansen test of overid	0.011	0.024	0.003
Diff-GMM	0.407	0.237	0.204
No of obs	21 800	21 800	21 800

Notes

The table reports log labor productivity with respect to export fraction from G7 countries after three different firms characteristics: (i) export-strategy, (ii) corporate ownership structure and (3) product classification.

All manufacturing firms in Sweden with 10 or more employees and observed over the whole period 1997-2004.

All the right-hand side variables are lagged one-three years, but only the instantaneous coefficients are reported.

Physical capital (log). Ordinary labor, (log), Skilled labor (labor) and capital structure, eight year dummies and 13 industry dummies are included in the regressions. Industry dummies are only included in the results presented in Column 1 and 2. p-values are reported in parentheses

Ln LP is log labor productivity, M-tot is log import value, M-scand, M-polbalt, M-g7, M-EU15other, M-row is import fractions from different markets, Ln K is log investments in machinery and other equipment, Ln Ord Lab is log ordinary labor, Ln Skill Lab is log employment with at least three years university education, Cap struc is debt/(dept+equity). Eight year dummies and 13 industry dummies (col 1 and 2) are included in the regressions.

APPENDIX I

Table A. Two-step System GMM

Dependent variable: Log value added per employee.

	2 lags **(1)**	3 lags **(2)**
LP $_{t-1}$	0.389 (0.000)	0.450 (0.000)
IM-scand	0.012 (0.000)	0.010 (0.000)
IM-polbalt	0.005 (0.156)	0.005 (0.229)
IM-g7	0.016 (0.000)	0.016 (0.000)
IM-roEU15	0.011 (0.003)	0.009 (0.041)
IM-row	0.008 (0.002)	0.007 (0.026)
Ln K	0.027 (0.000)	0.027 (0.000)
Ln Ord Lab	-0.131 (0.000)	-0.131 (0.000)
Ln Skill Lab	0.029 (0.000)	0.029 (0.000)
CS	-0.397 (0.000)	-0.391 (0.000)
AR(1) in first diff	0.000	0.000
AR(2) in first diff	0.953	0.766
Hansen test of overid	0.000	0.006
Sargan test instr. Diff-GMM	0.126	0.251
No of obs	26 984	21 800

Notes

The table reports the elasticity of log labor productivity with respect to log import value from five different regions.

All manufacturing firms in Sweden with 10 or more employees and observed over the whole period 1997-2004.

All the right-hand side variables are lagged one-three years, but only the instantaneous coefficients are reported.

Eight year dummies and 13 industry dummies are included in the regressions. p-values are reported in parentheses.

Ln LP is log labor productivity, M-tot is log import value, M-scand, M-polbalt, M-g7, M-EU15other, M-row is import fractions from different markets, Ln K is log investments in machinery and other equipment, Ln Ord Lab is log ordinary labor, Ln Skill Lab is log employment with at least three years university education, Cap struc is debt/(dept+equity). Eight year dummies and 13 industry dummies are included in the regressions

APPENDIX II

G7: U.S., Canada, U.K., France, Italy, Germany, Japan

Scandinavia: Norway, Finland, Denmark and Iceland

Poland and Baltic: Poland, Estonia, Latvia, Lithuania

EU15: Austria, Belgium, The Netherlands, Spain, Portugal, Greece, Luxembourg, Ireland

Rest of the world: all other countries