EFIGE IS A PROJECT DESIGNED TO HELP IDENTIFY THE INTERNAL POLICIES NEEDED TO IMPROVE EUROPE'S EXTERNAL COMPETITIVENESS

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Product adjustments: a firm-level analysis of the impact of a real exchange-rate shock

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European Firms In a Global Economy EFIGE

SEVENTH FRAMEWORK PROGRAMME

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ABSTRACT

Product adjustments: A firm-level analysis of the impact of a real exchange rate shock*

Using a new and extensive micro data set we investigate the impact of a change in international competitive pressure following a real exchange shock on multi-product firms' product mix. We only find weak evidence for the core competencies hypothesis, according to which, we would expect the exposed firms to reduce their product portfolio in response to the shock. But firms exposed to the shock significantly reduced their rate of product churning, relative to the control group of nonexposed firms. Moreover, we find a strong positive link between churning in the range of imported and exported products, suggesting that the product mix of imported inputs may be an important, but less understood, margin of adjustment.

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1 Introduction

Real appreciations are feared for their potential negative influence on profitability, investment and employment, but also believed to promote industrial restructuring and productivity growth as they strengthen competitive pressure. In Ekholm, Moxnes and Ulltveit-Moe (2007) we examined the impact of a change in competitive pressure following a sharp real appreciation of the Norwegian Krone in the early 2000s, and found that the shock led to productivity gains at the firm level.

But what were the sources of these productivity gains? We know that technological development, shedding of labor and increased capacity utilization played a role. What has so far not been examined is the role played by multi-product firms adjusting their portfolio of products in response to the shock. Access to detailed firm and trade data allows us to shed light on this particular channel. In doing so, we employ a rich data set for Norwegian manufacturing firms, their trade and their products. Not only are we able to investigate the development of firms' exports, but we are also able to link changes on the export side to changes on the import side.

Based on the empirical evidence on US manufacturing firms, we already know that the distribution of resources within firms reflected through the development of their product portfolio is influential in determining firm outcomes, see Bernard, Redding and Schott (2009a and 2006). Examining the extent to which an RER shock affects product adjustments, is also important as it allows us to get a better grasp of the forces that trigger reallocation and more efficient resource use within firms.

Our findings suggest that the RER shock induced firms to slow down or postpone the introduction of new products to the market, which translates to less adds to firms' product range and less firm-level product churning. Moreover, we see that churning was the firms' main margin of adjustment, not the *net* number of products exported. Hence, we only find support for a weak version of the core-competencies hypothesis put forward by Bernard, Redding and Schott (2006). Interestingly, we also find that there is a significant and positive link between firms' export product dynamics and import product dynamics. This suggests that the product mix of imported inputs may be an important, but less understood, margin of adjustment.

Our analysis contributes to three literatures. First, our paper is related to the new trade theory and heterogeneous firm model of Melitz (2003) that have been extended by Bernard, Redding and Schott (2006, 2009a, 2009b), Nocke and Yeaple (2006) and Mayer, Melitz and Ottaviano (2009) to incorporate multi-product firms. Closest to the present analysis are the papers by Bernard, Redding and Schott. They investigate the frequency, pervasiveness and determinants of product switching by US manufacturing firms. Moreover, analyzing the impact of trade liberalization on firms' product range, they find that reduced trade barriers induce firms to focus on their core competencies.

Second, our paper relates to the literature investigating the impact of RER shocks on firms' performance.[1] But with the exception of some recent contributions,[2] most of the literature on the impact of RER changes is based on industry-level analysis. In this paper, we apply a new and extensive micro data set for Norwegian manufacturing with detailed information on firms' exports as well as imports of intermediates. This allows us, in contrast also to previous firm-level studies, to calculate precise measures of trade exposure. In doing so, we are able to account for the heterogeneity across firms with respect to their net currency exposure – taking into account the share of exports in total output as well as the share of imported inputs in total costs – and thus to overcome one severe shortcoming of previous analyses of RER shocks; the lack of detailed, firm-specific measures of trade exposure. Moreover, detailed product information at the firm level allows us to investigate the product dimension of firms' adjustment to shocks, which to our knowledge has not been researched before.

[1] See e.g., Burgess and Knetter (1998), Branson and Love (1988), Campa and Goldberg (1995, 2001), Goldberg, Tracy and Aaronson (1999), Klein *et al.* (2003), Ekholm, Moxnes and Ulltveit-Moe (2007).

[2] See, e.g., Gourinchas (1999), Fung (2008), Fung and Liu (2008), Berman, Mayer and Martin (2009).

Finally, from a methodological point of view our paper is related to the studies of trade liberalization by Pavcnik (2002), Trefler (2004), and Bernard, Redding and Schott (2006), who – like us – base their analyses on difference-in-difference models.

The rest of the paper is organized as follows. In section 3 we present the data, describe the RER shock, and characterize multi-product firms. In section 3 we present the estimation strategy and the results on the effect of the RER shock on firms' product range. Finally, we examine the link between adjustments on the export side and firms' imports of intermediates. Section 4 concludes.

2 Data description

2.1 The panel

Our analysis is based on an exhaustive firm-level data set for the Norwegian manufacturing sector. The data set is based on several data sources. We use firm data from Statistics Norway's capital database, which is an unbalanced panel of all non-oil joint-stock companies[3] spanning the years 1996 to 2005, with approximately $8,000$ firms per year.[4] The panel provides information about total revenue, value added, employment, man hours, capital, total operating costs and intermediate costs, but not on firms' product lines. In 2005 the data set covered about 90 percent of manufacturing output in Norway.

Information about exports and imports is assembled from customs declarations. These data make up an unbalanced panel of all yearly exports and imports values by product and firm. The product *id* is based on the Harmonized System 8-digit (HS8) nomenclature. The trade data have been merged with the capital database, based on a unique firm identifier. The econometrics as well as descriptive statistics are based on a balanced panel of continuous exporters, defined as those firms exporting in the first and final year or the sample, comprising 1220 firms.[5]

In order to analyze the extent to which firms were hit by the real exchange rate shock, we calculate their *net currency exposure*, defined as the difference between the share of exports in sales and the share of imports in intermediates, reflecting the extent to which the shock is likely to affect firms' performance. In the Appendix we provide the theoretical background and details on the calculation of the net exposure variable.

Throughout the analysis net exposure is calculated based on 1996 data.[6] Median net exposure is approximately zero. In order to analyze the impact of the RER shock, we compare the activities and performance of firms with above median net exposure, with those with below median net exposure. Revenue weighted average net exposure was 12.1 percent in 1996, indicating that on average firms faced increased competitive pressure as a consequence of a real appreciation.

2.2 Exposure to the real exchange rate shock

Soon after the Central Bank of Norway adopted inflation targeting in March 2001, the real exchange rate appreciated by around 17 percent[7] (see Figure 4 in the Appendix). This had an adverse impact on exporting and import competing firms' profits and entailed increased competitive pressure. Out of approximately 8000 manufacturing firms, 31 percent were exporting and thus directly exposed to the

[3] The data set cover all joint-stock companies, which is the most common and preferred legal firm organization in Norway. The firms that are left out of the sample are in general very small.

[4] Statistics Norway's capital database is described in Raknerud *et al.* (2004).

[5] Since our main focus in this paper is on the product margin of trading firms, we abstract from firm entry/exit and export entry/exit.

[6] We evaluate the sensitivity of this approach in the results section.

[7] Measured by relative hourly wages costs for workers in manufacturing in Norway relative to major trading partners, denominated in a common currency. Other measures of the RER, e.g. from OECDs MEI (2008), show very similar trends. The nominal exchange rate (based on an importweighted index) fell by around nine percent.

shock. From 2001 to 2002 manufacturing exports fell by 9 percent, while it had been increasing every year from the early nineties, and again started to increase steadily from 2002 onwards.

Despite the RER shock and the fall in exports, from 2000 to 2004 labor productivity in Norwegian manufacturing increased by 24 percent. 73 percent of these productivity gains were linked to continuing firms rather than to exit and entry.[8] Empirical analysis has confirmed what the descriptives suggest, namely that productivity improvements were clearly linked to firms' trade exposure, see Ekholm, Moxnes and Ulltveit-Moe (2007). Figure 1 illustrates the link between firms' productivity growth and their exposure to the RER shock, controlling for size.[9] For both small and large firms, net exposed firms experienced significantly higher productivity growth in 2000-2004 relative to 1996-2000, compared to firms with below median net exposure.

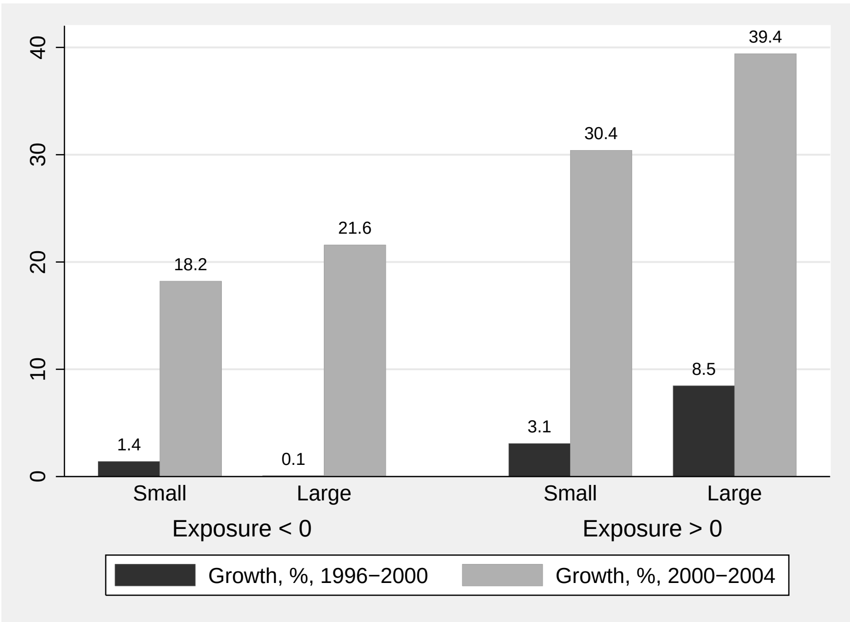

Figure 1: Average labor productivity growth, 1996-2000 and 2000-2004, by size and net exposure group.

2.3 Multi-product firms

Almost 90 percent of the exporting manufacturing firms were multi-product (MP) firms, i.e. exported more than one variety.[10] Table 1 offers an overview of the prevalence of multi-product firms depending on level of aggregation.

[8] See Ekholm, Moxnes and Ulltveit-Moe (2007).

[9] Size and exposure groups are based on 1996-data. Averages are weighted by employment shares. Small firms are defined as firms with less than 20 employees, while large firms have more than 20 employees.

[10] We define a variety as an HS 8-digit product, a product as an HS 5-digit product, and a sector as an HS 2-digit product. See Statistics Norway, http://www.ssb.no/english/subjects/09/05/nos_com_list/, for a description of the product categories.

Table 1: Prevalence of firms producing multiple varieties, products, sectors in 2004

Type of firm	% MP firms	% MP output	Mean products
Multiple sectors (2 digit)	75	94	5.19
Multiple products (5 digit)	85	96	12.37
Multiple varieties (8 digit)	87	97	14.05

Notes: Columns one and two summarize the share of MP firms and MP output respectively.
The final column reports the mean number of products across firms producing more than one each.
The population of firms is the set of firms exporting in both 1996 and 2004

Around half of the population of firms were more exposed to foreign markets through their exports than through their imports (> median net exposure). Figure 2 reports a breakdown of above and below median exposed firms into single and multi-product exporters.[11] The calculations are based on HS 8-digit categories. If we move up to a more aggregate classification level, the total share of multi-product firms is – not surprisingly – reduced, but not by more than around ten percent points.

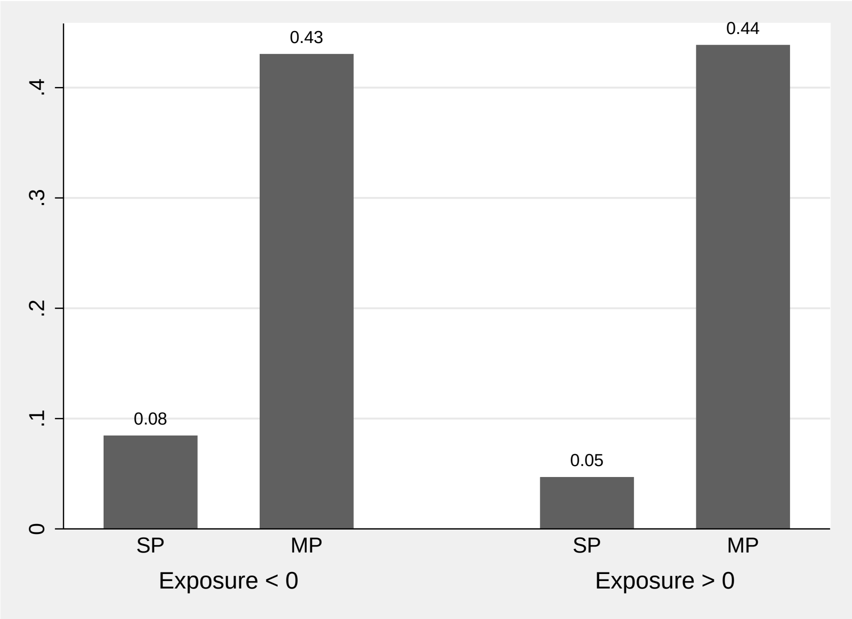

Figure 2: Share of firms according to exposure and number of products (HS 8)

Figure 2 illustrates that multi-product firms are not systematically different than single product firms with respect to net trade exposure. But multi-product firms differ from single product firms in other dimensions. Table 2 provides an overview of output, employment, real labor productivity and total factor productivity (see the Appendix for the definition of labor productivity and measurement of TFP). Multi-product (MP) firms tend to be around double the size of single product (SP) firms, and are up to sixteen percent more productive.[12] This finding is robust to the level of aggregation.

[11] The shares sum to one.

[12] Compared to evidence for US manufacturing (see Bernard et al, 2009) the difference between multi and single product firms is higher in Norway than in the US. This may however be explained by the fact that the US evidence is based on all manufacturing firms, while the evidence presented here is restricted to export firms.

Table 2: Multiproduct versus single product firm characteristics

Type of firm	Multiple Variety	Multiple product	Multiple Sector
Output	1.08^a	1.08^a	1.11^a
Employment	0.88^a	0.90^a	0.94^a
Labor productivity	0.11^a	0.10^a	0.10^a
TFP	0.16^a	0.15^a	0.16^a

Note: Results are from OLS regressions of log characteristics on a dummy variable, indicating the firms' status as well as industry and year fixed effects.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

The population of firms is the set of firms exporting in both 1996 and 2004

Interestingly, the multi-product premium related to output, employment and productivity increased from year 2000 to 2004, see Table 3. This suggests that multi-product firms might have restructured their activity more than single product firms in response to the RER shock. We know from Ekholm et al (2007) that productivity gains at the firm level were associated with labor shedding and increased tendency to outsourcing. But did multi-product firms also react to the shock by adjusting their product mix? To this we now turn.

Table 3: MP versus SP firm characteristics, before and after the RER-shock

Type of firm	Multiple Variety 2000	Multiple Variety 2004
Output	1.05^a	1.27^a
Employment	0.86^a	1.05^a
Labor productivity	0.07^b	0.10^b
TFP	0.11^a	0.16^a

Note: Results are from OLS regressions of log characteristics on a dummy variable, indicating the firms' status as well as industry fixed effects.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

The population of firms is the set of firms exporting in both 1996 and 2004

3 The impact of the RER-shock on product dynamics

3.1 Estimation Strategy

In order to investigate the influence of increased competitive pressure on the product mix, we rely on the heterogeneity of trade exposure across firms. This is the key feature that distinguishes our analysis from other studies attempting to quantify the effect of real exchange rate movements (see, e.g., Klein *et al.*, 2003; Gourinchas, 1999). It is also the feature that distinguishes the analysis from related studies on the impact of a change in competitive pressure due to trade liberalization (see, e.g., Pavcnik, 2002, and Trefler, 2004) or commodity prices (see Galdón-Sánchez and Schmitz, 2002, and Schmitz, 2005).[13]

To identify the causal effect of the RER shock on firms' product range and churning, we employ a simple differences-in-differences (DID) framework, reminiscent of the methodology used in Ekholm,

[13] For a discussion of the advantages of the chosen approach, see Ekholm, Moxnes and Ulltveit-Moe (2007).

Moxnes and Ulltveit-Moe (2007). The fundamental idea is to split firms according to their initial exposure to foreign markets. Hence we use the two groups defined above with above and below median exposure. We then proceed by analyzing the change in a set of outcome variables for these two groups. The DID framework allows us to control for time-invariant unobserved heterogeneity as well as common trends that affect both groups.

Let D_{it} denote a dummy variable for whether a firm was hit by an RER shock. Below we will specify the exact form of D_{it}. The observed outcome for firm i at time t is y_{it}, which can take two values, y_{0it} or y_{1it}. y_{0it} is the outcome if firm i is unaffected by the RER shock ($D_t = 0$), while y_{1it} is the outcome if firm i is affected by the shock ($D_t = 1$). We focus on the following outcome variables: $Adds_{it}$, $Drops_{it}$, $Churning_{it}$ and $Products_{it}$. We let $Adds_{it}$ and $Drops_{it}$ be defined as the number of exported varieties added or dropped for firm i from t to $t+1$. $Churning_{it}$ is simply the sum of $Adds_{it}$ and $Drops_{it}$, while $Products_{it}$ is the number of products exported at time t. Products are defined at the HS 8 digit level. Suppose that

$$E\left[y_{0it}|\gamma_t, A_i, X_{it}, D_{it}\right] = E\left[y_{0it}|\gamma_t, A_i, X_{it}\right], \tag{1}$$

i.e. that conditional on unobservable time invariant effects, A_i, observable time varying effects (defined below), X_{it}, as well as year effects, γ_t, the treatment variable D_{it} is as good as randomly assigned. Suppose further that $E\left[y_{0it}|\gamma_t, A_i, X_{it}\right] = \gamma_t + A_i + X_{it}\delta$ and that the effect of the RER shock is additive, $E\left[y_{1it}|\gamma_t, A_i, X_{it}\right] - E\left[y_{0it}|\gamma_t, A_i, X_{it}\right] = \rho$. In that case, the casual effect of the a shock in period t is identified as ρ in the following regression

$$y_{it} = \gamma_t + A_i + \delta X_{it} + \rho D_{it} + \varepsilon_{it} \tag{2}$$

The covariates in the vector X_{it} are employment (in terms of hours worked), capital stock and labor productivity (all in logs), as well as the number of products exported.[14]

We construct the treatment dummy D_{it} as the interaction between a year dummy ($Time_t$) and net exposure Λ_i, i.e. $D_{it} = (Time_t * \Lambda_i)$, and define $t = 1997$ as the omitted base year.[15] Exposure Λ_i refers to the firm's net exposure in 1996, the year before the first year of the panel, and takes the value of one if net exposure is positive, and the value of zero if exposure is negative.

ρ is a vector of DID coefficients to be estimated, one for each year. Hence the DID coefficient ρ_t measures the change in the outcome variable for the treatment group (firms with positive net exposure) from the base year 1997 to time t, relative to the change in the outcome variable for the control group (firms with negative net exposure). Our hypothesis is that ρ_t is significantly different from zero during the shock, but not prior to the shock. We include four years after the shock in order to account for possible lags in the adjustment to the shock.

Econometric issues: The DID approach relies on the identifying assumption that assignment to treatment (the interaction between year effects and exposure) is as good as random, conditional on unobserved time-invariant effects and observable time-varying covariates, summarized in equation (1). The assumption is violated if, for example, the trend growth in churning among the positively exposed is different from the growth among the negatively exposed even in the absence of the shock.[16] We minimize the risk of any such issues by using data for initial exposure, i.e. exposure from the year before the first year of the sample. Also, the use of both fixed effects and time varying firm covariates should minimize any remaining correlation between the error term and D_{it}. Third, in robustness checks below, we include a trend term in the regression, which would eliminate any spurious results due to different trends. Note

[14] Naturally, this control is dropped when $products_{it}$ is the outcome variable. We do not take the log of this variable because some firms have zero exported products.

[15] A simpler and more restricted model would be to define $D_{it} = 1$ when exposed firms enter the shock period, i.e. $\Lambda_i * shock_t$. Estimating such a model yields similar results.

[16] More precisely, that unobserved time-varying factors affect churning and those same factors also affect D_{it}.

that the use of time-specific DID coefficients ρ allows us to conduct a range of placebo experiments, since ρ should not be significantly different from zero in the years prior to the RER shock. This provides an indirect test of the identifying assumption.

3.2 Results

We estimate the model specified in (2) with $Adds_{it}$, $Drops_{it}$, $Churning_{it}$ and $Products_{it}$ as dependent variables. Starting with the outcome variable, the number of added products ($Adds_{it}$), Table 4 (Baseline model) shows that the estimated coefficient for the interaction term, ρ, is significantly negative for 2001. This suggests that the RER shock reduced the number of adds from 2001 to 2002, at the peak of the RER shock. The 2001-coefficient, at -1.03, means that above median exposed firms on average added roughly one product less from 2001 to 2002 compared to their adds in the base year 1997 and the control group of negatively exposed firms. The ρ's for other years are insignificant. It is especially reassuring to note that the ρ's prior to the RER shock are insignificant, indicating that exposure-specific trends in the outcome variable, unrelated to the RER shock, do not drive the results. Also note that the number of products exported is included in the vector of controls, so we are always comparing trends in the outcome variable for the above and below median exposed, conditional on the same number of products exported (and conditional on the firm fixed effect).

The result on the relationship between the RER shock and added products also proves to be robust to modifications. We explore a number of alternative econometric specifications. First, in order to check the sensitivity of the results to the vector of controls, we drop all time-varying covariates X_{it} in the regressions. Column (R2) in Tables 4 shows that the results are practically unchanged in this case.

Second, we check the sensitivity of the results to using net exposure (Λ_i) from the first year of the panel. Since firms may change their exposure status in the years prior to the shock, Λ_i might suffer from measurement error. An alternative approach is to use average exposure in the years prior to the shock, specifically, $\overline{\Lambda}_i = (1/5)\sum_{t=96}^{00} \Lambda_{it}$. The results are shown in column (R2) in Table 4. ρ_{2002} is negative and significant (at the 0.05 level). Hence, the reaction to the shock appears to be lagged by one year. However, in this specification simultaneity bias might be an issue, since in this specification $\overline{\Lambda}_i$ is no longer predetermined.

Third, we can check whether our results are robust to including a trend term. The trend term will control for systematic differences in the trend in the outcome variable between non-exposed and exposed firms. Specifically, we estimate the following regression: $y_{it} = \gamma_t + A_i + X_{it}\delta_1 + \delta_2 t_t \Lambda_i + \rho D_{it} + \varepsilon_{it}$, where t_t is the trend term. The results shown in column (R3) in Table 4 are very similar to the baseline and confirm that differential trends are not contaminating the estimates.

Fourth and finally, we estimate a model where (gross) export and import exposure are interacted with the year dummy separately, in addition to net exposure. Specifically, Λ_i^E is a dummy taking the value 1 if the firm's export share is higher than the median in the year prior to the start of the sample, and Λ_i^I is a dummy taking the value 1 if the firm's import share is higher than the median in the year prior to the start of the sample. We then include the interaction of Λ_i^E and year 2001 (the peak of the RER shock), as well as the interaction of and Λ_i^I with year 2001, in the regression. If export and import exposure independently influence the outcome variable, instead of net exposure, then the inclusion of these variables should kill the baseline DID estimate. As shown in column (R4) in Table 4, the strong ρ in 2001 remains, indicating that net exposure is indeed a useful concept for determining treatment and control groups.

Table 4: DID model. Outcome variable: Export Adds

	Baseline model		R1		R2		R3		R4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	-.55	(.33)	-.55^c	(.29)	-.72	(.44)	-.56^c	(.29)	-.55^c	(.33)
ρ_{99}	-.51	(.37)	-.56	(.36)	-.42	(.42)	-.48	(.32)	-.51	(.37)
ρ_{00}	-.27	(.46)	-.31	(.44)	-.59	(.49)	-.22	(.29)	-.27	(.46)
ρ_{01}	-1.03^a	(.42)	-1.04^a	(.40)	-.74	(.55)	-.96^b	(.43)	-1.50^a	(.47)
ρ_{02}	-.31	(.35)	-.33	(.36)	-.88^b	(.40)	-.23	(.34)	-.31	(.35)
ρ_{03}	-.37	(.45)	-.35	(.45)	-.69	(.52)	-.27	(.24)	-.39	(.45)
ρ_{04}	-.12	(.62)	-.09	(.62)	-.06	(.80)	-		-.11	(.63)
# obs	9370		9377		9370		9370		9370	
# firms	1218		1218		1218		1218		1218	
R-sq	.38		.0001		.38		.0001		.39	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

Moving on to the outcome variable, number of drops ($Drops_{it}$) we do not find any significant effect of the RER shock. This is also the case when we explore the four alternative econometric specifications outlines above. None of the estimated coefficients for the interaction term are significant, see Table 7 in the Appendix. The results for number of products ($Products_{it}$) are shown in Table 8 in the Appendix. The results suggest that the RER shock did not affect the net number of products exported.

As we move on to look at firms' churning of products ($Churning_{it} \equiv Adds_{it} + Drops_{it}$), the results in Table 5 suggest that there is a clear relationship between the RER shock and firm level product churning. The results from the baseline model are robust to the other econometric specifications. For all specifications except the model based on different exposure calculation (R2), the coefficient for the interaction term for 2001, ρ_{2001}, is significant and negative. In R2, we again see a lagged effect of the shock.

All in all, the RER shock induced firms to slow down or postpone the introduction of new products to the market, which translates to less firm-level product churning. Hence, *gross* churning was the firms' main margin of adjustment, not the *net* number of products exported.

Table 5: DID model. Outcome variable: Export Churning

	Baseline		R1		R2		R3		R4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	-.45	(.29)	-.28	(.18)	-.58	(.37)	-.43^{c}	(.25)	-.45	(.29)
ρ_{99}	-.28	(.38)	-.41	(.37)	-.27	(.42)	-.22	(.34)	-.27	(.38)
ρ_{00}	-.18	(.47)	-.43	(.40)	-.53	(.49)	-.09	(.34)	-.17	(.47)
ρ_{01}	-1.02^{a}	(.39)	-1.08^{b}	(.43)	-.86	(.57)	-.91^{b}	(.39)	-1.32^{a}	(.43)
ρ_{02}	-.23	(.36)	-.58	(.61)	-.87^{b}	(.38)	-.09	(.26)	-.23	(.36)
ρ_{03}	-.54	(.40)	-.59	(.58)	-.95^{b}	(.44)	-.38	(.27)	-.54	(.40)
ρ_{04}	-.19	(.57)	-.00	(.81)	-.39	(.63)			-.19	(.57)
# obs	9370		9377		9370		9370		9370	
# firms	1218		1218		1218		1218		1218	
R-sq	.86		.0005		.86		.08		.86	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

3.3 Is there a link between export and imports?

The majority of exporters are multi-product firms. However, 82 percent of the multi-product exporters in our balanced panel are also multi-product importers. In this section we examine how export product dynamics is correlated with import product dynamics. The left panel in Figure 3 shows the scatter between import and export adds, while the right panel shows the scatter between import and export drops.[17] The correlation in clearly positive, suggesting that churning on the output side is related to churning on the input side.

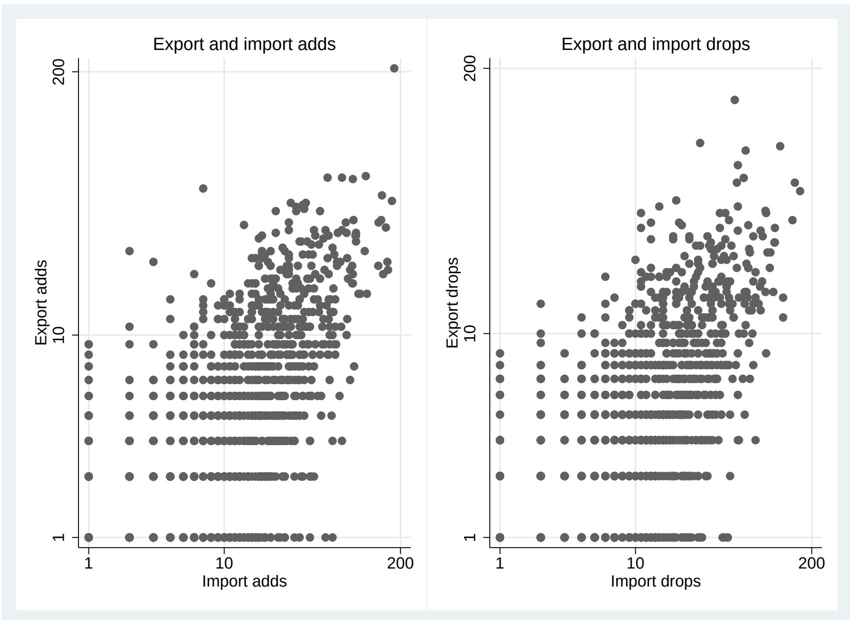

Figure 3: Linking exports and imports product dynamics.

[17] The figure is based on the balanced panel of exporters for 2004.

We run two fixed effects regressions to explore the relationship between changes in the product mix on the export and import side. We include the same controls ($\mathbf{X}_{it}$) as in the DID regressions, i.e. firm size (in terms of hours worked), capital stock and labor productivity (all in logs) as well as time dummies (γ_t):

$$Adds_{it}^E = \alpha_i + \gamma_t + \beta Adds_{it}^I + \boldsymbol{\delta}\mathbf{X}_{it} + \varepsilon_{it} \quad (3)$$

$$Drops_{it}^E = \alpha_i + \gamma_t + \beta Drops_{it}^I + \boldsymbol{\delta}\mathbf{X}_{it} + \varepsilon_{it} \quad (4)$$

where E = export and I = import. The results are reported in Table 6, and they show that there is a significant and positive link between firms' export and import product dynamics. Adds on the export side are associated with adds on the import side, and the same is true for drops. Even though these regression results do not allow us to conclude on the direction of causality, they do suggest that the product mix of the output and input side is intimately linked and furthermore that international production networks are widespread.

Table 6: Linking firms' export and import range

Dependent variable	Export Adds		Export Drops	
	Coef.	S.E.	Coef.	S.E.
Import Adds	.03[a]	(.01)		
Import Drops			.11[a]	(.01)
Year dummies	yes		yes	
Firm controls	yes		yes	
# obs	9552		9433	
# firms	1220		1216	
R-sq overall	.40		.47	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

Firm controls are identical to those used in the DID-analysis and described in section 4.1.

[a] significant at the .01 level, [b] significant at the .05 level, [c] significant at the .1 level

The interdependence between export and import product dynamics suggests that the adjustments on the export side in the aftermath of the shock should be reflected in adjustments on the import side. Therefore we ran the DID model again (see expression (2)), replacing export outcome variables with import variables instead (import adds, import drops, import churning and number of imported products).

In contrast to what we expected, based on the evidence on the close link between the export and import product mix, we did not find any significant effect of the RER shock on import product dynamics. The decline in adds and churning on the export side following the shock was not reflected on the import side, see Tables 9 and 10 in the Appendix.[18]

However, the lack of findings on the import side might be due to a set of counteracting forces. For almost all exporters the RER shock constituted a demand as well a supply shock: The appreciation reduced the firms' international competitiveness at the same time as imports of intermediates became cheaper. On the one hand, the demand shock hit firms' exports, and indirectly their imports, due to the reported link between export and import product mix. On the other hand, relatively cheaper imports should, all else being equal, encourage firms to import more products and services rather than sourcing these locally.

[18]Nor were import drops affected by the shock, see Table 11 in the Appendix.

Counteracting forces, with adjustments to the demand shock dominating in the short run, and adjustments to the supply shock dominating in the long run, may also explain the lack of a clear impact of RER shock on above median exposed firms' number of imported products, see Table 12 in the Appendix.

4 Concluding remarks

We expect firms to respond to the increased competitive pressure following a real appreciation. But despite there being numerous studies on the economic effects of real exchange rate shocks, there is still little evidence on the adjustment to such shocks at the firm level. Since firms within the same industry differ significantly in size, productivity, product range and trade exposure, firm level analyses are required in order to understand properly how the economy adjusts to real exchange rate shocks.

In this paper, we treat the sharp appreciation of the Norwegian Krone in the early 2000s as a natural experiment in order to assess the impact of a real exchange rate shock on firms' product range and dynamics. To identify the impact of the shock, we use firms' heterogeneous exposure to international markets. Our hypothesis is that those firms that are most exposed through their exports *ex ante* are the ones most affected by the shock in terms of increased competitive pressure.

Previous analysis of the same RER shock found that the shock was associated with substantial within-firm productivity gains for the net exporters, indicating that these firms responded to the tougher market conditions by improving efficiency. In this paper we ask whether part of these improvements were associated with dynamics in the product mix. We find that the firms facing the strongest increase in competitive pressure lowered their product churning rate during the shock. We interpret this as weak support for the core-competencies hypothesis put forward by Bernard et al (2006) and Mayer et al (2009). Moreover, we also find that there is a significant and positive link between firms' export product dynamics and import product dynamics. This suggests that the product mix of imported inputs may be an important, but less understood, margin of adjustment.

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A Appendix

A.1 Variables and definitions

The exhaustive firm-level data set for the Norwegian manufacturing sector is based on several data sources. It includes firm data from Statistics Norway's capital database, which is an unbalanced panel of all non-oil joint-stock companies spanning the years 1996 to 2005, with approximately $8,000$ firms per year. The panel provides information about total revenue, value added, employment, capital, total operating costs and intermediate costs. This panel is merged with another exhaustive firm-level data set for Norwegian manufacturing, containing information about exports and imports assembled from customs declarations. The trade data have then been merged with the capital database, based on a unique firm identifier.

- *Exports* denote the sum of a firm's export value across destinations.
- *Imports* denote the sum of a firm's import value of intermediates across sourcing countries.
- *Export exposure* is defined as export value relative to total revenue.
- *Import exposure* is defined as import value relative to total operating costs.
- *Net currency exposure* is defined as the difference between *Export exposure* and *Import exposure.*
- *Employees* and *firm size* refer to the number of persons employed in the firm.
- *Man hours* refers to the number of hours worked per firm per year.
- *Labor productivity* is measured as deflated value added divided by total number of hours worked.
- *Output deflators* refer to Statistics Norway's commodity price index for the industrial sector at the 3-digit NACE level.[19] Year 2000=100. There are separate indices for the domestic and export markets. Firm-level output deflators are calculated by deflating domestic and exported outputs separately.
- *Input deflators* refer to Statistics Norway's domestic commodity price index for domestic goods and the import deflator for imported inputs. Firm-level input deflators are calculated by deflating domestic and imported inputs separately.
- *Capital stock* is measured as annualized user cost of capital (including leased capital). The cost of capital is calculated as $R_{it}^k = (r + \delta_k)K_{it}^k$; where K_{it}^k is the real net capital stock of type k, for firm i at time t, k is either buildings and land (b) or other tangible fixed assets (o),[20] r is the real rate of return, which we calculated from the average real return on 10-year government bonds in the period 1996-2004 (4.2 percent), and k is the median depreciation rates obtained from accounts statistics. The total cost of capital is defined as $R_{it}^b + R_{it}^o$.
- *Relative hourly wage costs* for workers in manufacturing is a trade-weighted measure of relative wages measured in a common currency. The index is produced and updated annually by the Technical Calculating Committee on Income Settlements (Teknisk Beregningsutvalg, TBU).[21]

Further details on the variables in the firm database are provided by Raknerud, Rønningen and Skjerpen (2004).[22]

[19] http://www.ssb.no/english/subjects/08/02/20/ppi_en
[20] The latter group consists of machinery, equipment, vehicles, movables, furniture, tools, etc.
[21] http://www.regjeringen.no/nb/dep/aid/tema/Inntektspolitikk/rapporter-fra-tbu.html
[22] http://www.ssb.no/english/subjects/10/90/doc_200416_en/doc_200416_en.pdf

A.2 Price indices and measurement error

In most studies measuring productivity, output is deflated using industry-level price indices. A potential problem is that heterogeneous prices within sectors may bias the productivity measures and therefore lead to measurement error. For example, one might hypothesize that prices charged by highly-exposed firms decline in response to the shock, will incorrectly show up as a fall in output and productivity in the data, if our deflators are incorrectly measured.

We correct for potential measurement error by constructing deflators that reflect firms' exposure to foreign markets. We use three different price indices. The first two are producer price indices, one for exported goods (p^e_{jt}) and one for goods sold domestically (p^d_{jt}), both for all 3 digit NACE industries j. The third is an index for import prices p^i_{jt}, by 2 digit NACE. Given information about the firm's total sales, exports, total intermediate costs and imports, value added in constant prices has been constructed as $\begin{bmatrix} s_{it} & s^*_{it} & -v_{it} & -v^*_{it} \end{bmatrix} \mathbf{P}^{-1}_{jt} 100$, where s_{it} and v_{it} represent domestic sales and costs of domestically-sourced intermediates in current prices, and s^*_{it} and v^*_{it} represent foreign sales and costs of imported intermediates.[23] $\mathbf{P}_{jt}$ is the corresponding $(4x1)$ vector of price indices, $\mathbf{P} = \begin{bmatrix} p^d_{jt} & p^e_{jt} & p^d_{jt} & p^i_{jt} \end{bmatrix}'$.[24] Hence, value added in constant prices controls for the impact of the RER shock on prices for firms with a high export share.

A.3 Total factor productivity measurement

Total factor productivity (TFP) is estimated using the following value added production function: $y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \eta_{it}$; where y_{it} is deflated value added, k_{it} is deflated capital services, l_{it} is man hours (all in logs), ω_{it} is unobserved productivity and η_{it} is either measurement error or a shock to productivity which is not forecastable during the period in which labor can be adjusted.

OLS estimates of the production function are in most cases biased. First, if ω_{it} is observed by the firm before it chooses the optimal amount of labor and capital, ω_{it} will be correlated with l_{it} and k_{it}. Second, there may be selection bias because unobserved productivity may be correlated with the firm's exit decision.[25] We control for these two effects using Olley-Pakes (1996) techniques. We briefly describe the procedure, which consists of three stages. First, consider the investment (in logs) function $i_{it} = f(\omega_{it}, k_{it})$. Given that f is strictly increasing in ω_{it}, $\omega_{it} = f_t^{-1}(i_{it}, k_{it})$. The production function can then be written

$$y_{it} = \beta_l l_{it} + \phi_t (k_{it}, i_{it}) + \eta_{it} \tag{5}$$

where $\phi_t (k_{it}, i_{it}) = \beta_0 + \beta_k k_{it} + f_t^{-1}(i_{it}, k_{it})$. We approximate ϕ_{it} by a $4th$ order polynomial expansion with a full set of interactions. We allow the polynomial to vary over time by including year dummies as well as year dummies interacted with investment and capital.[26] OLS on equation (5) yields an unbiased estimate of β_l and the polynomial, $\phi_t (k_{it}, i_{it})$. β_k is unidentified as capital appears both linearly and in f_t^{-1}. Second, we find survival probabilities P_{it} by estimating a probit model of exit. Again, the regressors are a $4th$ order polynomial expansion along with year dummies. The third step of the estimation procedure uses the estimates of β_l, $\phi_t (k_{it}, i_{it})$ and P_{it} and substitute them into the

[23] s_{it} and v_{it} are calculated as total sales-exports and total intermediate costs-imports respectively. In a few cases s_{it} and v_{it} become negative due to data inconsistencies. These observations are dropped from the dataset.

[24] The price index for domestic intermediates equals the index for domestic output since price indices for intermediates are not available. Also, the price index for intermediate imports may not fully reflect the import content of sector j. However, we believe that this approximation is satisfactory since input-output tables show that most industries supply a major share of output to themselves. A more basic deflator using only price indices for the output side, constructed as $deflator_{it} = p^e_{jt} * \lambda_{it} + p^d_{jt} * (1 - \lambda_{it})$ yields similar results.

[25] For example, a firm's productivity and capital stock may jointly increase the probability of survival. Then, ω_{it} and k_{it} are negatively correlated in the selected sample. This creates a downward bias in the estimate of β_k.

[26] We choose the following periods: 1996-1998, 1999-2000, 2001-2002 and 2003-2004.

following equation

$$y_{it+1} - \beta_l l_{it+1} = \beta_k k_{t+1} + g\left(P_{it}, \phi_t - \beta_k k_t\right) + \xi_{it+1} + \eta_{it+1}$$

where $g()$ approximates $E\left[\omega_{it+1}|\omega_{it}, \chi_{it+1} = 1\right]$, which we choose to approximate by a $3rd$ order polynomial expansion in P_{it} and $\phi_t - \beta_k k_t = \omega_{it} + \beta_0$, including year dummies. Note that $\omega_{it+1} = g() + \xi_{it+1}$, so ξ_{it+1} represents the unanticipated part of firm productivity, which is mean independent of k_{t+1} (but not necessarily l_{t+1}). Since capital enters both linearly as separate input and inside $g()$, β_k is estimated by non-linear least squares. The TFP residuals are then calculated as $tfp_{it} = y_{it} - \widehat{\beta}_l l_{it} - \widehat{\beta}_k k_{it}$.

A.4 The real exchange rate shock

Figure 4: The Norwegian RER shock 2000-2002

A.5 Net exposure

The *net currency exposure* of a firm measures the extent to which a real exchange rate shock is likely to affect firms' performance. Consider revenue of a firm i: $R_i = p_i x_i + V p_i^* x_i^*$, where p_i and p_i^* are prices in local currency set at home and abroad, respectively, x_i and x_i^* are sold quantities at home and abroad, respectively and V is the nominal exchange rate expressed as units of domestic currency per unit of foreign currency. We can rewrite revenue as $R_i = \left(x_i + x_i^*/P_i\right) p_i$, where P_i is the real exchange rate (RER), $P_i \equiv p_i / V p_i^*$. An increase in P_i implies a real appreciation. The elasticity of revenue with respect to P_i is

$$\frac{\partial R_i}{\partial P_i}\frac{P_i}{R_i} = -\frac{V p_i^* x_i^*}{R_i} \equiv -\lambda_i \tag{6}$$

i.e. it is equal to the firm's export share. For given output and prices, a one percent real appreciation decreases total revenue with λ_i percent.

Symmetrically, we can define firm i's costs as $C_i = q_i v_i + V q_i^* v_i^*$, where q_i and q_i^* are prices in local currency of domestic and imported inputs, respectively, and v_i and v_i^* are used quantities of domestic and imported inputs, respectively. We can rewrite costs as $C_i = \left(v_i + v_i^*/Q_i\right) q_i$, where $Q_i = q_i / V q_i^*$. The elasticity of costs with respect to Q_i is

$$\frac{\partial C_i}{\partial Q_i}\frac{Q_i}{C_i} = -\frac{V q_i^* v_i^*}{C_i} \equiv -\widetilde{\lambda}_i \tag{7}$$

i.e. it is equal to the share of imported inputs in total costs. For given inputs and prices, a one percent real appreciation decreases total costs by $\widetilde{\lambda}_i$ percent.

Suppose $P_i = Q_i$, implying that the RER measured by output prices is equal to the RER measured by input prices. Then the elasticity of profits (Π_i) – revenues minus costs – with respect to a change in the real exchange rate can be expressed as:

$$\begin{aligned} \frac{\partial \Pi_i}{\partial P_i}\frac{P_i}{\Pi_i} &= \frac{P_i}{\Pi_i}\left(\widetilde{\lambda}_i \frac{C_i}{P_i} - \lambda_i \frac{R_i}{P_i}\right) \\ &= -\lambda_i - \frac{(\lambda_i - \widetilde{\lambda}_i)}{\Pi_i/C_i} = -\widetilde{\lambda}_i - \frac{\left(\lambda_i - \widetilde{\lambda}_i\right)}{\Pi_i/R_i}. \end{aligned} \tag{8}$$

Define the *net currency exposure* as the difference between the share of exports in sales and the share of imports in intermediates, $\Lambda_i \equiv \lambda_i - \widetilde{\lambda}_i$. Throughout the analysis net exposure is based on 1996 data. A positive net currency exposure ($\Lambda_i > 0$) implies that the effect on profits of a real appreciation (a rise in P_i) is negative.[27] The greater the net currency exposure, the more negative the impact on profits of an increase in P_i, the higher the probability of closure, and, thus, the greater the increase in competitive pressure resulting from the RER shock.

There are a few potential problems with our identification of currency exposure: (i) Even if $\Lambda_i = 0$, the firm may be exposed because revenues and costs are denominated in different currencies. However, for our analysis this is probably less of a problem, since the RER appreciated similarly against most countries. (ii) We do not observe the use of financial derivatives, i.e. to what extent firms hedge currency risk. However, we believe that this will not seriously bias our measure because survey evidence suggests that long-term (> 3 years) currency hedging is relatively uncommon.[28] Also, firms can only hedge against nominal currency shocks, not relative output or input price movements.

[27] Three features of (8) are worth noting: (i) Net exposure is divided by profit relative to revenue or sales. The profit effect of high-profit firms are, all else being equal, less sensitive to the net currency exposure to a real appreciation.(ii) Profits are affected by RER movements even for a firm with zero net exposure. This is because, as long as profits are positive, revenue is higher than costs. So, a one per cent depreciation will have a larger effect on revenues than on costs.(iii) The elasticity of profits is zero when $\widetilde{\lambda}_i\,(C_i/R_i) = \lambda_i$, so $\widetilde{\lambda}_i > \lambda_i$ for a firm with positive profits. Again, this is related to the point above, that the optimal import share is higher than the export share because revenue is higher than costs.

[28] See Norges Bank (the Norwegian Central Bank): "Penger og Kreditt" 1/2005.

A.6 Tables

Table 7: DID model. Outcome variable: Export Drops

	Baseline		R1		R2		R3		R4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	.07	(.10)	.32	(.31)	.17	(.14)	.06	(.11)	.07	(.10)
ρ_{99}	.21	(.16)	.20	(.26)	.14	(.17)	.20	(.17)	.21	(.16)
ρ_{00}	.07	(.12)	-.17	(.28)	.06	(.18)	.04	(.14)	.07	(.12)
ρ_{01}	-.00	(.15)	-.06	(.27)	-.12	(.18)	-.04	(.15)	.18	(.18)
ρ_{02}	.06	(.15)	-.34	(.37)	.02	(.20)	.02	(.21)	.06	(.15)
ρ_{03}	-.18	(.14)	-.25	(.40)	-.25	(.24)	-.23	(.14)	-.18	(.14)
ρ_{04}	.06	(.20)	.05	(.37)	-.18	(.30)			.06	(.20)
# obs	9552		9561		9552		9552		9552	
# firms	1220		1220		1220		1220		1220	
R-sq	.89		.00		.89		.55		.89	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

Table 8: DID model. Outcome variable: Number of exported products

	Baseline		R1		R2		R3		R4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	.41	(.40)	.40	(.40)	1.03^b	(.41)	.42	(.38)	.41	(.40)
ρ_{99}	-.02	(.34)	-.04	(.35)	.66	(.46)	.01	(.34)	-.02	(.34)
ρ_{00}	-.32	(.45)	-.38	(.45)	.72	(.49)	-.28	(.39)	-.32	(.45)
ρ_{01}	-.14	(.40)	-.09	(.41)	.55	(.61)	-.07	(.27)	-.02	(.48)
ρ_{02}	-.69	(.59)	-.64	(.58)	.37	(.80)	-.61	(.38)	-.69	(.59)
ρ_{03}	-.25	(.72)	-.11	(.67)	.21	(.88)	-.16	(.44)	-.25	(.72)
ρ_{04}	-.11	(.82)	-.00	(.74)	.61	(1.06)			-.11	(.82)
# obs	9552		9561		9552		9552		9552	
# firms	1220		1220		1220		1220		1220	
R-sq	.22		.00		.22		.00		.22	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

Table 9: DID model. Outcome variable: Import Adds

	Baseline		R1		R2		R3		R4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	-.22	(.43)	-.13	(.42)	-.51	(.54)	-.16	(.42)	-.22	(.43)
ρ_{99}	.16	(.56)	.23	(.52)	.30	(.62)	.29	(.47)	.16	(.56)
ρ_{00}	.14	(.65)	.29	(.66)	-.15	(.82)	.33	(.65)	.14	(.65)
ρ_{01}	-.68	(.53)	-.49	(.51)	-1.08^{c}	(.64)	-.43	(.53)	-.56	(.63)
ρ_{02}	.77	(.63)	.97	(.60)	-.15	(.77)	1.08^{c}	(.58)	.76	(.63)
ρ_{03}	-.38	(.75)	.02	(.70)	-.53	(.94)			-.38	(.75)
ρ_{04}										
# obs	8239		8246		8239		8239		8239	
# firms	1215		1215		1215		1215		1215	
R-sq	.81		.00		.81		.03		.81	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

Table 10: DID model. Outcome variable: Import Churning

	Baseline		R1		R2		R3		R4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	-.06	(.40)	.33	(.63)	-.21	(.52)	-.11	(.42)	-.06	(.40)
ρ_{99}	.14	(.53)	.55	(.74)	.38	(.62)	.04	(.48)	.13	(.53)
ρ_{00}	.09	(.60)	.94	(.87)	-.26	(.69)	-.04	(.63)	.09	(.60)
ρ_{01}	-.87	(.58)	.02	(.82)	-1.23^{b}	(.58)	-1.06^{c}	(.56)	-.62	(.67)
ρ_{02}	.70	(.69)	1.51	(.93)	-.15	(.76)	.47	(.55)	.70	(.69)
ρ_{03}	.27	(.64)	1.92^{b}	(.85)	.01	(.81)			.27	(.64)
ρ_{04}										
# obs	8239		8246		8239		8239		8239	
# firms	1215		1215		1215		1215		1215	
R-sq	.94		.00		.94		.32		.94	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

Table 11: DID model. Outcome variable: Import Drops

	Baseline		R1		R2		R3		R4	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	.19	(.30)	.60	(.58)	.34	(.35)	.13	(.29)	.19	(.30)
ρ_{99}	-.06	(.32)	.39	(.73)	-.01	(.37)	-.18	(.29)	-.06	(.33)
ρ_{00}	-.09	(.26)	.67	(.57)	-.17	(.32)	-.27	(.22)	-.09	(.26)
ρ_{01}	-.22	(.43)	.67	(.74)	-.23	(.48)	-.47	(.39)	-.11	(.44)
ρ_{02}	-.16	(.31)	.47	(.66)	-.15	(.38)	-.47^c	(.25)	-.16	(.31)
ρ_{03}	.58^c	(.33)	1.94^a	(.71)	.44	(.41)	.22	(.26)	.58^c	(.33)
ρ_{04}	.43	(.35)	1.22^c	(.68)	.28	(.40)			.43	(.35)
# obs	9552		9561		9552		9552		9552	
# firms	1220		1220		1220		1220		1220	
R-sq	.94		.00		.94		.11		.94	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level

Table 12: DID model. Outcome variable: Number of imported products

	Baseline		R1		R2		R3		R4	
	Coef.	S.E93).	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
ρ_{98}	.93	(.67)	.87	(.71)	1.07	(.81)	.73	(.65)	.93	(.67)
ρ_{99}	1.10	(.93)	.94	(.93)	1.06	(1.10)	.70	(.86)	1.10	(.93)
ρ_{00}	1.66^b	(.77)	1.47^c	(.79)	1.71	(1.03)	1.06	(.69)	1.66^b	(.77)
ρ_{01}	1.73^c	(.909)	1.80^c	(.98)	1.61	(1.09)	.93	(.80)	1.23	(1.08)
ρ_{02}	1.12	(1.07)	1.31	(1.07)	.61	(1.18)	.12	(.91)	1.12	(1.07)
ρ_{03}	2.44^b	(1.03)	2.79^b	(1.13)	1.30	(1.39)	1.24^b	(.60)	2.44^b	(1.03)
ρ_{04}	1.40	(.95)	1.69	(1.07)	.78	(1.38)			1.40	.95
# obs	9552		9561		9552		9552		9552	
# firms	1220		1220		1220		1220		1220	
R-sq	.40		.00		.39		.00		.39	

Notes: Standard errors clustered by industry (2 digit). Aggregation level: HS8.

R1: No controls. R2: Average pre-shock exposure (average 1996-2000) instead of initial exposure.(1996).

R3: Trend term included. R4: Export and import exposure, interacted with shock year, included.

^{a} significant at the .01 level, ^{b} significant at the .05 level, ^{c} significant at the .1 level