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The Effect of Real Exchange Rate Changes on Labour Productivity Growth

Gavin Murphy[a,b] and Iulia Siedschlag[a,b]

Abstract: We examine the effect of changes in international competitiveness on labour productivity growth through three channels: (i) export, (ii) import, and (iii) import competition. Using micro data from the Irish manufacturing over the period 1995-2002, we account for firms' heterogeneity in their exposure to international competitive pressure. Our econometric estimates indicate that a real exchange rate appreciation had a negative effect on labour productivity growth once a firm's export exposure was greater than 14 per cent. When a firm's import exposure exceeded 33 per cent, a real exchange rate appreciation had a positive effect on labour productivity. An increase in import competition due to a real exchange rate appreciation had no effect on a firm's labour productivity growth.

Key words: International competitiveness; Productivity; Firm heterogeneity.

JEL classification: F12; F41; F43.

Corresponding author: gavin.murphy@esri.ie

[a] Economic and Social Research Institute Dublin, Whitaker Square, Sir John Rogerson's Quay, Dublin 2, Ireland.
[b] Department of Economics, Trinity College Dublin

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1 Introduction

Globalisation both reflects and impacts on many aspects of a firm's performance. In particular, it offers firms greater opportunity to seek out new markets to export to as well as to source inputs from. This loosens the production constraints faced by firms which previously relied on domestic markets and provides the firm with scope to restructure and improve its productivity performance. At the same time, greater external exposure increases a firm's susceptibility to changes in international competitive pressures, which are also likely to impact on the firm's performance. While there is an emerging literature which studies the effect of real exchange rate movements on firm prices and profits, to date there is only very little empirical evidence on its impact on firm productivity.

From a theoretical perspective, there are several channels through which changes in international competitive pressure impact on firm productivity with potentially ambiguous effects overall. For instance, greater international competitive pressure may encourage firms to adopt more efficient production techniques or force less productive firms to exit the market (Melitz, 2003; Melitz and Ottaviano, 2008). Alternatively, increased competition through a real exchange rate appreciation which reduces firms' total sales may lead to lower productivity in increasing returns to scale firms (Fung, 2008). Other research suggests that a real appreciation, which improves access to better quality foreign inputs through greater affordability, may encourage technological innovation (Grossman and Helpman, 1991; Harris, 2001). At the same time, a real appreciation, which decreases export profitability, may discourage firms from adopting new technologies and improving the quality of their products, (Yeaple, 2005; Bustos, 2011). Given the potentially ambiguous effects of real exchange rate movements on firm productivity empirical research is clearly needed. Existing empirical evidence on the effect of real exchange rate changes on firm productivity performance is limited and existing findings on the relationship are inconclusive.

In this paper, we use micro data from Irish manufacturing over the period 1995-2002 and examine whether real exchange rate movements affect firm labour productivity growth. Further, we investigate a number of potential sources of the exchange rate induced productivity growth effects. In line with recent developments in the related theoretical and empirical literature, we account for three main channels through which firms are affected by real exchange rate movements: (i) sale of output to foreign markets; (ii) purchases of imported inputs; and (iii) import competition in the domestic market. We expect that the greater the firm's exposure through each channel, the greater the effect of a real exchange rate change. We test this hypothesis by interacting changes in firm-level real exchange rate with (i) the share of export sales in total sales; (ii) the share of imported material input costs in total purchases and (iii) a measure of import competition. We then examine whether the real exchange rate- induced productivity effects emanate from changes in firm investment behaviour or if

they can be attributed to changes in total factor productivity growth associated with changes in the scale of production.

An important novelty in our analysis over the related empirical literature is the construction of a firm-level real effective exchange rate (REER). Recent empirical papers such as Ekholm *et al*. (2012) and Nucci and Pozzolo (2010) highlight the importance of accounting for firm heterogeneity in terms of total export and import exposure when estimating the effect of real exchange rate changes on firm performance.[1] However, firms are also heterogeneous in their export and import exposures by trading partner. Given that bilateral real exchange rate movements can vary largely across trading partner countries, failure to account for firm trade exposure by trading partner country could bias estimates of the effect of real exchange rate changes on firm productivity growth. The construction of firm-specific REERs, which is possible due to the availability of firm-level trade data by destination to a number of Ireland's main trading partners, allows us to better account for the heterogeneous trade exposure of firms to real exchange rate changes by trading partner.

Our results offer new insights into how Irish manufacturing firms react to changes in international competitive pressure. We find that a real exchange rate appreciation had a negative effect on labour productivity growth once firm export exposure was greater than 14 per cent. A real exchange rate appreciation had a positive effect through the import channel once import exposure exceeded 33 per cent. We show that an increase in import competition due to a real exchange rate appreciation had no effect on labour productivity growth. In terms of the potential source of the real exchange rate induced productivity effects, we find that changes in the real exchange rate had no effect on firm investment growth through the export, import or import competition channels. In addition, our estimates suggest that plant utilization of economies of scale caused the negative effects of a real exchange rate appreciation through the export channel on labour productivity growth.

We begin in Section 2 by reviewing the relevant theoretical and empirical literature. In Section 3, we identify the hypotheses that we will test which are motivated by our discussion of the theoretical literature. We then present the empirical model that we estimate. Section 4 discusses in detail the data we use in our analysis. Section 5 reports the results on the relationship between real exchange rate changes and labour productivity growth. Section 6 summarises the findings. Section 7 concludes the paper.

[1] This is supported by earlier research by Bernard *et al.* (2007) which shows that within export sectors there are very large variations in firm trade exposures.

2 Literature Review

2.1 Channels of Real Exchange Rate Exposure

Campa and Goldberg (1999) identify three channels of exposure through which a change in the real exchange rate affects the international competitive pressure that firms face.[2] Real exchange rate exposure can occur from (i) the sale of output in foreign markets, (ii) purchases of imported inputs and (iii) import competition in the domestic market. The potential effect of real exchange rate changes on the first two channels can have opposing effects on the international competitive pressure faced by firms. For example, a real appreciation increases the price of exports in foreign currency and other things equal, should lead to a decrease in firm profits. The larger a firm's share of exports in total sales is, the larger the impact of a change in the real exchange rate on profitability will be. However, a real appreciation also decreases the price of imported inputs in the domestic currency and should lead to a reduction in costs and consequently an increase in firm profits. The opposite effects are true in the event of a real exchange rate depreciation. Therefore, the overall effect of real exchange rate movements on the profitability through the first two channels depends on the firm's net trade exposure to foreign markets. For example, a real exchange rate appreciation will lead to increased international competitive pressure for a firm whose exports exceed imported inputs. A real exchange rate depreciation will lead to a decrease in international competitive pressure for a firm whose exports exceed imported inputs.

The import competition channel refers to the effect of real exchange rate changes on the domestic firm's performance which is due to its influence on the competitive position of external firms in the domestic market. An exchange rate appreciation of the home currency against its trading partners will weaken the international competitive position of the domestic firm against foreign competitors in the domestic market. This should lead to a decrease in the profitability of domestic firms.

In addition, differences in a firm's market power may influence the effects of exchange rate fluctuations via firm import and export exposure on labour productivity growth. Campa and Goldberg (1999) and Nucci and Pozzolo (2001, 2010) show that the effect of exchange rate movements on the level of firm investment and employment vary according to a firm's monopoly power. They argue that firms with high price/cost margins tend to absorb exchange rate swings into their prices, and hence their mark-ups: consequently investment and employment by those firms is likely to be less sensitive to exchange rate movements. Therefore, differences in a firms' market power can be expected to influence the effects of exchange rate movements on labour productivity growth.

[2] We follow Galdon-Sanchex and Schmitz (2002) and define competitive pressure in terms of the firm's probability of closure. Accordingly, we consider how changes in real exchange rate movements affect firm profitability which in turn should impact on the firm's probability of closure. The degree to which changes in the real exchange rate impact on the competitive pressures depends on the level of a firm's exchange rate exposure.

2.2 Links Between International Competitive Pressure and Productivity

Having discussed the potential channels through which a change in the real exchange rate affects the competitive pressure that firms face, we now focus on how changes in the competitive pressure arising from a real exchange rate change may affect firm productivity. Recent models of international trade with heterogeneous firms which focus on the elimination of trade cost barriers and their impact on firm and industry performance are of particular relevance.[3] This literature shows that firm heterogeneity is important when explaining the gains from trade and provides valuable insights into the effect of changes in trade costs on productivity. One of the key findings of the earlier trade models with heterogeneous firms is that greater international competitive pressure may encourage firms to reduce their x-inefficiencies or force less productive firms to exit the market (Melitz, 2003; Melitz and Ottaviano, 2008). More recent models analyse the effects of trade liberalisation on firm productivity by incorporating firm decisions on technology adoption and innovation as potential drivers of productivity differences among firms. Based on the findings in these models, we can infer that a real exchange rate appreciation, which decreases export profitability, may lead to lower firm productivity as it discourages firms from adopting new technologies and improving the quality of their products, (Yeaple, 2005; Bustos, 2011).

An alternative channel through which real exchange rate movements impact on firm productivity is through its effect on the firm's scale of production. Fung (2008) incorporates a real exchange rate variable into the monopolistic competition model of Krugman (1979). In the model, a real exchange rate appreciation increases the relative costs of domestic producers compared to foreign competitors, and this induces two firm responses which have opposing effects on firm productivity, i.e. a scale effect and a selection effect. On the one hand, the effect of a reduction in competitiveness due to the exchange rate appreciation leads to a reduction in domestic firm sales in the home and foreign market while, on the other hand, it also leads to the exit of some domestic firms which provides surviving firms with the opportunity to expand production. Surviving firms' sales are likely to decline if the firms' exit rate is low or foreign firms do not increase their market share. If surviving firms exhibit increasing returns to scale, then the reduction in sales will lead to a reduction in productivity.

Another channel through which real exchange rate movements may affect a firm's productivity performance is through its effect on the affordability of higher quality foreign intermediate inputs that can also stimulate technological innovation (e.g. Grossman and Helpman, 1991; Boler *et al.* 2012). Boler *et al.* (2012) develop an international trade model with heterogeneous firms. In their model, declining import input costs lower the marginal production costs and raise firm profitability, which consequently raises the return to incurring fixed R&D costs. This suggests that a real exchange rate

[3] Feenstra (1989) shows that exchange rate movements which are large and persistent may have a similar impact on firm behaviour as changes in tariffs do. For example, a depreciation of the home currency is equivalent to an increase in the import tariff in the home market and a decrease in the export tariff in the foreign country destination. (The reverse is true of exchange rate appreciations).

appreciation, which lowers the cost of imported inputs and in turn supports R&D investment, would lead to productivity gains.

The theoretical ambiguity surrounding the impact of changes in international competitive pressure on firm productivity offers a compelling motive for empirical investigation of this relationship. Our research relates to an emerging empirical literature which examines the effects of real exchange rate changes on firm productivity. For example, Ekholm *et al*. (2012) estimate the effect of real exchange rate movements on productivity in Norwegian manufacturing firms. They use a difference-in-differences estimation approach to examine whether the sharp appreciation in the Norwegian Krone in early the 2000s had a greater impact on the productivity of firms which initially had large net trade exposures. Unlike previous research, they account for the offsetting effect of an appreciation on the cost of imported inputs. Their findings suggest that the increased threat to profitability emanating from a real exchange rate appreciation had a positive effect on firm productivity. Further, their analysis suggests that the productivity gains were attributable to cuts in employment and technology improvement.

Fung (2008) investigates the impact of the large appreciation of the Taiwan dollar, following the 1985 Plaza Accord, on the production and productivity of surviving firms in the Taiwanese manufacturing sector. Using an industry-level measure of real exchange rates, she finds that real exchange rate appreciation increases surviving firms' exports and domestic sales, which result in greater total sales. The results also show that the currency appreciation had a positive effect on firm-level productivity growth as the high exit rate of less productive firms enabled the surviving firms to increase their scale of production. Tomlin and Fung (2010) investigate whether industry-level exchange rate movements have distributional effects on productivity. Based on Canadian plant level data, they use quantile regression analysis and show that, in most industries, the appreciation of the industry-level trade-weighted Canadian real exchange rate had a positive impact on plant productivity at the lower end of the productivity distribution, and find that it had a negative effect on productivity at the higher quantiles of the distribution. The positive effect at the lower end of the productivity distribution is due to the exit of smaller, less productive plants, while the result at the higher quantiles is due to changes in firm scale of production.

On the productivity gains which arise through reallocation and efficient resource use within firms, Moxnes and Ulltveit-Moe (2010) examine how multiproduct firms adjust their portfolio of products in response to the sharp appreciation in the Norwegian Krone in the early 2000s. They find that the real exchange rate shock had a limited effect on the net number of products firms exported. Product churning appears to be the firms' main margin of adjustment. Firms which face the strongest increase in international competitive pressure reduce their product churning rate by the greatest margin.

Fernandes and Paunov (2009) find a positive and significant impact of import competition on plant-level product quality upgrading. They use census data on manufactured products by Chilean plants over the period 1997-2003 to investigate the impact of changes in import competition, proxied by imported product transport costs, on product quality upgrading. They show that import competition

had an insignificant effect on quality upgrading where the "technology gap" between foreign competitors and local producers is high.[4]

Other indirect evidence on the effect of real exchange rate changes on productivity can be taken from Alvarez and Lopez (2009) who investigate the impact of a real exchange rate depreciation on wage inequality using Chilean plant level data for the period 1990-1999. They show that depreciation in the industry real exchange rate led to an increase in the share of skilled labour in the total wage bill. Their findings suggest that a real depreciation induces exporting plants to upgrade product quality and become more skill-intensive. These results are in line with models such as Verhoogen (2008), which show that an increase in export profitability will encourage firms to use new technologies and upgrade product quality. They also find that changes in the real exchange rate had no effect on a firm's exit and entry decision but did impact on a firm's export intensity. These findings suggest that the intensive margin of exports is relatively more important for technology adoption.

In summary, the theoretical relationship between international competitive pressure and productivity growth is ambiguous. In addition, the effect of changes in the real exchange rate on firm profitability (international competitive pressure) will differ depending on the channels through which the firm is exposed. A number of issues arise out of the discussion of the related empirical literature. First, a number of the empirical studies do not fully account for all channels of exchange rate exposure as identified by Campa and Goldberg (1999). This is mainly due to the lack of data on imported inputs. Second, many of the studies depend on the variation in industry-level measures of the real exchange rate to identify the effect on firm performance measures, such as sales and productivity growth (e.g. Fung, 2008; Tomlin and Fung, 2010). Recent papers such as Elkholm *et al*. (2012) and Nucci and Pozzolo (2010) do account for firm heterogeneity in terms of total export and import exposure; however, they are unable to account for firm heterogeneity in terms of total export and import exposure by trading partner.[5] Real exchanges rate movements can vary largely across trading partner countries. As a consequence, failure to accurately account for firm trade exposure by trading partner country can affect the correct estimation of the effect of real exchange rate changes on firm productivity growth.[6]

In the next section, we outline our empirical approach which addresses the shortcomings we have identified in the literature.

[4] Another related paper is Altomonte *et al.* (2008) who find that import penetration had a positive effect on productivity in a sample of Italian firms over the period 1996-2003.

[5] This may not be so much of an issue in Elkholm *et al.* (2012) as they argue that the Norwegian Krone appreciated by approximately 20 per cent against all its main trading partners over the period of analysis.

[6] Figures 1 and 2 highlight noticeable differences in the movement of Ireland's bilateral real exchange rates with its main trading partners

3 Econometric Framework and Estimation Strategy

This section discusses the empirical strategy which we will use to study the impact of real exchange rate changes on firm labour productivity growth via import and export exposure, and import competition.[7]

3.1 Hypotheses to be Tested

As discussed above, real exchange rate changes affect firm labour productivity through the export and import channels. The effect of real exchange rate changes is likely to differ across firms according to the degree of import and export exposure. In other words, the implications of real exchange rate changes for profitability and in turn a firm's incentive to improve productivity are conditional on how externally exposed a firms' profits are.[8] Furthermore, the relationship between changes in profitability and productivity growth is ambiguous.

Accordingly, we test the hypothesis that the potential effect of a real exchange rate change on firm labour productivity growth depends on the level of import and export exposure, and the degree of import competition faced by the firm.

3.2 Model Specification

In our empirical analysis, we investigate whether the effects of the real exchange rate changes on labour productivity growth are conditional on the external exposure characteristics of the firm. The model which relates firm labour productivity growth to real exchange rate movements is expressed as follows:

$$\Delta y_{it} = \alpha_0 + \alpha_1 \Delta reerx_{it} + \alpha_2 X_{it-1} + \alpha_3 \Delta reerx_{it} * X_{it-1} + \alpha_4 \Delta reerm_{it} + \alpha_5 M_{it-1} + \alpha_6 \Delta reerx_{it} * M_{it-1} + \alpha_7 \Delta reerx_{kt} + \alpha_8 ImpCom_{lt-1} + \alpha_9 \Delta reerx_{kt} * ImpCom_{lt-1} + \delta Z_{it-1} + \gamma T_{kt-1} + \tau_t + u_{it} \quad (1)$$

The dependent variable Δy is the annual log growth of real turnover per employee. The subscripts *i*, *k*, *j* and *t* denote firm *i,* 3-digit industry *k* and time period *t,* respectively. X is the export share in total

[7] Due to the unavailability of data on firms' capital stock in the CIP dataset, we are unable to examine how changes in the real exchange rate affect other measures of productivity growth such as Total Factor Productivity growth.

[8] For example, the export weighted real exchange rate, $\Delta reerx_{it}$, is defined as the export weighted average of Ireland's exchange rates with its exporting partners. The weights used are the average share of exports to each destination as a percentage of total average exports over the period. Therefore, the firm level real exchange rate measure provides a weighted measure of changes in price competitiveness. For example, assume there are two firms and both only export to the UK; Firm A exports 100% of its produce to the UK, therefore 100% of revenue depends on UK market. Firm B exports 1% of its produce to the UK therefore export revenue makes up just 1% of total revenue. As the export weights used in the construction of each firms export weighted real exchange rate is the same (i.e. share equals 100%), both firms will experience the same change in their export weighted real exchange rate (i.e. change in export weighted real exchange rate = 1* Change in real UK/IRE exchange rate). It is clear the implications for profitability and in turn their incentives to improve productivity are very different. The effect of a real exchange rate change on productivity growth will differ from firm to firm depending on the share of total revenue which comes from export sales.

sales and M is the share of imported material inputs in total purchases. Both variables are lagged by one period to allay the possible simultaneity bias arising from the effect of real exchange rate variations on the degree of firms' external exposure. Z and T are vectors of firm and industry characteristics that influence labour productivity growth suggested by previous empirical findings. Firm and industry variables are lagged by one period unless stated otherwise. The firm-level controls used in the model include the natural logarithm of total employees, which controls for firm size, the natural logarithm of real output per person to account for productivity of the firm, the annual logarithmic growth in the ratio of managerial, technical and clerical wages to manual worker wages to proxy for changes in firm skill intensity, export and import dummy variables, (X_dum and M_dum). The industry level controls include a measure of import competition available at the 2-digit level. The Herfindhal index calculated at the 3-digit industry level accounts for competitive pressure the firm faces within the industry. We also include the annual 3-digit industry real sales growth excluding firm *i* in period t ($industrygrowth$). This variable controls for time-varying industry specific effects which may impact on firm labour productivity growth. τ_t controls for time-varying effects which are common across firms in each period. We estimate the model using an OLS fixed effects estimator to control for unobserved firm-specific and industry-specific variables which are constant over the period.

The most important variables for our purposes are the firm export and import weighted real exchange rate change variables ($\Delta reerx_{it}$ and $\Delta reerm_{it}$ respectively). The firm export-weighted real exchange rate is defined as the export-weighted sum of Ireland's bilateral real exchange rates with the UK and US, the real effective exchange rates with the EU13, and the real effective exchange rate with the rest of the world (ROW), i.e. remaining top 20 trade destinations.[9] The weights used to construct the export-weighted real exchange rate are equal to the firm's average share of exports to each of the four trading partner destinations over the period. The use of the firm average exports to each destination ensures that changes in the firm-level real effective exchange rate only reflect changes in the real exchange rate.[10] The import-weighted real exchange rate measure is constructed in an analogous way. As firms which do not import or export could potentially become exporters or importers, changes in the exchange rate may also affect their productivity performance. To account for this, we assign the average firm export (import) weighted real exchange rate in the respective 3-digit industry for each year to the non-exporting (non-importing) firms.

To test whether the impact of real exchange rate movements vary with export and import exposure, we interact the two real exchange rate variables with the firm export and import exposure variables respectively (i.e. $\Delta reerx_{it} * X_{it-1}$ and $\Delta reerm_{it} * M_{it-1}$). To investigate whether the effect of real exchange rate movements on labour productivity growth depends on the level of import competition

[9] The EU13 group of countries consists of Austria, Belgium, Luxembourg, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, and Sweden. The top 20 rest of the world trade destinations (ROW) are Japan, Singapore, Switzerland, Norway, Malaysia, Korea, Republic of, China, P.R.: Mainland, Taiwan, Canada, China, P.R.: Hong Kong, Australia, Philippines, South Africa, Israel, Saudi Arabia, Mexico, Thailand, Russian Federation, Poland and Turkey

[10] The construction of the firm real effective exchange rates is described in greater detail in the next section.

in an industry, we interact this variable with $\Delta reerx_{k,t}$ which is the average firm export-weighted real effective exchange rate in 3-digit industry *k*. As discussed in Section 2, theory provides no clear priors as to the expected sign of the real exchange rate changes on labour productivity growth.

It is necessary to clarify that with the inclusion of the interaction effects, the estimated coefficients on the terms $\Delta reerx_{it}$, $\Delta reerm_{it}$, X_{it-1},$M_{it-1}$and $Impcom_{lt-1}$ should not be interpreted as unconditional effects. For example, the estimated coefficient on $\Delta reerx_{it}$ captures the effect of a change in the real exchange rate when export exposure is equal to zero. This variable can be interpreted as the effect of a real exchange rate change on the productivity growth of non-exporting firms. In theory, other things equal, changes in the real exchange rate would alter the productivity threshold required to overcome the fixed costs of entering a new export market and thus affect the incentive to increase productivity before entry. For example, depreciation in the export-weighted real exchange rate could be expected to increase the incentive to improve productivity of non-exporting firms. In addition, the import (M_{it-1}) and export (X_{it-1}) terms capture the effect of import and export exposure when the real exchange rate change term is equal to zero. The literature which examines the link between exports and imports and productivity growth tends to find positive or zero effects. In theory, it is argued that firms which export or import more have better access and exposure to foreign markets and thus have greater opportunities to obtain better inputs and receive technological transfers, which improves their productivity performance. Castellani (2002) and Girma *et al.* (2004) find a positive effect of export intensity (export as a share of total sales) on productivity growth, while Aw *et al.* (2000) and Blalock and Gertler (2004) find that the link is not large or significant. Interestingly, recent research by Vogel and Wagner (2010) shows that productivity gains arise from self-selection into importing rather than from "learning by importing".[11]

As discussed earlier, in our model specification, the effects of changes in the respective real effective exchange rates are conditional on import and export exposure, and import competition. The marginal effect of a change in the export-weighted real exchange rate on productivity growth when the export exposure is greater than zero is calculated as $\frac{\partial lp}{\partial reerx} = \varphi_1 + \varphi_3 X_i$. The marginal effect of a change in the import-weighted real exchange rate on productivity growth is equal to $\frac{\partial lp}{\partial reerm} = \varphi_4 + \varphi_6 M_i$. Finally, the marginal effect of a change in the 3-digit industry export-weighted real exchange rate on productivity growth for a given level of import competition is equal to $\frac{\partial lp}{\partial Impcom} = \varphi_7 + \varphi_9 Impcom_k$.

Once we estimate the real exchange rate effects on labour productivity growth we proceed to investigate the potential sources through which the effects occur. Labour productivity growth can be affected by real exchange-rate-induced changes in the capital-labour ratio.[12] For example, it is possible that in a net exporting firm a decrease in labour productivity growth may be driven by a

[11] The focus of this area of research is now on determining whether the link between firm productivity and exporting (importing) arise from self-selection or by "learning by exporting (importing)". There is strong support for the self-selection of the most productive firms into exporting. Recent research by Vogel and Wagner (2010) shows that productivity gains arise from self-selection into importing rather than from "learning by importing" for German manufacturing firms.

[12] The firm capital stock variable is not available in the dataset.

decrease in investment induced by a decrease in profitability due to a real exchange rate appreciation (Nucci and Pozzolo, 2001). To investigate if real exchange rate changes impact on investment, we replace the labour productivity variable in our model with a firm investment growth variable, Δinv_{it}.

We also consider whether the effects of real exchange rate changes on labour productivity growth are attributable to TFP growth associated with economies of scale. As outlined above, changes in competitive pressure affect the total sales of the firm, if the firm is characterised by IRS, such a change in international competitive pressure may lead to a reduction in labour productivity growth. To address this issue, we reestimate Equation (1) dividing our sample into industries that the existing literature suggests are subject to increasing and moderate returns to scale, and those with low returns to scale. We divide the sample of firms according to the returns to scale classification constructed by Pratten (1988).

4 Data and Descriptive Statistics

In this section, we discuss the data that we use and provide descriptive statistics on the main variables used in our analysis. We also provide a detailed description of firm-level real effective exchange rate variables that we construct.

4.1 Firm-Level Variables

The firm-level data used in this paper are obtained from the Irish Census of Industrial Production (CIP).[13] The survey is conducted annually. The CIP is a census of all manufacturing, mining and utilities plants with 3 or more employees. A more detailed survey which includes questions on export and import trading partner countries is completed by firms with greater than 20 persons engaged. The analysis conducted in this paper is based on this more detailed survey; hence it excludes firms with less than 20 persons engaged. We use data over the period 1995 to 2002 for the following variables: the country of ownership, value of sales, share of sales exported, share of exports in total sales and the share of imported material inputs in total purchases each classified by trading destination and the number of employees. Industry classification is in accordance with the NACE Rev. 1 for the period 1995 to 2001 and NACE Rev. 1.1 for 2002. To deflate the variables expressed in nominal terms we use producer price indices at the industry level. When possible the price deflators at 4-digit level were used, otherwise the 3-digit deflator or then the 2- digit deflators were used.

The CIP dataset provides a breakdown of firm export and imported input shares for a number of destinations. This breakdown enables us to construct firm-specific real effective exchange rate measures. Specifically, the dataset contains information on firm exports and imported input shares to/from the UK and the US, a number of European Union country groupings, such as EU13, Eurozone and the rest of the European Union, along with a rest of the world category (ROW). Ideally, one would

[13] Recent research papers which have used the CIP include McCann (2011), Fitzgerald and Haller (2010).

like information on trade exposure to each specific country; nevertheless the UK and US are two of Ireland's most important trading partners.

With the changing composition of the European Union and the rest of the world trade category in the 1990s and 2000s, the longest period over which the composition of the European group of countries and ROW categories remains consistent is 1995 to 2002. This is the longest length of time for which a consistent measure of a firm's real exchange rate can be constructed.

4.2 Construction of Firm-Specific Real Exchange Rates

We construct two firm-specific real exchange rate measures: (i) firm export-weighted real effective exchange rate and (ii) firm imported input weighted real effective exchange rate. The firm export-weighted real effective exchange rate is defined as the weighted sum of Ireland's bilateral real exchange rates with the UK and US and real effective exchange rates with the EU13 and the ROW (i.e. remaining top 20 trade destinations) group of countries. The firm's export weights are equal to the firm's average share of exports to each destination over the period. The use of the firm's average exports to each destination ensures that changes in the firm-level real effective exchange rate only reflect changes in the real exchange rates. The firm-specific export-weighted real exchange rate is expressed as follows:

$$reerx_{it} = \sum_k [\frac{x_i^k}{X_i}(RER_t^k)] + \sum_j [\frac{x_i^j}{X_i}(REERe_t^j)] \quad (4)$$

where $reerx_{it}$ is defined as the firm's export-weighted real exchange rate. The *i* indexes firms, *t* denotes each year period, *k* denotes the respective trading partner countries UK or US; *j* refers to respective trading partner area (i.e. EU13 or ROW); X is the value of firm's exports to all trading partners. x is the value of firm export sales to the trading partner indexed by the superscript. *RER* refers to the real exchange rate between Ireland and its trading partner indexed by the superscript. In order to incorporate a firm's export exchange rate exposure to the EU13 and the ROW, we weigh the Ireland-EU13 and Ireland-ROW export real effective exchange rates $REERe_t^j$, by a firm's export share to each destination respectively. The export real effective exchange rate for Ireland with the EU13 set of countries is constructed by weighting Ireland's bilateral real exchange rates with the EU13 by the average share of Irish exports to each EU13 country as a percentage of total Irish exports to the EU13 region. The export real effective exchange rate for Ireland with the ROW set of countries is constructed by weighting Ireland's bilateral real exchange rates with Ireland's remaining top 20 trading partners, by the average share of Irish exports to each country in this group. The firm-specific imported input weighted real exchange rate $reerm_{it}$, is constructed in an analogous fashion to the $REERX_{it}$ index.

Data used to construct the firm-specific exchange rates are taken from a number of sources. Ireland's bilateral real exchange rate with the UK and US and its real effective exchange rate with the EU13 and ROW group of countries are constructed using the CPI deflators and Ireland's nominal bilateral

exchange rate. These data were taken from the IMF's World Economic Outlook dataset. Ireland's aggregate bilateral exports and imports of goods in current dollars are obtained mainly from the International Monetary Fund's International Financial Statistics. CPI data for China were taken from the World Development Indicators. Exchange rate information for Taiwan was taken from Officer (2011).

4.3 Industry-Level Variables

To account for the role of foreign competition in the domestic market, we construct an import competition variable using data from the OECD STAN database which contains a range of structural indicators at the level of industry and country. Import competition is constructed as imports divided by the value of production minus exports plus imports in each 2-digit industry.

4.4 Descriptive Statistics

In this section, we discuss the summary statistics of the main variables of interest in our sample.[14] In our empirical analysis, we estimate the effects of RER changes for domestic firms only. We excluded enterprises that have total sales or the number of employees equal to zero in more than half of their years in the sample. We dropped enterprises if more than half of their observations were estimated or imputed by the Central Statistics Office due to non-response or incomplete returns. We exclude firms with two observations that have at least one profit margin observation smaller than -1. [15] Firms with negative profits in all years and at least one observation smaller than -1 are excluded. Also, 3-digit industries with five observations or less in all years are dropped.

Table 1 presents the summary statistics on the number of enterprises and the share of exporters and importers by year. The figures show that manufacturing firms in Ireland are very open to international trade. The share of firms which import is greater than the share which export; on average 71 percent of firms import over the period compared with 62 percent of firms who export. On average, 20 percent of the firms in the sample neither export nor import over the period. On average, 52 percent of firms both export and import over the period. These summary statistics emphasise the importance of accounting for both the export and import channels when analysing the effects of exchange rate fluctuations on firm performance. Table 3 presents information on the share of exporters and importers by destination. The UK and EU group of countries are the two most important export and import markets. On average 92 and 51 percent of exporters export to the UK and EU, respectively while 92 and 59 percent of importers import from the UK and EU, respectively.

Table 4 presents the summary statistics by year on firms labour productivity growth over the period of study. The average annual growth rate in labour productivity ranges between 1 and 6 percent over the period. There is a large variation in the labour productivity growth rate in each year as evidenced

[14] Statistics on enterprises are based on all reporting plants that completed the extended CIP survey in NACE sectors 10-36. The data cleaning criteria are based on those applied in Fitzgerald and Haller (2010) and Haller (2011).

[15] Profit margins are defined as the ratio of turnover less wages and purchases of goods and services to turnover.

by the size of the standard deviation. Table 5 shows that firms which exported and imported outperformed those firms which relied solely on the domestic market in terms of labour productivity growth in the majority of years.

Table 5 shows that the average export-weighted real exchange rate change, faced by exporting firms is -0.01 percent over the sample period with a standard deviation of 4.3 percent. Its value at the 25th and 75th percentiles is -3.7 percent and 3.5 percent respectively. The average firm-level import-weighted real exchange rate change is -0.009 per cent over the sample period with a standard deviation of 4.3 percent. The figures suggest there is a non-negligible level of variation in these variables. The correlation between the firm import and export-weighted real exchange rate growth rate in each year is presented in Table 6. The correlation between the two firm REER measures is very low and ranges between -0.01 and 0.17 over the period.

5 Results

In this section, we discuss the results of our empirical analysis. In Table 7, we present the results based on Equation (1). Our results are based on an unbalanced data panel of Irish owned firms. What are the effects of real exchange rate movements on labour productivity growth? First, the coefficients on $\Delta reerx_{it}$, $\Delta reerm_{it}$ and $\Delta reerx_{kt}$ are insignificant which suggests that changes in the respective export and import-weighted real exchange rates did not affect the labour productivity growth of non-exporting, non-importing firms or firms in non-import competing industries respectively. We find that the effects of import (M_{it-1}) and export (X_{it-1}) exposure and $Impcom_{kt-1}$ were insignificant when real exchange rate movements were equal to zero. The results show that lagged labour productivity was negative and significant implying that firms which had a low level of labour productivity experienced subsequent higher labour productivity growth. Lagged skill intensity growth had a significant positive effect on labour productivity growth. Also, firms which imported in the previous period experienced subsequent higher labour productivity growth.

The positive and significant coefficient on the import exposure and import-weighted real exchange rate change interaction, i.e. $\Delta reerm_{it} * M_{it-1}$, suggests that the reduction in competitive pressure on the import side due to a real exchange rate appreciation had a positive and significant effect on labour productivity growth. This suggests that the increase in profitability through this channel leads to improved labour productivity growth.

Our results presented in Table 7 provide limited information on the relationships of interest as the estimates only identify the effect of real exchange rate movements on labour productivity growth when the modifying variable (i.e. import or export exposure or import competition) was equal to zero. For example, it is possible that the marginal effect of a real exchange rate appreciation on labour productivity growth could be significant for values of export exposure greater than zero. Accordingly,

we graphically illustrate the marginal effects of real exchange rate changes on productivity growth across the range of values of import and export exposure, and import competition.[16]

The solid sloping lines in Figures 3 (i) - (iii) indicate how the marginal effect of a real exchange rate movement on labour productivity growth across the range of values of import and export exposure, and import competition. The dashed lines either side of the solid line provide the upper and lower confidence bounds. When both dashed lines are either above or below the x-axis the real exchange rate change effect is significant at the 10 percent level. Figure 3 (i)-(iii) are constructed based on estimates in Table 7. For ease of exposition, we focus on the marginal effect of a real exchange rate appreciation. We assume that the marginal effect of a real exchange rate depreciation is symmetric. We find that a real exchange rate appreciation had an increasingly negative effect on labour productivity growth once the level of export exposure is greater than 14 percent. In Figure 3 (ii), we find that a real exchange rate appreciation had an increasing positive effect on labour productivity growth once a firms' level of import exposure exceeded 33 percent. The marginal effects of a real exchange rate appreciation as import competition increases are presented in Figure 3 (iii). Our results suggest that increased competition in the domestic market arising from a real exchange rate appreciation had no effect on labour productivity growth for any level of import competition.

We next examine a number of potential sources through which the real exchange rate induced labour productivity growth effects occur. Labour productivity growth can be affected by real exchange-rate-induced changes in the capital–labour ratio, which is not readily available in this data set. As discussed earlier, a reduction in labour productivity growth may result from a decrease in investment growth induced by a real exchange rate change which reduces profitability. To investigate if this is the case we reestimate Equation (1) but replace the dependent variable with a firm investment growth variable, Δinv_{it}. The estimates of the model are presented in Table 8 and the relevant marginal effects are shown in Figure 4. We find that changes in the real exchange rate had no effect on firm investment growth through the export, import or import competition channels.

We also consider whether the effects of real exchange rate changes on labour productivity growth are attributable to TFP growth associated with economies of scale. A change in the real exchange rate is likely to alter the demand for a firm's exports. If a firm exhibits increasing returns to scale, then changes in demand for its exports are likely to lead to changes in its labour productivity. We reestimate Equation (1) dividing our sample into industries that the existing literature suggests are subject to increasing and moderate returns to scale, and those with limited returns to scale. The results are reported in Table 9 while the marginal effects are presented in Figure 5 (a) and (b). We find that the effect of a real exchange rate change through the export channel is significant for a proportion of firms in high economies of scales industries only. This finding suggests that it is likely that plant utilization of economies of scale caused the positive effects through the export channel on labour productivity growth. On the import side, the real exchange rate induced labour productivity

[16] We use the STATA code provided by Brambor *et al.* (2006) to plot the marginal effects of the exchange rate changes across each of the modifying variables and to estimate the corresponding standard errors of the marginal effects.

growth effects are significant for a similar range of import exposure values across both samples. This result suggests that, on the import side, there are other relevant sources of productivity growth other than those which relate to economies of scale.

6 Conclusions

This paper investigates the effects of real exchange rate movements on labour productivity growth of Irish manufacturing firms through export and import exposures. The response of labour productivity growth through the export channel reflects changes in the firm's price competitiveness of exports in foreign markets. The import channel reflects changes in the cost of imported inputs due to real exchange rate changes. Real exchange rate movements also affect domestic firms' competitive position vis-à-vis import competition in the domestic market. The real exchange rate induced changes in profitability are likely to alter the firm's incentive to improve its labour productivity growth. The theoretical literature shows that the relationship between firm profitability and productivity is a complex one, with various models implying that both increases and decreases in profitability can have ambiguous changes in labour productivity. It is therefore an empirical question whether changes in the real exchange rate through each of the channels of exposure affect productivity growth.

In our empirical analysis, we provide novel evidence on the effect of changes in the real exchange rate on labour productivity growth in Irish manufacturing firms over the period 1997 to 2002. To identify the real exchange rate effects on labour productivity growth through the three channels mentioned above, we interact the real exchange rate change with (i) the share of export sales in total sales, (ii) the share of imported material input costs in total purchases and (iii) import competition. An important innovation in our analysis is the use of a firm-level real effective exchange rate which more accurately captures the heterogeneity of changes in a firm's international competitiveness. This measure is superior to more aggregate real effective exchange rate measures used in previous studies.

Our results suggest that, over the period 1997-2002, a real exchange rate appreciation reduces labour productivity growth once export exposure exceeds 14%. Our results suggest that plant utilisation of scale economies is one potential source for this real exchange arte induced labour productivity growth effect. We find that a real exchange rate appreciation on the import cost side increased labour productivity growth once the import exposure was above 33%. We find no effect of a real exchange rate change on labour productivity through the import competition channel. Also, the real exchange rate-induced productivity growth effects were not due to changes in investment growth.

Another potential source of the real exchange rate induced productivity growth effects is through firm innovation activity. In future work, we intend to examine whether changes in the real exchange rate influence the firm's decisions to (i) invest in innovation; (ii) how much to invest in innovation; and (iii) the type of innovation output to be created or adopted by the firm (i.e. product, process or organisational innovation).

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Tables

Table 1: Number and share of firms exporting and importing

	1997	1998	1999	2000	2001	2002	Mean
number of enterprises	657	1511	1437	1424	1205	1193	1238
share of enterprises exporting	0.66	0.58	0.58	0.62	0.63	0.62	0.62
share of enterprises importing	0.77	0.68	0.68	0.72	0.71	0.70	0.71
share of firms which export and import	0.57	0.48	0.48	0.54	0.54	0.53	0.52
share of firms which neither export or import	0.14	0.22	0.21	0.20	0.20	0.20	0.20

Table 2: Trade exposure measures

	1997	1998	1999	2000	2001	2002
share of export sales in total sales	0.42	0.37	0.36	0.36	0.47	0.48
standard deviation	0.33	0.32	0.32	0.33	0.38	0.38
share of imported material inputs in total inputs	0.49	0.47	0.46	0.45	0.51	0.53
standard deviation	0.31	0.31	0.32	0.32	0.34	0.35
share of imported material inputs in total purchases	0.24	0.23	0.23	0.22	0.25	0.25
standard deviation	0.18	0.18	0.19	0.19	0.20	0.20

Table 3: Number and Share of Exporters and Importers by Destination

	1997	1998	1999	2000	2001	2002	Mean
share exporters ex to uk	0.92	0.91	0.92	0.94	0.92	0.92	0.92
share exporters ex to eu	0.53	0.49	0.49	0.51	0.50	0.52	0.51
share exporters ex to usa	0.24	0.24	0.23	0.26	0.25	0.25	0.24
share exporters ex to row	0.34	0.28	0.26	0.32	0.31	0.27	0.30
share importers imp form uk	0.94	0.92	0.92	0.92	0.91	0.90	0.92
share importers imp from eu	0.59	0.54	0.56	0.60	0.61	0.61	0.59
share importers imp from usa	0.17	0.17	0.18	0.19	0.17	0.17	0.18
share importers imp from row	0.20	0.20	0.20	0.23	0.21	0.22	0.21

Table 4: Summary Statistics: Labour Productivity Growth

	1997	1998	1999	2000	2001	2002
All firms						
Mean	0.04	0.03	0.06	0.04	0.01	0.02
Standard deviation	0.24	0.25	0.29	0.32	0.28	0.28
25th percentile	-0.08	-0.09	-0.08	-0.10	-0.10	-0.09
Median	0.03	0.03	0.05	0.02	0.01	0.02
75th percentile	0.14	0.15	0.19	0.17	0.13	0.14
exporting and importing firms						
Mean	0.04	0.04	0.05	0.04	0.03	0.02
Standard deviation	0.22	0.26	0.26	0.31	0.27	0.29
25th percentile	-0.07	-0.09	-0.08	-0.10	-0.09	-0.09
Median	0.03	0.04	0.04	0.02	0.02	0.03
75th percentile	0.15	0.15	0.17	0.16	0.14	0.15
non-exporting and non-importing firms						
Mean	0.03	0.04	0.06	0.03	-0.03	0.00
Standard deviation	0.31	0.23	0.27	0.33	0.31	0.28
25th percentile	-0.09	-0.07	-0.08	-0.11	-0.13	-0.10
Median	0.06	0.04	0.05	0.02	-0.01	0.01
75th percentile	0.20	0.16	0.20	0.15	0.13	0.12

Table 5: Summary Statistics on Firm Level Import and Export Weighted Real Exchange Rates

	$\Delta reerx_{it}$	$\Delta reerm_{it}$
Mean	-0.010	-0.009
Standard deviation	0.043	0.043
25th percentile	-0.370	-0.040
Median	-0.017	-0.015
75th percentile	0.035	0.035

Table 6: Correlation between Firm Level Import and Export Weighted Real Exchange Rates

Year	Correlation
1997	0.09
1998	-0.01
1999	0.17
2000	0.07
2001	0.15
2002	0.08

Table 7: The Effect of Exchange Rate Changes on Labour Productivity Growth: Non-Linear Effects

	(1)
$\Delta reerx_{it}$	-0.262
	(0.186)
X_{it-1}	-0.021
	(0.028)
$\Delta reerx_{it} * X_{it-1}$	-0.278
	(0.253)
$\Delta reerm_{it}$	-0.194
	(0.155)
M_{it-1}	0.050
	(0.041)
$\Delta reerm_{it} * M_{it-1}$	1.350***
	(0.406)
$\Delta reerx_{k,t}$	-0.049
	(0.275)
$importcomp_{l,t-1}$	0.035
	(0.028)
$importcomp_{l,t-1} * \Delta reerx_{k,t}$	0.229
	(0.256)
$y_{i,t-1}$	-0.842***
	(0.024)
$herfindahl_{j,t-1}$	-0.065
	(0.084)
$\Delta skill_{i,t-1}$	0.012**
	(0.005)
$size_{i,t-1}$	0.033
	(0.026)
$X\_dum_{i,t-1}$	-0.013
	(0.015)
$M\_dum_{i,t-1}$	0.030**
	(0.013)
$industrygrowth_{k-i,t}$	-0.006
	(0.011)
Year dummies	Yes
Observations	7427
No of groups	1853
Adjusted R^2	0.390

Notes: The dependent variable is the annual logarithmic growth in real output per employee. The estimates were obtained with fixed effects OLS estimator. ***, **, * denote significance at the 1%, 5% and 10% level. Firm-level clustered robust standard errors are in the parenthesis. Detailed definition of variables is reported in Table 10

Table 8: The Effect of Exchange Rate Changes on Firm Investment Growth: Non-Linear Effects

	(1)
$\Delta reerx_{it}$	-0.260
	(1.167)
X_{it-1}	0.083
	(0.210)
$\Delta reerx_{it} * X_{it-1}$	-0.373
	(1.560)
$\Delta reerm_{it}$	-0.456
	(1.189)
M_{it-1}	-0.539*
	(0.327)
$\Delta reerm_{it} * M_{it-1}$	0.357
	(2.997)
$\Delta reerx_{k,t}$	1.322
	(1.857)
$importcomp_{l,t-1}$	-0.048
	(0.161)
$importcomp_{l,t-1} * \Delta reerx_{k,t}$	-2.488
	(1.903)
$y_{i,t-1}$	-0.245*
	(0.125)
$herfindahl_{j,t-1}$	-0.563
	(0.755)
$\Delta skill_{i,t-1}$	0.011
	(0.039)
$size_{i,t-1}$	-0.834***
	(0.150)
$X\_dum_{i,t-1}$	-0.094
	(0.112)
$M\_dum_{i,t-1}$	0.012
	(0.097)
$industrygrowth_{k-i,t}$	0.039
	(0.064)
Year dummies	Yes
Observations	5508
No of groups	1074
Adjusted R^2	0.015

Notes: The dependent variable is the annual logarithmic growth in real investment. The estimates were obtained with fixed effects OLS estimator. ***, **, * denote significance at the 1%, 5% and 10% level. Firm-level clustered robust standard errors are in the parenthesis. Detailed definition of variables is reported in Table 10

Table 9: The Effect of Exchange Rate Changes on Labour Productivity Growth: Non-Linear Effects, Low versus High Economies of Scale Industries

	Low EOS	High EOS
	(1)	(2)
$\Delta reerx_{it}$	-0.168	-0.448*
	(0.283)	(0.257)
X_{it-1}	-0.057	0.014
	(0.038)	(0.042)
$\Delta reerx_{it} * X_{it-1}$	-0.309	-0.191
	(0.331)	(0.414)
$\Delta reerm_{it}$	-0.239	-0.022
	(0.222)	(0.218)
M_{it-1}	0.127**	-0.054
	(0.056)	(0.058)
$\Delta reerm_{it} * M_{it-1}$	1.327**	1.044*
	(0.544)	(0.630)
$\Delta reerx_{k,t}$	0.140	-0.257
	(0.492)	(0.347)
$importcomp_{l,t-1}$	0.072	0.035
	(0.131)	(0.029)
$importcomp_{l,t-1} * \Delta reerx_{k,t}$	0.797	0.191
	(0.506)	(0.318)
$y_{i,t-1}$	-0.832***	-0.857***
	(0.036)	(0.034)
$herfindahl_{j,t-1}$	0.100	-0.184*
	(0.142)	(0.104)
$\Delta skill_{i,t-1}$	0.008	0.015**
	(0.007)	(0.007)
$size_{i,t-1}$	0.042	0.021
	(0.038)	(0.035)
$X\_dum_{i,t-1}$	0.026	-0.046***
	(0.025)	(0.018)
$M\_dum_{i,t-1}$	0.006	0.055***
	(0.019)	(0.018)
$industrygrowth_{k-i,t}$	0.002	-0.006
	(0.026)	(0.013)
Year dummies	Yes	Yes
Observations	3566	3859
No of groups	895	974
Adjusted R^2	0.384	0.401

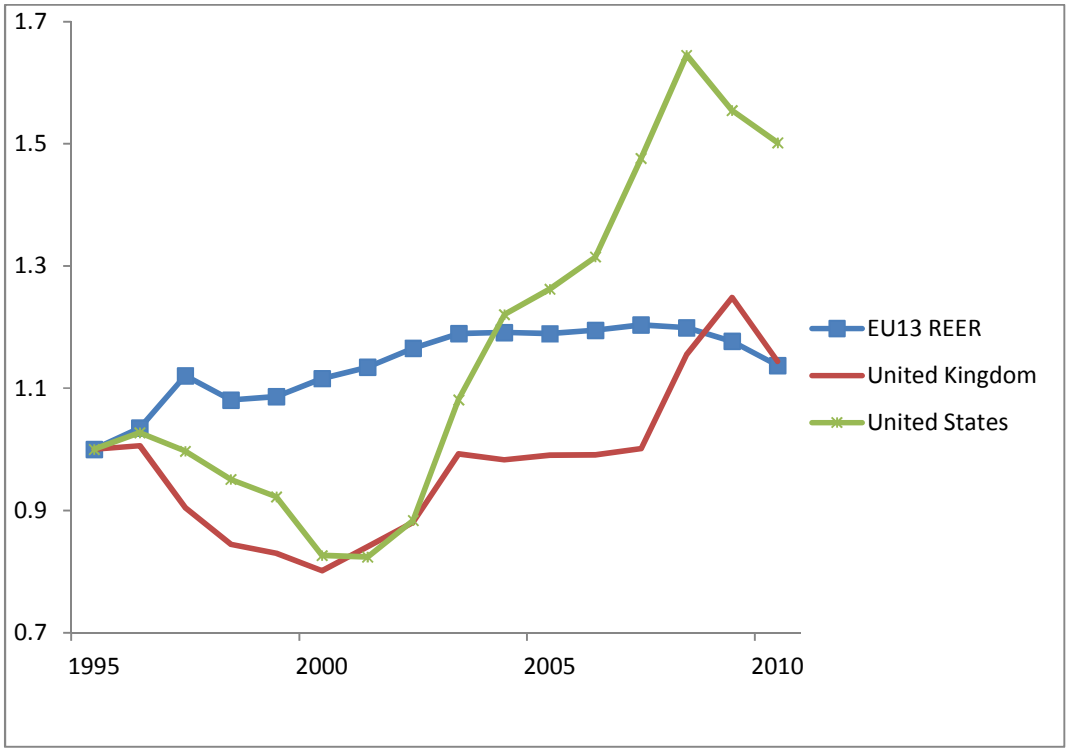
Notes: The dependent variable is the annual logarithmic growth in real output per employee. The estimates were obtained with fixed effects OLS estimator. ***, **, * denote significance at the 1%, 5% and 10% level. Firm-level clustered robust standard errors are in the parenthesis. Detailed definition of variables is reported in Table 10

Table 10: Definition of Variables Used in Regressions

Variable	Definition
$\Delta reerm_{it}$	Log growth in import-weighted real exchange rate in firm i in between period t-1 and t
M_{it-1}	Log of imported inputs exposure ratio in period t-1
$\Delta reermd_{it}$	Dummy variable equal to one if $\Delta rerm_{it}$is positive and 0 otherwise
X_{it-1}	Log of export exposure ratio in period t-1
$\Delta reerxd_{it}$	Dummy variable equal to one if $\Delta rerx_{it}$is positive and 0 otherwise
$\Delta reerx_{it}$	Log growth in export-weighted real exchange rate in firm i in between period t-1 and t
$y_{i,t-1}$	Log of real output in firm i in period t-1
$X\_dum_{i,t-1}$	Dummy variable equal to 1 if firm exports and 0 otherwise in period t-1
$M\_dum_{i,t-1}$	Dummy variable equal to 1 if firm imports and 0 otherwise in period t-1
$markup_{i,t-1}$	Firms price mark up in period t-1
$foreign_{i,t-1}$	Dummy variable equal to 1 if firm is foreign owned in period t-1and 0 otherwise
$industrygrowth_{k-i,t}$	Average real output growth in 3-digit industry k excluding firm i in period t
$\Delta skill_{i,t-1}$	Annual log growth in the ratio of managerial and technical employees to clerical employees in period t-1
$importcomp_{l,t-1}$	Measure of foreign import competition 2-digit industry l in period t-1
$\Delta reerx_{k,t}$	Average log growth in export-weighted real exchange rate in 3-digit industry k between period t-1 and t
$\Delta reerxd_{k,t}$	Dummy variable equal to one if $\Delta rerx_{k,t}$ is positive and 0 otherwise
Δinv_{it}	Log growth in real investment in firm i in between period t-1 and t

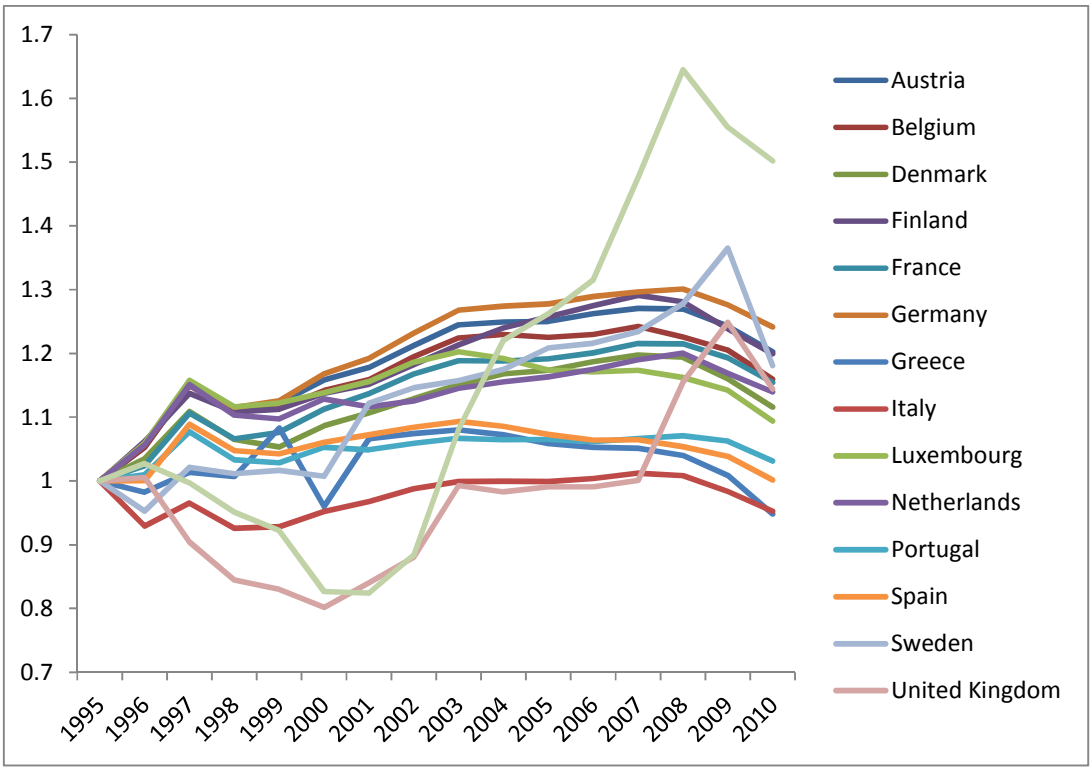
Figures

Figure 1: Ireland's Real Exchange Rate with UK, US and EU13, 1995-2010



Note Real exchange rate based on CPI indices, EU 13 REER is constructed by summing the weighed real exchange rate of each EU13 country, where the country weights are equal to the country average trade with Ireland as a percentage of Ireland's total trade to the EU13 region over the period. Data used was obtained from IFS.

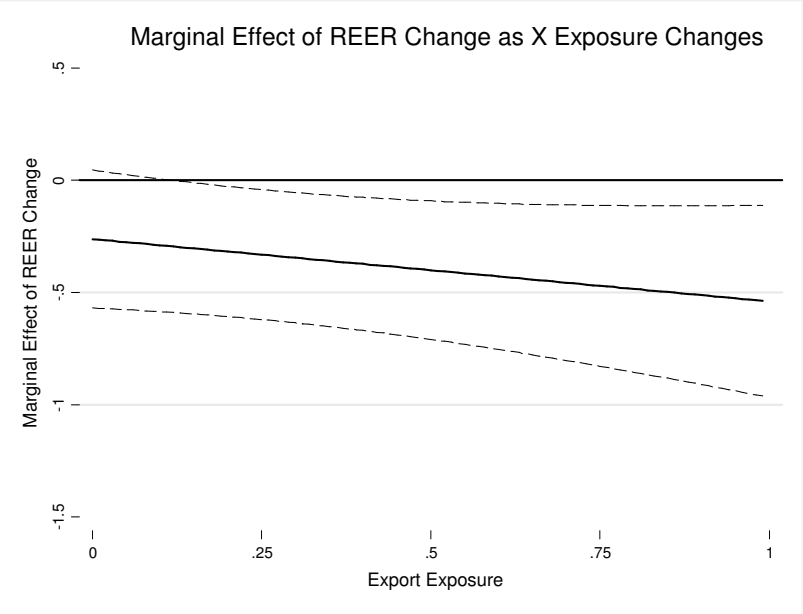
Figure 2: Ireland's Real Exchange Rate with Main Trading Partners, 1995-2010



Data source: IFS. Note: Real exchange rates based on CPI indices.

Figure 3: The Marginal Effect of an Exchange Rate Appreciation on Labour Productivity Growth as (i) Import and (ii) Export Exposures and (iii) Import competition change

(i)



(ii)

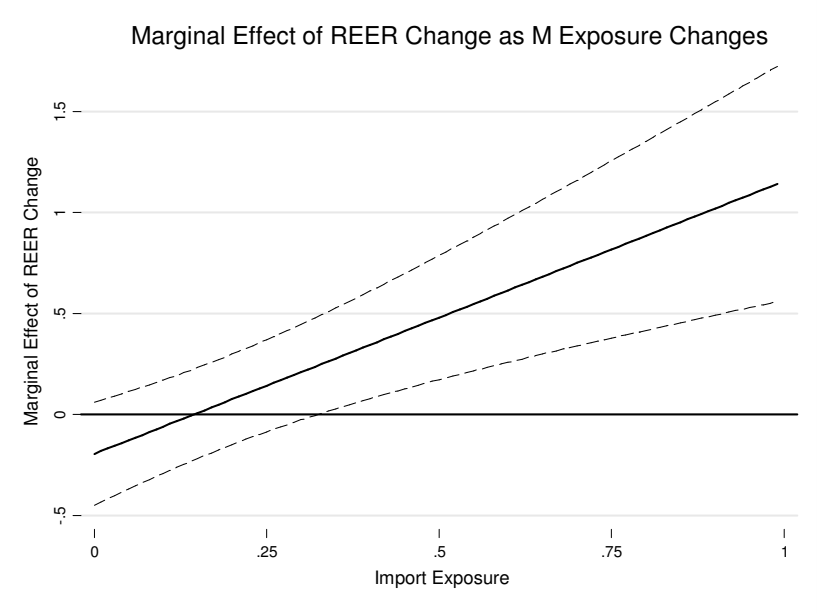
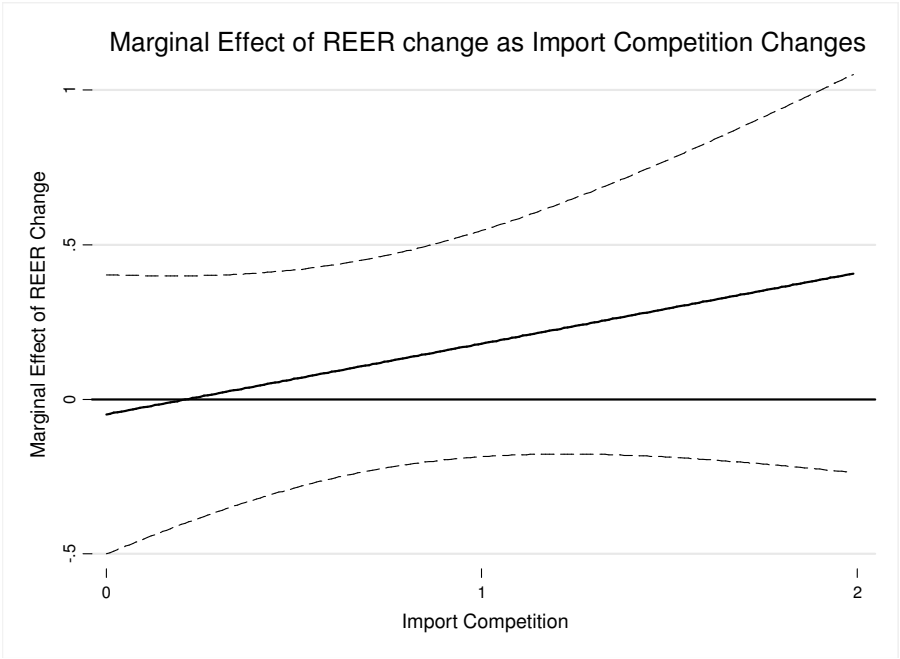


Figure 3 contd. The Marginal Effect of an Exchange Rate Appreciation on Labour Productivity Growth as (i) Import and (ii) Export Exposures and (iii) Import competition change

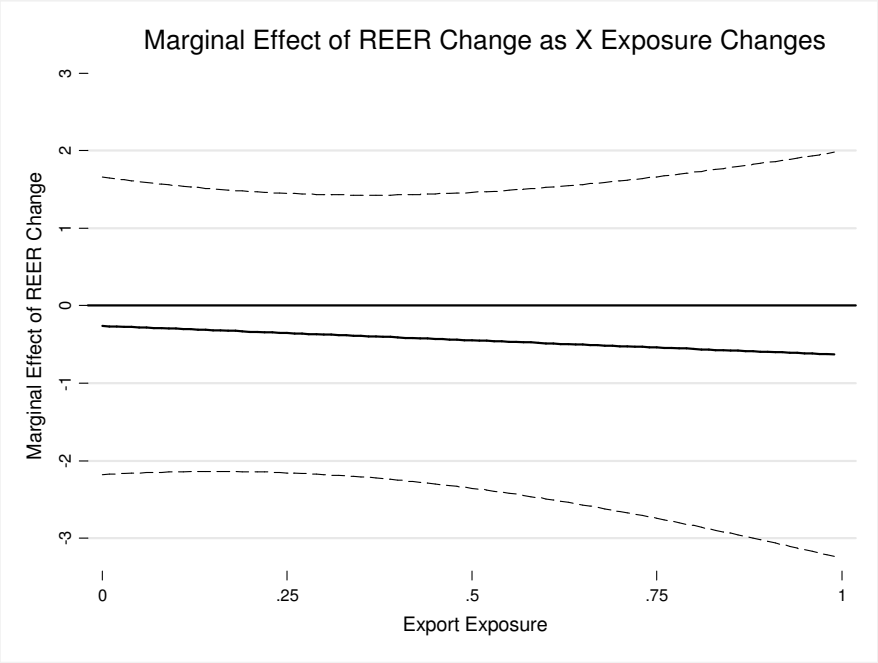
(iii)



Note: The solid sloping lines indicate the marginal effect of an exchange rate depreciation on labour productivity growth change across the range of values of import exposure. The marginal effect of a real exchange rate change is significant at the 10 % level once both the upper and lower confidence interval lines (i.e. dashed lines) are above or below the x-axis.

Figure 4: The Marginal Effect of a Real Exchange Rate Change on Investment Growth as (i) Export and (ii) Import Exposure and (iii) Import Competition Changes

(i)



(ii)

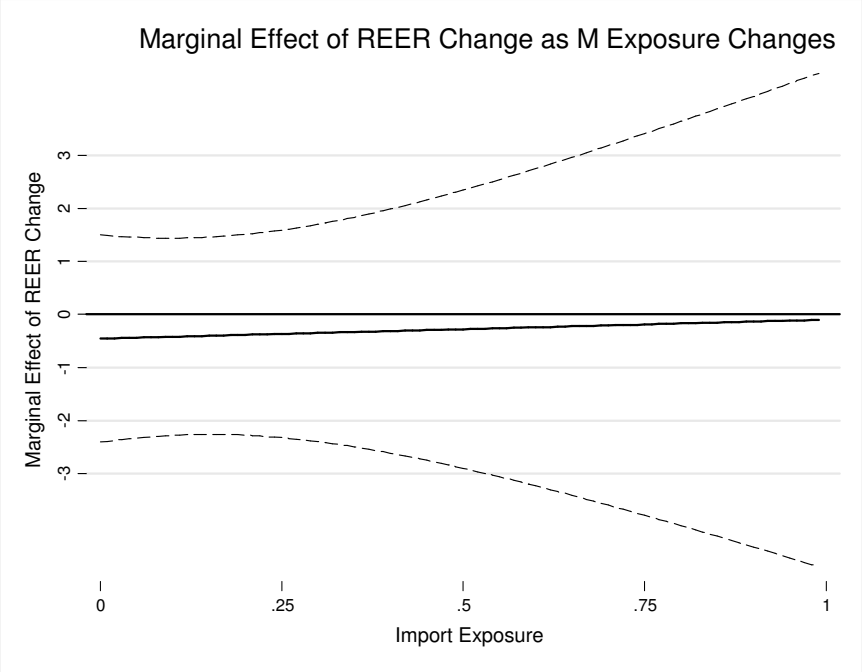
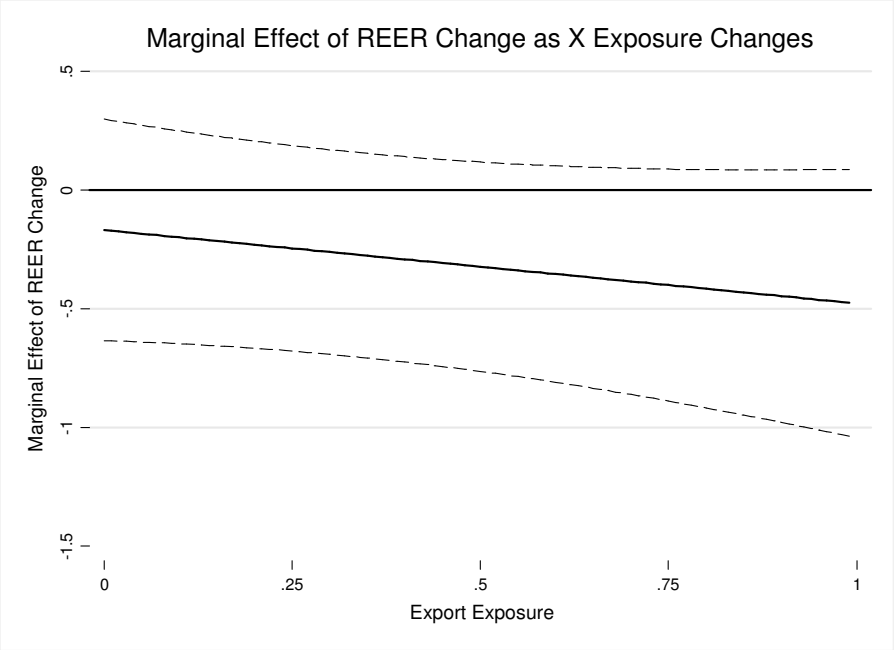


Figure 5 (a): The Marginal Effect of Real Exchange Rate Change as Export Exposure Changes, (i) Low versus (ii) High Economies of Scale Industries.

(i) Limited Economies of Scale Industry Sample



(ii) High and Medium Economies of Scale Industry Sample

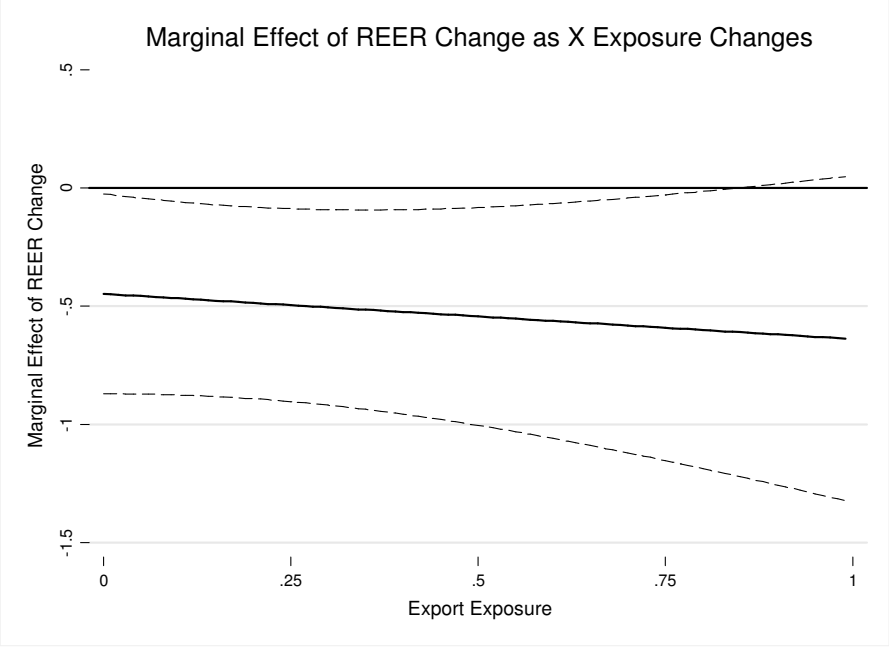
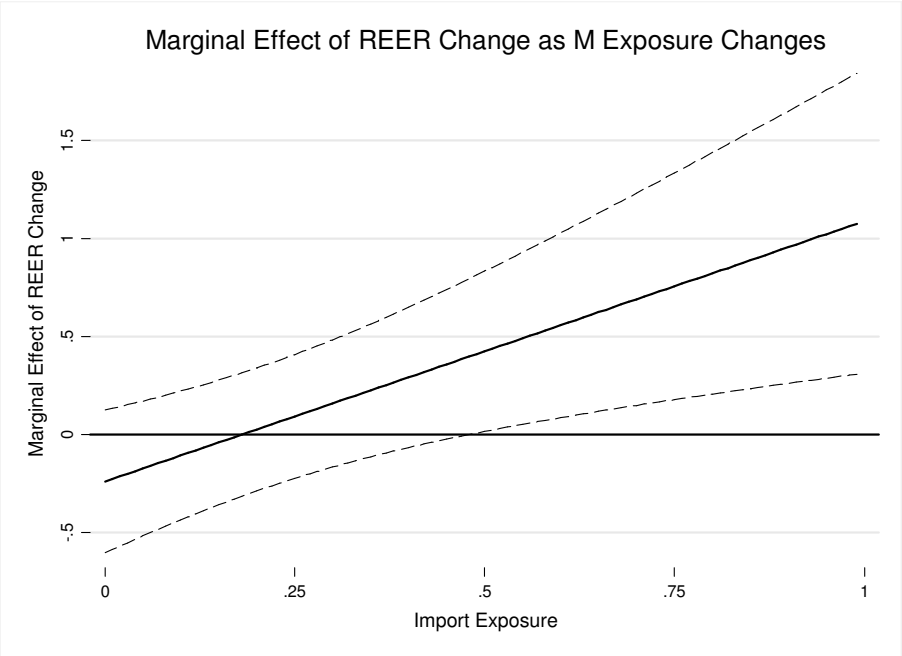
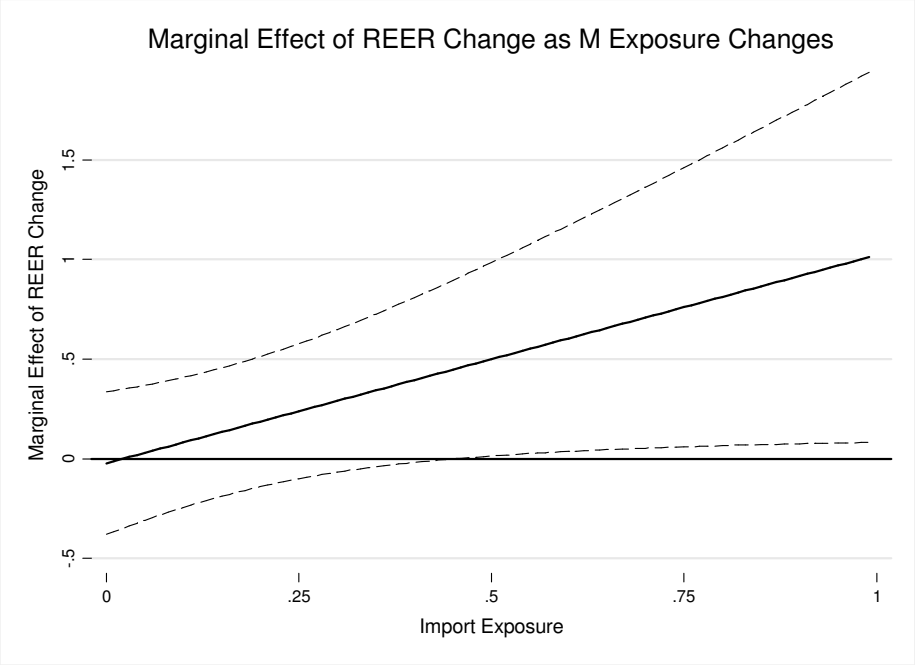


Figure 5 (b): The Marginal Effect of Real Exchange Rate Change as Import Exposure Changes, (i) Low versus (ii) High Economies of Scale Industries.

(i) Limited Economies of Scale Industry Sample



(ii) High and Medium Economies of Scale Industry Sample



Appendix

Table A 1: Variable Descriptions and Sources

Variable	Description	Source
Labour productivity growth	The log difference of real turnover per employee. Turnover is deflated using industry wholesale price deflators available from the CSO. Firm turnover was deflated to constant 2000 values using the most disaggregated industry level price available, i.e. 4-, 3-, or 2-digit price deflators, respectively.	CSO
Exports exposure	Total export sales value relative to total sales	CSO
Import exposure	Cost of imported material inputs relative to total expenditure (purchases plus labour costs)	CSO
Employees	Total number of people employed in the firm	CSO
Firm Size	The size variables are binary variables equal to one if the firm's average number of employed over the period is within a certain size range of employees and zero otherwise.	CSO
Firm-level export and import-weighted real exchange rate	The variables are described in detail in the main text	CSO; OECD; Central Bank of Ireland; Officer, 2011; WDI
Price cost margin	Total sales less total variable cost (wage bill plus materials and fuel expenditures) divided by total sales.	CIP
Import penetration	The value of imports divided by the value of production minus exports plus imports for industry j at the 2-digit level.	OECD STAN DATA

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2012		
	438	Consumption in Ireland: Evidence from the Household Budget Survey *Petra Gerlach-Kristen*
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