Firm-level volatility and exports

Gonzague Vannoorenberghe *

Tilburg University and CentER

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Abstract

This paper looks at the relationship between trade openness and sales volatility at the firm level. The analysis builds on a two-country monopolisitic competition model of trade in which firms face demand uncertainty on their domestic and export markets as well as convex costs of production in the short run. The paper has three main conclusions, which I test empirically using the Amadeus dataset for France between 1998 and 2007. First, exporting firms substitute sales in the short run between their domestic and export markets. A firm facing an unexpectedly high demand shock in one market finds it optimal to raise its sales there and to reduce its sales in the other market. I identify this effect in the data both for firms which continuously export and for those which enter and exit the export market. Second, as a direct consequence of the short run substitution between markets, I show that a firm's openness raises the volatility of its domestic sales but stabilizes its exports. Third, I show that the global sales of firms which export less than 10% of their output are less volatile than these of comparable non-exporters, while very open exporters appear more volatile. This suggest both that exporters benefit from a diversification effect and that the export activity comes with substantial additional volatility.

Keywords: firm-level volatility, trade openness

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*Tilburg University, Room K 420 PO Box 90153 5000 LE Tilburg, Netherlands. Tel. +31 13 466 2511, e-mail:G.C.L.Vannoorenberghe@uvt.nl. I would like to thank Eckhard Janeba, as well as participants to the Brussels workshop in international trade, the ETSG in Rome and the SIUTE seminar in Lille for very useful comments.

1 Introduction

The opinion that trade acts as a source of economic volatility seems to gain importance in the popular debate with each recession. Politicians periodically face - or trigger - demands for increased protectionism to shield domestic consumers and firms from foreign shocks. The importance of the trade volatility relationship for the political debate has been matched in the last decade by a growing scientific interest for the question. A large literature, starting with Rodrik (1998), has examined this link empirically. Most studies find that openness to trade indeed raises macroeconomic volatility (Easterly et al. (2001), Kose et al. (2003)), though this result has been qualified by others (Bejan (2006), Cavallo (2007))[1]. However, virtually no work investigates the precise transmission mechanisms of volatility between markets, which largely remain a black box. One reason is that the standard approach has taken a purely macroeconomic perspective, leaving aside more disaggregated levels of analysis, in particular firm behavior. The relationship between trade openness and volatility at the firm level remains largely unexplored, though it may provide a better understanding of the mechanisms at stake.

The main contribution of the present paper is to address these problems by taking two innovative steps. First, I develop a partial equilibrium model of trade which allows to analyze the firm-level relationship between trade openness and different components of sales volatility. Second, I test the prediction of this model and quantify it using comprehensive information on the balance sheet of French firms between 1998 and 2007 (the Amadeus dataset).

The theoretical analysis builds on a model of trade with demand uncertainty to examine the impact of market-specific demand shocks on the production and export volumes of firms. I use a two-country monopolistic competition framework with heterogeneous firms, but depart from the literature in two important ways. First, firms are heterogeneous with respect to their openness level, defined as the ratio of exports to global sales. It is a consequence of the different tastes for a firm's product on its domestic and foreign markets and allows to generate predictions linking the openness level of a firm and its volatility. Second, firms produce with convex costs in the short run and face demand shocks on the domestic and foreign markets. These shocks are imperfectly correlated and induce exporting firms to substitute sales between

[1]This literature also characterizes the effect of other dimensions of globalization, such as capital market liberalization, on output volatility. The focus of the present paper is exclusively on trade in goods. For the effect of financial development on the volatility of firms, see for example Thesmar and Thoenig (2005).

the domestic and the export market in the short run[2]. For example, an exporter facing a positive demand shock on its home market will sell less on its export market in order to take profit of the favorable domestic conditions. This mechanism provides a new channel through which shocks spread between markets and yields a number of sharp predictions for the link between the openness level of a firm and the different components of the volatility of its sales.

The main conclusions of the paper are threefold. First, exporting firms substitute sales in the short run between their domestic and export markets. I show theoretically and empirically that a higher than average sales growth in one market is associated with a lower than average growth in the other. This result holds both for firms which continuously export and for those which only do so occasionally. Second, exporters with a high openness level have in equilibrium more volatile domestic sales and less volatile exports than exporters with a low openness level. It is a direct consequence of the market substitution highlighted above: demand shocks induce a sales substitution which is proportionally small for the larger market and large for the smaller market. The empirical analysis confirms the quantitative importance of this effect. Third, I show that exporting firms with an openness level above 10% are more volatile than comparable non exporters, suggesting that the exporting activity is inherently volatile. Firms with an openness level below 10% are, on the other hand, less volatile than comparable non-exporters, which is consistent with a standard diversification argument.

The present model is related to different strands of the literature.

From the modeling perspective, it borrows from the recent and growing literature on heterogeneous firms in trade, in the line of Melitz (2003). An important difference with most of the existing papers is that firm heterogeneity does not come from different productivity levels but from the taste parameters for varieties in the utility function, as in Crozet et al. (2007). This modeling strategy allows exporting firms to have different levels of openness, as long as they receive two uncorrelated taste parameters for their product in the domestic and export market.

The relationship between openness and volatility has been extensively studied in the last decade. Most studies investigate it at the country level using cross-section or panel data and find that trade and financial openness are positively

[2]As will be shown in Appendix, the model is robust to alternative types of shocks, such as changes in transportation costs or in productivity. The analysis concentrates on demand shocks for convenience but all results could be replicated by a combination of firm-level productivity shocks combined with shocks in the costs of trade.

correlated with the volatility of output growth (Rodrik (1998), Easterly et al. (2001), Kose et al. (2003)). This result has however been qualified by a number of works: Bejan (2006) shows that the correlation depends on the level of development of countries, Bekaert et al. (2006) find that financial liberalization reduces consumption volatility, and Cavallo (2007) argues that trade openness reduces output volatility due to its dampening effect on financial volatility. di Giovanni and Levchenko (2009) interestingly go one step further and distinguish the effects of trade openness on sector level volatility, on the comovement between sectors and on country specialisation. They find that the overall effect of openness is to increase output volatility.

A number of recent works, such as Comin and Philippon (2005), Davis et al. (2006) and Buch et al. (2008), examine the evolution of firm-level output volatility over time and provide interesting insights on the factors influencing it. They however do not relate firm volatility to trade openness. Buch et al. (2009) is to my knowledge the only paper studying the link between openness and output volatility at the firm level. Using two German firm-level datasets, they point to a rather weak relationship between the two, and suggest that the sales of exporting firms may be less volatile than those of non-exporters. However, they cannot address the predictions of the present paper, since they assume that firms ship a constant exogenous share of their output to each market. Their analysis moreover suffers from data limitations, as their Germany-wide dataset does not include information on openness at the firm level.

I develop the model in section 2 and highlight its predictions for firm-level growth and volatility in section 3. I describe the data in section 4 and test the empirical predictions of the model in section 5. Section 6 addresses some robustness issues and section 7 concludes.

2 The Model

2.1 Demand

The world consists of two countries, Home (H) and Foreign (F), and many sectors. Time, indexed by t, is discrete and infinite. The analysis in the present paper concentrates on a given sector S, leaving other industries in the background. The representative consumer in country i derives a per-period sub-utility for sector S, which consists of a continuum of varieties, given by[3]:

$$u_{it} = \left[\int_{\omega\in\Omega} \zeta_{it}(\omega)\chi_i(\omega)(q(\omega))^{\frac{\epsilon-1}{\epsilon}} d\omega \right]^{\frac{\epsilon}{\epsilon-1}} \quad \text{for } i \in \{H, F\} \tag{1}$$

where the measure of the set Ω is the mass of available varieties in sector S, $q(\omega)$ is the consumption level of variety ω and ϵ is the elasticity of substitution between varieties, which is assumed to be larger than one. Consumer preferences exhibit the love of variety property following Dixit and Stiglitz (1977). The taste of consumers for a given variety depends on two parameters. The first, χ_i, is time invariant and variety specific. I assume for simplicity that the distribution of χ_i across varieties has support $(0, \infty)$, and that χ_H and χ_F are uncorrelated. The fact that consumers in a country have a strong taste for a variety is not informative about the taste for this variety in the other country. The second parameter, ζ_{it}, is a time-varying idiosyncratic shock to the taste for each variety, which is independent of χ_H and χ_F.

At time t, consumers in i spend in each period an amount I_{it} on the consumption of varieties from sector S and maximize their per period sub-utility u_{it} subject to the budget constraint:

$$\int_{\omega} p_{it}(\omega)q(\omega) = I_{it} \tag{2}$$

where $p_{it}(\omega)$ is the price of a variety ω in market i and at time t. The demand for a variety ω in time t and market i is:

$$q_{it}(\omega) = \beta_{it}(\omega)\chi_i(\omega)(p_{it}(\omega))^{-\epsilon}P_{it}^{\epsilon-1}I_{it} \tag{3}$$

where

$$P_{it} = \left[\int_{\omega\in\Omega} (\beta_{it}(\omega)\chi_i(\omega))^{\epsilon}(p_{it}(\omega))^{1-\epsilon} d\omega \right]^{\frac{1}{1-\epsilon}} \tag{4}$$

is the aggregate price of a composite good defined by $Q_{it} \equiv u_{it}$.

The demand for a good is an increasing function of its taste parameters and of the price index P_{it}, which summarizes the prices of all available varieties in sector S at time t in country i.

To simplify the notation, I define $\beta_{it}(\omega) \equiv \zeta_{it}(\omega)P_{it}^{\epsilon-1}I_{it}$ as the time varying part of the demand of variety ω in country i. It consists of both idiosyncratic demand shocks as well as of market wide changes, such as variations in the income spent on goods of sector S. $\beta_{it}(\omega)$ is drawn in each period from a

[3]Since the analysis concentrates only on sector S, I do not include a sectoral index.

country specific distribution. I assume that there is no autocorrelation in the β_{it}, and no correlation between shocks in the two countries[4]. The distribution of β_{it}, $G_i(\beta_{it})$, is assumed constant over time with support $[\underline{\beta}_i, \overline{\beta}_i]$, mean μ_i and variance σ_i^2.

2.2 Firms

In each country, there is a continuum of firms in sector S, each choosing to produce a different variety ω.

From (3), the demand faced by firm j on market i can be rewritten as:

$$q_{jit} = \beta_{jit}\chi_{ji} \tag{5}$$

and the total expenditure of consumers in i on the variety of firm j at time t is:

$$e_{jit} \equiv p_{jit}q_{jit} = q_{jit}^{\frac{\epsilon-1}{\epsilon}}(\beta_{jit}\chi_{ji})^{\frac{1}{\epsilon}} \tag{6}$$

Since most of the following analysis is conducted from the point of view of a given firm, I omit the subscript j in the following.

Production uses two factors, capital (k) and labor (l), which firms rent in each period at exogenous and constant prices r and w[5]. Firms produce with a Cobb Douglas production function combining capital and labor:

$$y = k^{\gamma}l^{1-\gamma} \tag{7}$$

Capital is assumed to be a fixed factor in the short run, in the sense that the stock of capital at t is decided upon at $t-1$, before the realization of the time varying preference shocks. Labor, on the other hand, is fully flexible and can be immediately adapted.

In order to produce, firms have to pay a per-period fixed cost of production f, which generates increasing returns to scale in the long run. Whether these costs are paid in terms of labor or capital has no bearing on the results[6]. I assume for simplicity that the decision whether to produce at time t has to be taken at $t-1$, before the realization of the time varying shocks.

[4] All results hold as long as the shocks are not perfectly correlated, assuming that they are uncorrelated however simplifies the notation.

[5] r and w are set equal across countries for simplicity.

[6] To simplify the notation, assume that the fixed costs either require the use of $\frac{f}{r}$ units of capital or $\frac{f}{w}$ units of labor. The amount spent per period on fixed costs is therefore equal to f.

To simplify notation, define $\alpha \equiv \frac{1}{1-\gamma} > 1$. The short run cost function and the marginal costs of production are given by:

$$c(y) = rk + wy^{\alpha}k^{1-\alpha} + f \quad (8)$$

$$c'(y) = w\alpha y^{\alpha-1}k^{1-\alpha} \quad (9)$$

Due to the assumption of fixed capital in the short run, the short run costs of production are convex.

Each firm also has the possibility to export to the other country if it finds it profitable. For expositional clarity, I will from now on conduct the analysis from the point of view of the home country (H). Exporting requires the payment of two types of costs. Iceberg costs τ_i are the number of goods that must be shipped in order for one unit of the good to arrive at destination in market i. It is equal to one for the domestic market ($\tau_H = 1$), reflecting that there are no costs of shipping goods within a country. Selling a good in the foreign market is on the other hand associated with costs of transportation or tariffs, which are summarized by $\tau_F \equiv \tau \geq 1$. Additionally, exporting firms incur a fixed per period cost of exporting f_x, which reflects the additional costs of doing business abroad, of maintaining a distribution network, etc. I assume that this cost has to be paid at t, after the realization of the time varying shocks β_{Ht} and β_{Ft}.

As usual in this type of models, I assume that firms face no financial constraints. Regardless of past profits, they can always finance capital and fixed costs as long as they expect non-negative profits for the next period[7]. The timing of the firm's problem can be summarized as follows. At time $t = 0$, firms learn their demand parameters χ_H and χ_F and the distribution of the time varying shocks β_{Ht} and β_{Ft}. Firms then maximize their per period profits from period $t = 1$ onwards. The maximization of period t profits proceeds in three steps. (i) at $t-1$, firms decide whether to produce in period t. They therefore choose at $t-1$ whether to pay f at time t. (ii) at $t-1$, firms choose their capital level for period t. (iii) at t, after the realization of the time-varying demand shocks, firms decide whether to export or not and choose how much to produce by setting their use of labor.

The market participation strategy of a firm at time t can be: (i) not to produce (strategy N) (ii) to sell only on the domestic market (strategy H) (iii) to sell on both markets (strategy G). For simplicity, I will denote as f_s, $s \in \{N, H, G\}$ the total fixed costs associated to a given strategy, i.e. $f_N = 0$

[7]All profits of a firm are paid to the representative consumer as dividends, and all losses are covered by the consumer. Firms rent the factors of production from the representative consumer in each period and face no intertemporal constraint.

$f_H = f$ and $f_G = f + f_x$. Note that no firm has an interest in selling only on the export market. If it exports, a firm needs to pay both the fixed costs of production (f) and the fixed costs of export (f_x). It therefore needs to pay no additional fixed cost to sell on the Home market. As long as $\chi_H \beta_{Ht} > 0$ however, it can sell from (3) an infinitesimal amount on the Home market at an infinite price, and will therefore find it optimal to do so. This shows that no firm exports without selling on the domestic market. I now solve the firm's problem by backward induction.

I first derive the optimal level of sales and profits taking the capital level (k) as given. If a firm decides to produce only for market H at time t, it makes profits equal to the consumer's expenditure on its good in market H minus its costs of production. From (6), the profits of a firm depends on its demand parameters χ_H and β_{Ht}, and is given by

$$\pi_{Ht}(q_H, k) = q_H^{\frac{\epsilon-1}{\epsilon}} (\beta_{Ht}\chi_H)^{\frac{1}{\epsilon}} - c(q_H) - f \tag{10}$$

Maximizing profits with respect to the quantity it sells q_H and rearranging using that sales are equal to expenditure for each product yields the optimal sales level:

$$s_H(k) = \left(\frac{\epsilon - 1}{\epsilon \alpha w}\right)^{\frac{C}{\alpha-1}} k^C (\beta_{Ht}\chi_H)^{1-C} \tag{11}$$

where $0 < C \equiv \frac{(\alpha-1)(\epsilon-1)}{\alpha\epsilon-\epsilon+1} < 1$. The parameter C drives the importance of capital in the determination of sales, and reflects the impact of the technology (α) and of preferences (ϵ). For a given ϵ, a higher C is associated with a stronger convexity in the costs of production as it reflects a larger share of capital in the production.

The optimal sales of a domestic firm are increasing in β_{Ht}, which reflects a high demand for the variety of the firm. This may be due to a large idiosyncratic demand shock (ζ_{Ht}) or to favorable market conditions ($P_{it}^{\epsilon-1} I_{it}$). Firms with a high long-run taste parameters χ_H also have higher sales. Due to the convexity of the short run cost function, optimal sales are concave in χ_H and β_{Ht}.

Plugging the optimal sales in the profits equation (10) yields the maximized profits for a domestic firm at time t given capital k:

$$\pi_{Ht}(k) = \lambda k^C (\chi_H \beta_{Ht})^{1-C} - rk - f \tag{12}$$

where $\lambda \equiv \left(1 - \frac{\epsilon-1}{\epsilon\alpha}\right)\left(\frac{\epsilon-1}{\epsilon\alpha w}\right)^{\frac{C}{\alpha-1}}$. A similar analysis can be conducted for a firm deciding to export at time t (firms with strategy G at t) with global sales s_{Gt}. Let q_{GHt} and q_{GFt} denote the quantities sold by an exporting firm on its domestic and export market and s_{GHt} and s_{GFt} be the corresponding sales (price times quantity sold). The profits of an exporting firm consist of its sales on both markets minus the costs of production and of exporting. From (6), the profits of an exporting firm are:

$$\pi_{Gt}(q_H, q_F, k) = q_H^{\frac{\epsilon-1}{\epsilon}} (\beta_{Ht}\chi_H)^{\frac{1}{\epsilon}} + q_F^{\frac{\epsilon-1}{\epsilon}} (\beta_{Ft}\chi_F)^{\frac{1}{\epsilon}} - c(q_H + \tau q_F) - f - f_x \quad (13)$$

Maximizing and rearranging using (6) yields the firm openness level (υ), which is the optimal ratio of its exports to global sales:

$$\upsilon_t = \tau^{1-\epsilon} \frac{\beta_{Ft}\chi_F}{\beta_{Ht}\chi_H + \tau^{1-\epsilon}\beta_{Ft}\chi_F} \quad (14)$$

The openness of a firm depends both on firm-specific parameters and on factors common to all firms. The common factors are: (i) the iceberg transportation costs (τ), which reduce the relative size of exports, and (ii) the aggregate conditions on both markets, such as the price index or income, which are part of β_{Ft} and β_{Ht}. The higher the price index on the export market, and the higher the aggregate income on that market, the easier it is for all firms to export and the higher their openness. The firm- specific factors are the ratio of the time invariant taste parameters ($\frac{\chi_F}{\chi_H}$), which determines the long run heterogeneity in openness between firms, and the time varying idiosyncratic demand shocks.

The firm-specific factors account for the well-established fact that exporters differ with respect to their openness level[8]. It can however not be accounted for by traditional models of heterogeneous firms with two countries and a single source of heterogeneity[9].

Plugging (14) back into the first order conditions and rearranging using (6) yields the optimal sales on market i ($s_{Git}(k)$) of a firm with capital level k, as well as its global sales $s_{Gt}(k) = s_{GHt}(k) + s_{GFt}(k)$.

$$s_{Git}(k) = k^C \left(\frac{\epsilon-1}{\epsilon\alpha w}\right)^{\frac{C}{\alpha-1}} \tau_i^{1-\epsilon}\beta_{it}\chi_i \left[\beta_{Ht}\chi_H + \tau^{1-\epsilon}\beta_{Ft}\chi_F\right]^{-C} \quad (15)$$

$$s_{Gt}(k) = k^C \left(\frac{\epsilon-1}{\epsilon\alpha w}\right)^{\frac{C}{\alpha-1}} \left(\beta_{Ht}\chi_H + \tau^{1-\epsilon}\beta_{Ft}\chi_F\right)^{1-C} \quad (16)$$

[8]Eaton et al. (2008) among others.

[9]With the exception of Arkolakis (2008) who uses a marketing cost argument to show that heterogeneously productive firms choose different levels of market penetration in foreign markets.

The interpretation is in many ways similar to the domestic case in (11). The main difference is that the sales of an exporting firm on a given market depend on the value of its taste parameters in both markets. This is due to the convexity of the short run cost function, which creates a link between the two markets. For instance, if a firm receives a high taste shock on its export market in a given period, the resulting increase in optimal production raises its marginal costs, and therefore reduces its sales on the domestic market.

Plugging the optimal sales from (15), and the implied optimal quantities, in (13) gives the optimized profit level of a firm exporting in t given a level of capital k:

$$\pi_{Gt}(k) = \lambda k^C \left(\beta_{Ht}\chi_H + \tau^{1-\epsilon}\beta_{Ft}\chi_F\right)^{1-C} - rk - f - f_x \tag{17}$$

In each period, firms decide whether to export or not by comparing the maximized profits of the two strategies and export if $\pi_{Gt}(k) \geq \pi_{Ht}(k)$, i.e. if:

$$\lambda k^C \left[\left(\beta_{Ht}\chi_H + \tau^{1-\epsilon}\chi_F\beta_{Ft}\right)^{1-C} - \left(\chi_H\beta_{Ht}\right)^{1-C}\right] - f_x \geq 0 \tag{18}$$

I define $\beta_F^I(\beta_{Ht}, \chi_H, \chi_F, k)$ as the smallest foreign demand shock for which a firm finds it profitable to export given its home demand shock. If it is equal to $\underline{\beta}_F$ ($\overline{\beta_F}$), which means that given the realization of β_{Ht}, firm j will (not) export for any realization of β_{Ft}. From (18) and from the support of β_F, it is given by:

$$\beta_{Ft}^I = \begin{cases} \overline{\beta}_F \\ \left[\left(\frac{f_x}{\lambda}k^{-C} + (\chi_H\beta_{Ht})^{1-C}\right)^{\frac{1}{1-C}} - \chi_H\beta_{Ht}\right]\frac{1}{\tau^{1-\epsilon}\chi_F} \quad if < \overline{\beta}_F \;\&> \underline{\beta}_F \\ \underline{\beta}_F \end{cases}$$

For a given demand shock β_{Ft} on the export market, a firm exports if it has a sufficiently (i) large demand parameter on the export market (χ_F) (ii) low demand on the domestic market ($\chi_H\beta_{Ht}$) (iii) large capital level. Condition (ii) is due to convexity of costs in the short run, which makes it more costly and therefore less profitable to export in periods with a large demand on the domestic market.

In the second step of backward induction, I derive the optimal capital level that firms use for production. Firms choose their capital level for t at $t-1$, i.e. without knowing the realization of the idiosyncratic demand shocks β_{Ht} and β_{Ft}. They therefore maximize their expected profits, given by:

$$
\begin{aligned}
E(\pi) &= \lambda k^C \left(\int_{\underline{\beta}_H}^{\overline{\beta}_H} (1 - G_F(\beta_F^I(\beta_H)))(\chi_H \beta_H)^{1-C} dG_H(\beta_H) \right) \\
&+ \lambda k^C \left(\int_{\underline{\beta}_H}^{\overline{\beta}_H} \int_{\beta_F^I(\beta_H)}^{\overline{\beta_F}} \left(\chi_H \beta_H + \tau^{1-\epsilon} \chi_F \beta_F\right)^{1-C} dG_F(\beta_F) dG_H(\beta_H) \right) \\
&- rk - f - f_x \left(\int_{\underline{\beta}_H}^{\overline{\beta}_H} (1 - G_F(\beta_F^I(\beta_H))) dG_H(\beta_H) \right) \qquad (19)
\end{aligned}
$$

The first and second line respectively stand for the mean variable profits (sales minus labor costs) of a firm when it does not and when it does export. The third line accounts for the costs of capital, for the fixed costs of domestic sales and for the fixed costs of exports. Since the firm can decide in the short run whether to export or not, it only pays f_x if it does export.

Since there are no deterministic changes from one period to another in the model, a firm faces at each time t the same problem with regard to the optimal choice of its capital for the next period. The maximization problem with respect to capital is therefore time invariant and is well behaved under the following assumption:

Assumption 1 $\frac{(1-C)^2}{C} > \frac{f_x}{f} \overline{\beta}_F$

Proposition 1 *Under Assumption 1, each producing firm has a unique profit-maximizing capital level k^*.*

Proof. *See Appendix* ■

An increase in capital impacts the profits of a firm in three ways. First, it raises its costs linearly at rate r. Second, it raises the average variable profits (through k^C in (19)), an effect which is concave as $C < 1$. Third, if $\underline{\beta}_F < \beta_F^I < \overline{\beta}_F$ it decreases β_F^I, and raises the probability that a firm exports, thereby increasing its average variable profits. If, for some parameters and capital levels, the third effect is strong compared to the second, average variable profits may be convex in capital, posing a problem of multiplicity.

Assumption 1 is sufficient to ensure that such a case cannot happen. The assumption consists of two parts. First, the left hand side of the inequality requires that C be not too large. The reason is that if C is small, k^C is very concave and β_F^I is not very sensitive to a change in k. This makes sure that the third effect described above is small compared to the second effect, and that expected profits are concave in k. Second, the right hand side of the inequality requires that the fixed costs of production are large enough compared to the fixed costs of exports. This prevents the existence of firms which sell infinitesimal amounts on the domestic market and which export only in the case of a very favorable shock on the foreign market. For such firms, the impact of an increase in capital would mostly come from a decrease in β_F^I, and their expected profits would not necessarily be concave. Under the Assumption 1 , such firms do not find it profitable to pay the fixed costs of production and therefore do not produce.

In terms of long-run export status, there are three types of producing firms in the model. Some firms, the non-exporters (NE), never export regardless of the realization of the short run shocks. These are the firms for which export is not profitable even when they draw shocks $\underline{\beta}_H$ on the home market and $\overline{\beta}_F$ on the export market, i.e. firms for which $\beta_F^I(\overline{\beta}_H) = \overline{\beta_F}$. On the other hand, continuous exporters (CE) export in each period, irrespective of the realization of the short run shock and are those firms for which $\beta_F^I(\underline{\beta}_H) = \underline{\beta_F}$. Firms for which $\beta_F^I(\beta_H) \in (\underline{\beta}_F, \overline{\beta}_F)$ for some $\beta_H \in [\underline{\beta}_H, \overline{\beta}_H]$ will be exporting in some periods only, and will be referred to as switchers (SW).

The following proposition details the category in which each firm falls as a function of χ_H and χ_F. To simplify the exposition, I define χ_H^* as the demand level on the home market that makes a non-exporter indifferent between producing or not.

Proposition 2

1. *For $\chi_H > \chi_H^*$, firms with a small χ_F never export, firms with intermediate values of χ_F are switchers and firms with large χ_F always export.*

2. *The larger the χ_H the larger the range of χ_F for which firms are switchers.*

3. *For $\chi_H < \chi_H^*$, firms with small χ_F do not produce. All producing firms in this range are either switchers or continuous exporters.*

Proof. *See Appendix* ■

Proposition 2 is illustrated by figure 2 in the Appendix, which shows the export status of a firm as a function of χ_H and χ_F for a simulation of the model.

Corollary 1 *For $G(\chi_H^*)$ small enough, continuous exporters have on average larger sales than switchers and switchers have larger sales than domestic firms.*

3 Predictions

In this section, I derive four testable predictions of the model. The first two predictions clarify the nature of the empirical link between firm-level exports and domestic sales which result from the short run substitution between markets as highlighted in the previous section. The other two predictions derive the empirical consequences of this substitution channel on the volatility of sales of exporters on each market. I define the sales volatility of a firm on a given market as the variance of the growth rate of its sales on that market. I will denote the percentage change in the sales of a firm between two periods as 'growth rate' of sales, although there is no long-term growth due to the stationary structure of the model. 'Growth rate' and 'rate of change' can be used interchangeably.

3.1 Growth rates of sales

3.1.1 Non-exporters

The growth rate of sales of a non-exporter with successive parameters can be directly derived from (11):

$$g_{Ht} = \frac{s_{Ht}}{s_{Ht-1}} - 1 = \left(\frac{\beta_{Ht}}{\beta_{Ht-1}}\right)^{1-C} - 1 \tag{20}$$

For simplicity, I conduct the analysis using the approximation $log(1+\lambda) \approx \lambda$ for λ small, so that:

$$g_{Ht} \approx (1-C)\left(log(\beta_{Ht}) - log(\beta_{Ht-1})\right) \tag{21}$$

The growth rate of sales of a domestic firm is governed by the change in the home demand parameter β_{Ht}, which is the only relevant source of variation in the model from the point of view of a non-exporter.

3.1.2 Continuous Exporters

For home-based exporters, it is useful to distinguish the growth rates of domestic sales (g_{GHt}) and of exports (g_{GFt}). From (15), the growth rate of sales of a home exporter in market i can be approximated as:

$$\begin{aligned} g_{Git} \approx \quad & log(\beta_{it}) - log(\beta_{it-1}) - Clog(\tau_i^{1-\epsilon}\beta_{it}\chi_i + \tau_n^{1-\epsilon}\beta_{nt}\chi_n) \\ + \quad & Clog(\tau_i^{1-\epsilon}\beta_{it-1}\chi_i + \tau_n^{1-\epsilon}\beta_{nt-1}\chi_n) \end{aligned} \tag{22}$$

where $\{i, n\} \in \{\{H, F\}, \{F, H\}\}$.

The growth rate of sales of an exporting firm on market i depends on the shocks that it receives in the home and in the foreign market. The growth of sales of an exporter on market i is larger (i) the stronger the increase in the realization of the firm specific demand shock (given by $log(\beta_{it}) - log(\beta_{it-1})$) (ii) the lower the rise in the weighted average of realizations of the idiosyncratic demand shocks on both markets. The rationale behind (22) is that the growth of sales on a given market is large if the change in the demand shock on this market is more positive than the change on the other market. Differentiating the right hand side of (22) with respect to β_{it} and β_{nt} at the mean value of the random variables ($\beta_{it} = \beta_{it-1} = \mu_i$ and $\beta_{nt} = \beta_{nt-1} = \mu_n$) confirms this intuition:

$$g_i^i(\psi_i) \equiv \left.\frac{\partial g_{Git}(\chi_i, \chi_n)}{\partial \beta_{it}}\right|_{\mu_i,\, \mu_n} = \frac{1}{\mu_i}\left[1 - C\psi_i\right] > 0 \tag{23}$$

$$g_i^n(\psi_i) \equiv \left.\frac{\partial g_{Git}(\chi_i, \chi_n)}{\partial \beta_{nt}}\right|_{\mu_i,\, \mu_n} = -\frac{C}{\mu_n}(1 - \psi_i) < 0 \tag{24}$$

where $\psi_i(\chi_i, \chi_n) \equiv \frac{\tau_i^{1-\epsilon}\mu_i\chi_i}{\tau_i^{1-\epsilon}\mu_i\chi_i + \tau_n^{1-\epsilon}\mu_n\chi_n}$ is the share of market i in the sales of a home-based exporter for the mean idiosyncratic shocks μ_n and μ_i. ψ_i is time invariant as it depends on χ_H and χ_F, which are realized at $t = 0$. ψ_F can be interpreted as the mean openness level of a firm. Since the parameters χ_F and χ_H differ across firms, exporters are heterogeneous with respect to their openness level ψ_F.

I show in the Appendix that the first order Taylor approximation of the covariance between the growth rates of exports and domestic sales is negative. If an exporter wishes to raise its sales on a market i in the short run, it can: (i) employ more labor, which comes with convex costs (ii) reduce its production for market n. An exporter will always find it optimal to use both channels, as long as the shocks on both markets are not identical. The second channel ensures that exporters substitute production between markets in the short run in order to adapt to time varying shocks. This generates the first testable implication of the model:

Prediction 1 *For continuous exporters, the within firm growth rates of domestic sales and of exports are negatively correlated.*

3.1.3 Switchers

The analysis of the growth rate of switchers can be split in four different cases. First, if a switcher neither exports at $t-1$ nor at t, its growth rate of sales is the same as that of non-exporters as in (21). The expected growth of its domestic sales is therefore zero. Second, if a firm exports at $t-1$ and at t, the analysis is similar to that of continuous exporters. The expected value of its growth rate of domestic sales and of exports is zero, and the negative correlation between the growth rates on its two markets as highlighted in Prediction 1 holds for the spells in which it exports. Third, a switcher may export at $t-1$ and stop exporting at t. The growth rate of its domestic sales is in this case given by:

$$\begin{aligned} g_{Ht}^{XD}(\varphi_t, \varphi_{t-1}) &= (1-C)log(\beta_{Ht}) - log(\beta_{Ht-1}) - Clog(\chi_H) \\ &+ Clog(\beta_{Ht-1}\chi_H + \tau^{1-\epsilon}\chi_F\beta_{Ft-1}) \end{aligned} \tag{25}$$

where the superscript XD represents the change in exporter status between $t-1$ and t from exporter to non-exporter.

The expected value of the growth rate of domestic sales given that a firm stops exporting is given by[10]:

$$E_{XD}(g_{Ht}^{XD}) \equiv E\left(g_{Ht}^{XD} | \{(\beta_{Ht}, \beta_{Ft}) : \beta_{Ft} < \beta_F^I(\beta_{Ht}), (\beta_{Ht-1}, \beta_{Ft-1}) : \beta_{Ft-1} > \beta_F^I(\beta_{Ht-1})\}\right) \tag{26}$$

It takes into account that if a firm stops exporting, it must have at t a higher demand shock on the home market and/or a lower demand shock on the foreign market than in period $t-1$. These shocks mean that it is relatively more profitable to sell on the domestic market at t than at $t-1$. If the shocks are sufficiently strong, they induce the firm to stop selling on the

[10] An explicit expression for this expected value can be found in Appendix - see proof of Lemma 1.

export market as the profits from its foreign sales would not cover the fixed costs of exporting in period t.

Fourth, a switcher may not export at $t-1$ and start exporting at t. The growth rate of its domestic sales is then given by:

$$\begin{aligned} g_{Ht}^{DX}(\varphi_t, \varphi_{t-1}) &= log(\beta_{Ht}) - (1-C)log(\beta_{Ht-1}) + Clog(\chi_H) \\ &- Clog(\beta_{Ht}\chi_H + \tau^{1-\epsilon}\chi_F\beta_{Ft}) \end{aligned} \tag{27}$$

where the superscript DX stands for the fact that the firm starts exporting in period t. The expected value of its growth rate in a period when it starts exporting is defined as:

$$E_{DX}(g_{Ht}^{DX}) \equiv E\left(g_{Ht}^{DX} | \{(\beta_{Ht}, \beta_{Ft}) : \beta_{Ft} > \beta_F^I(\beta_{Ht}), (\beta_{Ht-1}, \beta_{Ft-1}) : \beta_{Ft-1} < \beta_F^I(\beta_{Ht-1})\}\right) \tag{28}$$

Lemma 1 $E_{XD}(g_{Ht}^{XD}) > 0$ *and* $E_{DX}(g_{Ht}^{DX}) < 0$

Proof. *See Appendix* ∎

Two effects account for the positive growth of domestic sales of a switcher when it stops exporting[11]. First, the fact that it stops exporting at t reveals that, the demand parameter on the home market is likely to be higher than at $t-1$. A high home demand parameter is indeed one of the reasons why a switcher may stop exporting and a higher home demand parameter means a strong growth on the home market. Second, if a firm stops exporting at t, it shifts the use of all its factors of production for sales on the home market, thereby further increasing domestic sales.

The second testable implication of the model follows from lemma 1 and from the fact that the expected growth rate of domestic sales is zero if the firm remains exporter or remains domestic.

Prediction 2 *When a switcher stops exporting, it has a high and positive growth of domestic sales compared to other periods. If it starts exporting, it has a lower growth of domestic sales than in other periods.*

The above prediction does not apply to firms which start exporting for the first time or which definitely stop exporting as these are not part of the analysis. Indeed, due to the likely presence of high sunk costs of entry on the export market, the fact that a firm exports for the first time[12] probably

[11] The reverse argument hold for periods in which a firm starts exporting.

[12] For evidence of the sunk cost nature of entry on the export market, see ...

reflects more complex dynamic changes in its productivity pattern and in its capital accumulation that are not captured by the present stationary model. Similar problems would apply for firms definitely dropping out of the export market[13].

3.2 Sales volatility

This section examines the consequences of the model for the volatility of the sales of non-exporters and continuous exporters.

3.2.1 Non-exporters

The sales volatility of non-exporters is defined as the variance of the growth rate of their sales. From (21) and since β_H is i.i.d. over time, it can be approximated as follows [14]:

$$VAR(g_{Ht}) \approx 2(1-C)^2 \frac{\sigma_H^2}{\mu_H^2} \tag{30}$$

where μ_H and σ_H^2 denote the mean and the variance of the time varying idiosyncratic demand shock on the Home market β_H. The higher the variance of domestic demand shocks, the higher the sales volatility of domestic firms.

3.2.2 Continuous Exporters

In order to provide a complete analysis of the impact of trade openness on the volatility of sales of continuous exporters, I divide the analysis into two parts. In a first step, I look at the link between the openness of a firm and the volatility of its domestic sales and of its exports separately. In a second step, I concentrate on the link between openness and volatility of global sales. I conduct a comparative statics exercise for sales volatility with respect to ψ_F in order to examine the equilibrium correlation between openness and volatility in the cross-section of firms.

[13]For more on the dynamics of first time entrants or dropouts on and from the export market, see:...

[14]For small shocks, the variance of a function θ of a random variable x can be approximated using a first order Taylor expansion as:

$$VAR(\theta(x)) \approx \theta'(x_0)^2 VAR(x) \tag{29}$$

where x_0 is the mean of the distribution of x.

I first turn to a separate study of the sales volatility of exporting firms on their domestic and on their export market. As for the case of non-exporters, I use a first order Taylor expansion to approximate the volatility of sales on market i. It is a weighted sum of the variance of demand shocks in both markets:

$$VAR(g_{Git}) \approx V\tilde{A}R(g_{Git}) = 2(g_i^i(\psi_i))^2\sigma_i^2 + 2(g_i^n(\psi_i))^2\sigma_n^2 \tag{31}$$

Plugging (23) and (24) in (31) and differentating with respect to the openness level ψ_F yields:

$$\frac{\partial V\tilde{A}R(g_{GFt})}{\partial \psi_F} = -4C\left[(1-C\psi_F)\frac{\sigma_F^2}{\mu_F^2} + C(1-\psi_F)\frac{\sigma_H^2}{\mu_H^2}\right] < 0 \tag{32}$$

$$\frac{\partial V\tilde{A}R(g_{GHt})}{\partial \psi_F} = 4C\left[(1-C+C\psi_F)\frac{\sigma_H^2}{\mu_H^2} + C\psi_F\frac{\sigma_F^2}{\mu_F^2}\right] > 0 \tag{33}$$

The above derivatives suggest that, in equilibrium, firms with a larger openness have less volatile exports and more volatile domestic sales. The reason for this is the short-run substitution between markets outlined earlier. Let a firm have a small openness level, a constant demand parameter on the foreign market and face a short run positive shock on the domestic market. Since such a firm exports on average a small amount of its production, it cannot increase its domestic sales much by decreasing sales on the export market, but mainly raises its use of labor in the short run. Due to the convex costs of labor however, this firm does not increase its domestic sales much, so that the volatility of its domestic sales is quite low. The substitution between markets, which is small compared to the domestic sales, is however large as a proportion of exports, and generates much volatility on the export market is then large. This effect is summarized in the second testable prediction of the model:

Prediction 3 *In the cross-section of continuous exporters, the openness level of firms is (i) positively correlated with the volatility of their domestic sales (ii) negatively correlated with the volatility of their exports.*

Differentiating (32) and (33) once more shows that the effect of openness on the volatility of both markets is non linear:

$$\frac{\partial^2 V\tilde{A}R(g_{GFt})}{\partial^2 \psi_F} = \frac{\partial^2 V\tilde{A}R(g_{GHt})}{\partial^2 \psi_F} > 0 \tag{34}$$

Back of the envelope calculations suggest that the channel highlighted in the derivation of Prediction 3 may be quantitatively important. Assume that the demand shocks on the home and foreign markets are identically distributed ($\sigma_H^2 = \sigma_F^2$ and $\mu_H = \mu_F$). Using the approximation of the variance in (31), the ratio of the volatility of exports to the volatility of domestic sales of a firm with openness ψ_F is given by:

$$\frac{VAR(g_{Ft})}{VAR(g_{Ht})} = \frac{(1 - C\psi_F)^2 + C^2(1 - \psi_F)^2}{(1 - C(1 - \psi_F))^2 + C^2\psi_F^2} \tag{35}$$

Taking an elasticity of substitution $\sigma = 3.8$, as is standard in the literature[15], and a fraction of capital in the production function: $\gamma = 0.33$, (35) shows that the exports of a firm with an openness level $\psi_F = 0.15$ are 2.9 times more volatile than its domestic sales although the inherent volatility of both markets are equal.

I now turn to the volatility of the global sales of exporters. From (16), the growth rate of the world sales of a continuous exporter with parameters φ_t and φ_{t-1} can be approximated as:

$$\begin{aligned} g_{Gt}(\varphi_t, \varphi_{t-1}) \approx & \quad (1 - C)log(\chi_H \beta_{Ht} + \tau^{1-\epsilon}\chi_F \beta_{Ft}) \\ & - \quad (1 - C)log(\chi_H \beta_{Ht-1} + \tau^{1-\epsilon}\chi_F \beta_{Ft-1}) \end{aligned} \tag{36}$$

and its variance as:

$$VAR(g_{Gt}) \approx V\tilde{A}R(g_{Gt}) = 2(1 - C)^2 \left[(1 - \psi_F)^2 \frac{\sigma_H^2}{\mu_H^2} + (\psi_F)^2 \frac{\sigma_F^2}{\mu_F^2} \right] \tag{37}$$

The variance of the global sales of an exporter is the weighted sum of the variances of the idiosyncratic taste shock parameters β_{Ht} and β_{Ft} where the weights depend on the importance of each market for the firm. Since the two shocks are not correlated[16], firms which are present in both markets benefit from a diversification effect. Differentiating the above expression with respect to ψ_F shows that openness has a U-shaped effect on volatility. The more volatile the foreign market, the lower the level of openness which minimizes sales volatility. The analysis can readily be extended to introducing shocks in trade costs (θ), which only affect (37) to the extent that $\frac{\sigma_F^2}{\mu_F^2}$ is a weighted average of the demand and transport cost shocks. If the exporting activity is

[15] Bernard et al. (2003), Ghironi and Melitz (2005).

[16] The same qualitative result would hold for a partial correlation.

inherently volatile, this should be reflected by the fact that very open firms should be more volatile than comparable non-exporters. Comparing (37) with (30) establishes the following prediction:

Prediction 4 *If exporting is inherently more volatile than selling on the domestic market, the global sales of exporters with a small (large) openness are less (more) volatile than the sales of comparable domestic firms.*

4 The Data

I use the Amadeus dataset provided by Bureau van Dijk to test the predictions of the model. This pan-european dataset provides extensive balance sheet data on more than five million European businesses. I use the data for France since they include information on exports at the firm level and cover a very large fraction of enterprises. The data stem from the compulsory yearly reports of balance sheet information to the Tribunal de Commerce, which almost all firms have to comply with[17]. The Amadeus data covers approximately 90% of these firms. The large coverage of the Amadeus dataset is an important advantage, which has made it ever more popular in work on trade at the firm level[18].

In this study, I concentrate on firms from the manufacturing sector between 1998 and 2007, as this ten year period has a very good coverage. I deflate sales using the 2-digit sector specific output deflator provided by the KLEMS dataset with 2000 as reference year. Data on consolidated results, which include the balance sheets and results of French or foreign subsidiaries are dropped out of the sample in order to make sure that the results are not driven by sales of subsidiaries on foreign markets. I further drop firms with less than 5 years data on their growth rate as well as firms with an unweighted mean growth rate of sales in the top and bottom percentile[19]. This leaves me with a sample of 69639 firms.

Some descriptive statistics for these firms are shown in Table 1[20]. There is a large proportion of small firms in the data: the median sales are 638.000

[17]Some legal forms such as the Société en nom commun (SNC) are not subject to this obligation, but these are very rare and special organisations.

[18]Among others Helpman et al. (2004), Konings and Vandenbussche (2008), Del Gatto et al. (2007).

[19]To be kept in the sample, firms should have an average growth rate of sales per year between -18% and 213% over the ten years.

[20]For 'average' variables I report the median and the mean of the firm-level average of the variable over time.

euros and the median number of employees is 9. The size distribution of firms, whether defined as average sales or employment is as expected very skewed. The median growth rate of sales is 4.7% over the ten year period. This growth is not captured by the stationary model in sections 2 and 3, and may be due to trend increases in the stock of capital, in real aggregate income or in the development of better technologies.

	Nb Firms	Mean	Median
Average Sales (in thousand euros)	69639	8687	638
Average number of employees	66274	37.3	7.4
Number of years in sample	69639	8.89	9
Average age	73219	17.1	12.5
Average growth rate of sales ($\overline{g}_{it}$)	74750	8.1%	2.3%

Table 1: Descriptive statistics of the dataset

I divide firms according to their export status into four categories. The first two are continuous exporters (ce) and continuous non exporters (cne). Continuous exporters and non-exporters are those firms reporting respectively strictly positive exports and zero exports for all non missing observations[21]. Firms which are neither continuous exporters nor continuous non-exporters include those which enter the export market for the first time, those which definitely stop exporting and firms switching between exporting and non exporting over the time period. Due to the limited time span and coverage of the data, it is difficult to disentangle genuine switchers as they are modeled in section 3 from firms changing their long run export strategy, which export for the first or for the last time. I will define switchers as all firms which export in the first and in the last period for which they are in the data, and which do not export at least once between these two periods. The definition of switchers therefore only isolates a sub-sample of the firms which would be defined as switchers according to section 2. Indeed, I exclude firms which do not export in 1998 or in 2007 but may have done so in 1997 and 2008 and would therefore also be switchers. This definition allows however to make sure that the firm identified as switchers correspond to the theoretical model.

17% of all firms are continuous exporters, while 43% are continuous non exporters and 7% are switchers. In a given year, on average 35% of firms do export. Table 2 summarizes the main characteristics of the different groups.

As is well-known from the seminal paper of Bernard and Jensen (1995) and the large subsequent literature, exporting firms are very different from non

[21] Alternative treatments for missing observations do not affect the analysis. Of the 611792 firm-year observations used in the analysis, only have a missing export status

	ce	cne	switchers	others
Number of firms	12077	30229	5022	22311
Average Sales (in thousand euros)	21769	3522	12599	7724
Average number of employees	91	13	53	36
Average age	24.8	13.4	21.4	17
Number of years in sample	9	8.8	9	9
Average growth rate of sales ($\overline{g}_{it}$)	6.3%	8.5%	7.6%	10.0%

Table 2: Descriptive statistics of firms according to export status

exporters. They are much larger in terms of sales and number of employees, as well as in sales per employee. Their average growth rate and the variance of their sales are smaller than for non exporters, which may be due to the fact that exporters are usually older and more mature. Furthermore, as expected from the model in section 2, switchers are between continuous exporters and continuous non-exporters in terms of size.

In order to shed more light on the characteristics of continuous exporters, I separate their sales between exports and domestic sales, which are computed as total sales minus exports. Average sales on the domestic market are 14 million euros and average exports are 8.2 millions euros[22]. I compute an average openness measure for each continuous exporter as:

$$op = \frac{1}{\sum_{t=1998}^{t=2007} \mathbf{1}(s_{GFt} \neq ., s_{Gt} \neq .)} \sum_{t=1998}^{t=2007} \frac{s_{GFt}}{s_{Gt}} \tag{38}$$

where $\mathbf{1}(s_{GFt} \neq ., s_{Gt} \neq .)$ is the indicator function indicating that data on exports and global sales are non-missing. The distribution of *op*, which is an approximation of ψ_F in the model, is shown in Figure **??**. It has a peak at 5% and a median of 15%. Most firms export only a small fraction of their output each year. Computing the distribution of openness separately for each year yields almost the same distribution, which has not changed over the ten year period. Exports appear much more volatile than domestic sales. The mean logarithm of volatility is -3.36 for domestic sales and -1.10 for exports, which is an order of magnitude higher[23]. Note that the channel highlighted in the derivation of Prediction 2, which suggests that the substitution of sales between markets in the short run magnifies the sales volatility on the smaller market, can account for a part of this difference. As shown in the discussion of (35), when the shocks in both markets are identically distributed, the model

[22]The corresponding median are 2.4 and 0.43 million euros.

[23]Export volatility is 10 times higher than the volatility of domestic sales.

predicts that the exports volatility of a firm with the median openness level of 15% is approximately three times higher than the volatility of its domestic sales.

The test of Prediction 1 relies on the panel structure of the data and not on averages over the period. In order to make sure that outliers for firm-year observations do not drive the result, I drop observations in the top and bottom 1% of the growth rates of domestic sales, exports and capital[24]. This leaves me with a sample of 68867 firm-year observations for continuous exporters over 9 years (all observations for the first year in the sample are dropped due to the computation of growth rates).

5 Results

In this section, I test the empirical predictions derived in the model.

5.1 Prediction 1: the short run substitution between markets

The first prediction established that, conditional on the growth of capital, the within firm growth rate of domestic sales and of exports are negatively correlated.

In order to test this relationship, I regress the growth rate of exports on the growth rate of domestic sales using the sample of continuous exporters. I first use Pooled OLS, controlling for a number of additional regressors. j and s are respectively a firm and a sector indicator. The estimating equation is given by:

$$g_{jGFst} = \rho_0 + \rho_1 g_{jGHst} + \rho_2 X_{js} + \rho_3 X_{jst} + d_t + d_s + u_{jst} \tag{39}$$

where d_t and d_s are time and 4-digit NACE sector dummies. ρ_1 is the parameter of interest, which is the residual correlation of the growth rates of domestic sales and exports. X_{jst} contains firm-specific, time varying, characteristics such as the growth rate of capital, or the financial leverage of a

[24] In order to be kept in the sample, the growth rate of domestic sales must be between -63% and 189%, the growth rate of exports between -91% and 1356% and the growth rate of capital between -73% and 443%. In order for the first difference estimator not to be driven by outliers, I also drop observations in the top and bottom percentile of changes in growth rates.

firm[25], which proxies for its financial constraints. X_{js} is a vector of firm specific characteristics, which are constant over time. This includes for all specifications different measures of size, such as the average global sales, the average tangible fixed assets and the average openness over the period. Since the errors are likely to be heteroscedastic and autocorrelated, I use robust cluster standard errors for inference. The results are shown in the first two columns of Table 3. Both specifications show that ρ_1 is negative and significant, i.e. that the growth rate of sales in the domestic and in the export market are negatively correlated. An alternative explanation for this negative correlation could be that shocks on the domestic and export markets are negatively correlated. It however seems implausible for French firms, which mainly export to European countries[26] with which shocks are likely to be positively correlated[27].

I then conduct a fixed effect and a first difference regression of the estimating equation (39), where time invariant elements are dropped out. These methodologies have the advantage to isolate the within firm residual correlation, which is what Prediction 1 is about. The regression results are reported in columns 3 to 6 of Table 3. The estimates of ρ_1 are again negative and significant, and are stronger than in the Pooled OLS case.

All estimations however have a quite low R^2, which may be due to the fact that short-run shocks to the firm-level growth rate of sales are mostly driven by other unexplained idiosyncratic factors.

5.2 Prediction 2: Switchers

The second prediction shows that if a switcher starts exporting in a given period, it should have a negative and smaller than usual growth on the domestic market. On the other hand it should have a higher than average growth on the domestic market in periods when it stops exporting. As emphasized earlier, this prediction only holds for firms defined in the model as switchers, i.e. for firms which export neither for the first nor for the last time.

The test of prediction 2 consists of determining whether the growth of domestic sales of switchers is (i) positive and higher than average in years when

[25]Firm leverage is here computed as a non-weighted average over time of the ratio of (non current liabilities + loans) over shareholders funds.

[26]64% of French exports were directed towards its 24 partners in the European Union in 2006 according to the OECD STAN database.

[27]see Bordo and Helbling (2003) for the correlation of average demand shocks between European countries.

they stop exporting (ii) negative and lower than average when they start exporting again. Using the 5022 firms identified as switchers in the data, I compute the residuals of a regression of the growth rate of domestic sales on sector and year dummies in order to partial out common effects to firms in a sector or in a given year. I then compare the mean of these residuals in years when switchers stop exporting, start exporting, or do not change export status. In the years when they do not change their export status, switchers have, after partialling out the time and sector effects, an average domestic growth rate of −1.2%. In the years when they stop exporting, their domestic sales grow on average by 15.3% while they decrease by 11.5% in years when they start exporting again. These differences are highly significant and are exactly in line with the model of section 2.

I further conduct two unreported robustness checks, which leave the results essentially unchanged. First, I regress the growth rate of domestic sales on year and firm fixed effects and conduct the same analysis again. Controlling for firm specific effects do not affect the results. In a second step, I regress the growth rate of domestic sales on sector and year dummies, as well as on a number of firm level characteristics such as average size, average openness level, age and growth rate of capital. This again barely affects the conclusions.

The above analysis was conducted for firms which may have very different exporting histories. Over the period, some of the switchers have exported only two periods while others may have exported in almost all periods. The sequence of exporting and non-exporting spells is furthermore very different between firms. A number of studies[28] suggest however that the costs of (re-)starting to export may depend on the time that elapsed since the last export spell of a firm. In order to limit the risk that such dynamic effects blur the analysis and restricts the comparability between switchers, I restrict the sample of interest to the 2108 firms which export in each period except for one. The risk of loss in export knowledge should be negligible for such firms, and restricting the analysis to them allows to consistently compare the evolution of the growth rate of domestic sales over time. The year in which these firms do not export is firm-specific and evenly spread over the period. I again filter out sector and year effects[29] and compute the mean residuals for the year in which a firm stops exporting as well as for the two previous and following years. Figure reffigswitchers displays the results.

As shown in Prediction 2, the year in which a switcher stops exporting is

[28]Such as .

[29]Using firm fixed effects or other characteristics again does not affect the results.

associated with a massive rise in the growth rate of domestic sales (+24%). In the following year on the other hand, when the switcher re-enters the export market, its domestic sales drop by on average 13%. These effects are strongly significant and provide additional evidence of a substitution between markets at the firm level.

As an additional consistency check with the model, I compute the correlation of the unexplained part of the growth rate of domestic sales with the mean openness level of a firm[30] It appears that in the year when the firm stops exporting, the correlation coefficient is 0.58, while it is -0.46 in the following year, when the firms starts reexporting. In the other three periods considered, the correlation is 0.02. Such a pattern is consistent with the idea of a within firm substitution between markets. A firm with a high average openness will sell much more on the domestic market in a period when it does not export, as it will transfer a large part of its output to this domestic market.

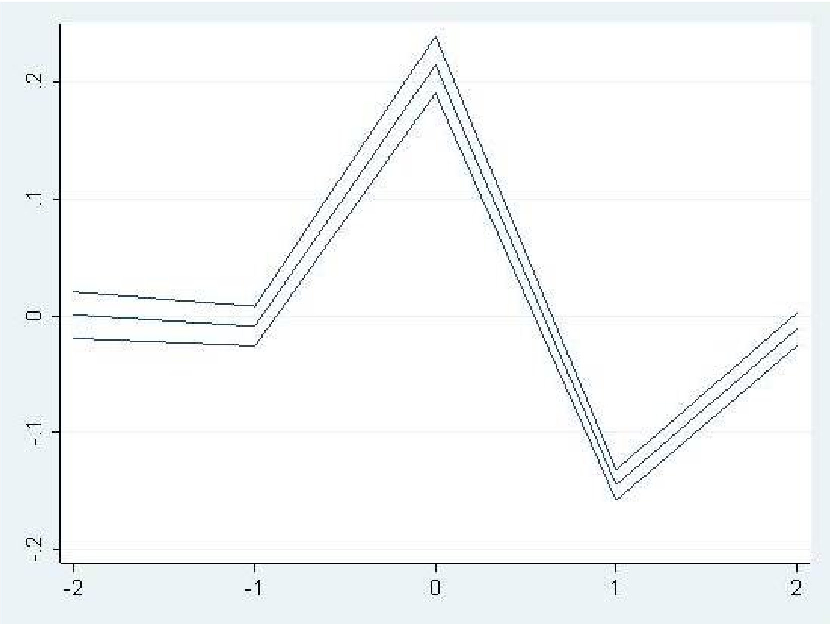

Figure 1: Path of growth of domestic sales purged of sector and year effects for switchers (with 95% confidence interval).

I further conduct two unreported robustness checks, which leave the results essentially unchanged. In a first step, I regress the growth rate of domestic

[30]The openness level is here the average openness level of the firm over the years in which it exports. I furthermore partial out the sectoral effect by taking the residuals of a regression of the openness level and sector dummies.

sales on year and firm fixed effects. The evolution pattern of the unexplained part of the growth of domestic sales is similar to the one pictured in Figure 1. In a second step, I regress the growth rate of domestic sales on sector and year dummies, as well as on a number of firm level characteristics such as the average size, the average openness level and the growth rate of capital. This again barely affects the conclusions.

5.3 Prediction 3: Market share and volatility

The third prediction establishes that the larger the openness level of a firm (i) the larger the volatility of its domestic sales and (ii) the lower the volatility of its exports. For the empirical implementation of the prediction, it is important to recognize that the model potentially leaves out a number of factors which may influence the volatility of sales in reality. In order to account for this, I first compute the residuals of a regression of the growth rate of sales on year and firm fixed effects, as well as on the growth rate of capital[31]. It allows me to partial out all factors which are not taken into account by the model in determining the growth rate of sales and to construct the firm-level variance of conditional growth rates as the individual sum of squared residuals. Repeating this procedure for the growth rate of domestic sales, of exports and of total sales I compute the corresponding volatility measures, which are in line with the theoretical predictions. To test the first part of the prediction, I regress the volatility domestic sales on the average openness of firms using OLS on a cross section of continuous exporting firms. There is one observation per firm since the time dimension has been used to compute volatility. Denoting $VARD \equiv VAR(g_{GHt})$ as the variance of the growth rate of domestic sales, the estimating equation is:

$$Log(VARD_{js}) = \nu_0 + \nu_1 op_{js} + \nu_2 op_{js}^2 + \nu_3 X_{js} + d_s + u_{js} \tag{40}$$

where d_s is a dummy for the NACE 4-digit sector and X_{js} accounts for a number of firm level characteristics which have been found to impact volatility in the literature. Results are reported in the first two columns of Table 4. Consistently with previous studies[32], size and age[33] reduce sales volatility,

[31] As a robustness check, I also conduct the following analysis using the residuals of regressions of the growth rates of sales on the covariates of regression POLS2. The conclusions are unchanged.

[32] Buch et al. (2009) among others.

[33] Using the log average employment as a measure of size does not affect the results. Age is the average age of the firm over the period.

reflecting that more mature firms are also more stable. The average capital level of firms, as measured by their average tangible fixed assets also appears to reduce volatility while firm leverage raises volatility. This is consistent with the discussion in Braun and Larrain (2005). I also include a dummy for firms located in Paris to reflect the particularity of the capital in France, both as a geographical market and as an attractor of headquarters[34]. In the second column of Table 4, I additionally control for the average growth rate of domestic sales over the period. It allows controlling for the fact that firms with a higher growth rate will mechanically exhibit a higher variance of these growth rates. Finally, I include in the second column the size of intangible fixed assets for the firm to account for the fact that firms which invest in high technology, with higher but less certain returns, may be more volatile[35] but this channel appears insignificant for the present dataset.

In both columns, the coefficient ν_1 is strongly positive and significant, as expected from Prediction 3. ν_2 is either insignificant or negative. Combining the two coefficients confirms that the more open a firm is, the more volatile it is in its domestic market. The effect is quantitatively large: consider an exporter with an openness level close to zero and a variance of domestic sales at the 25th percentile of the volatility distribution of domestic sales for exporting firms. If this same exporter were to export almost its whole output, the variance of its domestic sales would be multiplied by nine and correspond to the 85th percentile of the volatility distribution.

In order to test part (ii) of the prediction, I conduct a similar analysis using the log variance of export growth ($VARX \equiv VAR(g_{GFt})$) as the dependent variable. The estimating equation is:

$$Log(VARX_{js}) = \nu'_0 + \nu'_1 op_{js} + \nu'_2 op^2_{js} + \nu'_3 X_{js} + d_s + u_{js} \qquad (41)$$

The firm specific covariates are the same as in the first two columns of the Table, and have the same sign with the exception of the dummy for Paris, which becomes insignificant. The second column accounts for the average growth rate of the exports to control for the effect of a Results are reported in the third and fourth column of Table 4. In both columns, the coefficients ν'_1 and ν'_2 are significant and, as expected, respectively negative and positive. Combining the two coefficients confirms that more open firms have a lower volatility on their export market. The effect is again quantitatively very strong: consider an exporter with an openness level close to zero and an

[34]Alternative geographical definitions such as large cities or population density are insignificant.

[35]Comin and Philippon (2005) point out that sales volatility may depend on R&D intensity.

export volatility at the 75th percentile. If the same exporter were exporting almost its whole output, the variance of its exports would be divided by twenty and it would be at the 30th percentile of the volatility distribution.

The negative link between export volatility and openness found in Table 8 could however be due to the fact that more open firms export to more markets, with imperfectly correlated shocks, thereby benefiting from a diversification effect reducing the volatility of their exports[36] . In terms of the model, this would translate into a correlation between the openness level of a firm and the variance of its export market. Equations (32) and (33) would be modified by adding a term including $\frac{\partial \sigma_F^2}{\partial \psi_F}$, which is negative. Not controlling for this effect would therefore bias the effect of openness on $VARD$ and on $VARX$ downward. Though I cannot refute this alternative explanation due to lack of data on export destination, it should be noted that most French exporters export to only a few markets. Using data for 1986, Eaton et al. (2004) show that 35% of French manufacturing exporters export to only one market, while only 20% export to more than 10 markets. The diversification effect between export markets is therefore likely to be limited. Eaton et al. (2008) further show that the average domestic sales of French exporters are strongly positively correlated with the number of markets to which they export. This observation is consistent with models in which firms need to pay fixed costs for each market to which they export. The volumes of sales to these markets therefore has to be substantial, so that only large and productive firms are able to enter many markets. For a given level of openness, larger firms are therefore likely to export to more markets. To capture this correlation, I introduce an interaction term between the mean openness of a firm and its size, and use it as a proxy of the number of markets to which a firm exports. The coefficient on this interaction term should therefore be negative for both the $VARD$ and $VARX$ equations as shown above. The results of this extension are presented in Table 5 and show that the interaction term is insignificant and does not affect the estimates of the coefficients on openness. This result should be interpreted with caution, as the interaction term is not an ideal proxy for the number of markets to which a firm exports.

A potential concern about the approach followed up to now is that of reverse causality. There are indeed reasons to think that firms would like to avoid markets which are very volatile[37].

[36]An extended version of the model to many countries can be founded in the Appendix.

[37]A number of studies suggest that insecurity on export markets may affect the decision by firms to trade, see Crozet et al. (2008) or Riano (2007) among others. The negative correlation between the sales volatility and the involvement of a firm on a market may therefore be due to the fact that firms avoid volatile markets.

In order to make sure that there is a causal link from openness to volatility, I instrument the openness level of exporters based on their geographical characteristics. Using the geographical location of a unit - country, sector, or firm - as an instrument for its openness is an established tradition since the work of Frankel and Romer (1999)[38]. I use the distance of a firm to the next border as an instrument for its openness, where I define a border as a land border or as one of the eight most important seaports. The exact computation of the instrument is described in the Appendix. The first stage of the IV estimation is reported in Table 6 and shows as expected a strongly negative and significant effect of the distance to the border on the openness level of a firm. Though the partial R-squared of the excluded instrument is small (0.6%), the F-test of significance of the excluded instrument is 47, which is well above usually taken as a rule of thumb for detecting weak instruments[39].

The results of the second stage are shown in Table 7. The first and second columns respectively test Prediction 3 (i) and 3 (ii) and show the second stage of the 2SLS estimation of (40) and (41). Both effects have the same sign as in the OLS case and remain strongly significant, showing that there is a causal effect of the openness level of an exporter on the volatility of its domestic sales and of its exports.

Such a strategy is of course not exempt from criticisms. First, the location of a firm is not purely exogenous, and a firm willing to export to one market may wish to locate close to it. Second, the data reports the postal address of a firm's headquarter, and not of its production sites, so that the reported location of multi-plant firms has little informational content. In order to alleviate these two concerns, I run a separate analysis excluding all firms having more than 200 employees on average over the period, as these are much more likely to be multi-plant firms or to have chosen their location endogenously. Unreported results show that the results are barely affected.

5.4 Prediction 4: Volatility of exporters and diversification effect

Prediction 4 highlights that exporters with small openness levels should be less volatile than comparable non-exporters, as they benefit from a diversification effect. This conclusion is independent of the assumptions made about the variance of both markets. However, if foreign markets are more volatile

[38] di Giovanni and Levchenko (2009) for example apply this at the sectoral level.

[39] Stock et al. (2002) suggest that an instrument is weak if the F-test is lower than 10.

than the French market or if the export activity is inherently volatile, for example due to shocks in the transport costs or on the exchange rate, openness should be positively correlated with volatility.

In order to test this prediction, I conduct an OLS regression on the cross section of continuous exporters and non-exporters. The estimating equation is:

$$Log(VAR_{js}) = \nu_0'' + \nu_1'' op_{js} + \nu_2'' op_{js}^2 + \nu_3'' X_{js} + \nu_4'' d_{ce} + d_s + u_{js} \qquad (42)$$

The above specification is very similar to the one used for prediction 2 except for the additional dummy variable d_{ce} which takes value 1 if a firm is a continuous exporter and 0 otherwise. Since all firms which switch status between exporters and non exporters in the period have been dropped out of the sample, the reference group is exclusively constituted of continuous non-exporters. Results are presented in Table 4.

All elements of the X_{js} vector have the same sign and interpretation as in the regressions for Prediction 3. The effect of openness on volatility is summarized by the coefficients ν_1'', ν_2'' and ν_4''. First, the continuous exporter dummy is negative and significant, a result which is consistent with Buch et al. (2009). Exporters with a small openness are less volatile than non-exporters, as expected from Prediction 4. Volatility of global sales is, on the other hand, increasing in the openness level of a firm, suggesting that foreign markets are more volatile than the French market, and that they tend to cause additional volatility of global sales. The coefficients suggest that firms with an openness level of less (more) than 10% tend to be less (more) volatile than comparable non-exporters. The economic effect of openness on the volatility of global sales is substantial. Consider a non-exporter with a median volatility of sales. If it were exporting 5% of its output, its sales volatility would be at the 40th percentile of the distribution, while it would be at the 60th percentile if it were exporting 95% of its output. It therefore appears that the diversification effect is rather limited compared to the increased volatility that the export activity brings about.

6 Robustness

In this section, I conduct three main robustness checks to the results obtained in the previous section: (i) I examine the link between openness and the variance of the growth rate of employment and value added at the firm level

(ii) I control for inventories in the test of prediction 4 (iii) I control for the multinational character of some firms.

6.1 Volatility of employment and value added

I have conducted the analysis up to now using a definition of firm volatility based on the growth rate of sales. It is the main measure used in the literature and allows to analyze the domestic and export markets separately as in predictions 1 and 2[40]. As a robustness check, I test whether the results of prediction 3 apply to other measures of volatility. Two of them are of particular interest. First, the growth rate of value added provides an interesting robustness check of the result, as it makes sure that these are not driven by the use of intermediate goods. Second, it can be shown that the model generates a similar result as prediction 4 for the volatility of the growth rate of employment. Employment volatility at the firm level may have the most important welfare consequences for individual households facing the risk of losing their job. Unreported results show that similar qualitative conclusions hold for both alternative variables, though the diversification effect does not appear significant in all specifications. The positive association between trade openness and both employment and volatility are however robust, confirming the substantial volatility of the export activity.

6.2 Inventories

Variations in inventories may be an important concern as changes in output do not in reality map one to one to changes in sales. Buch et al. (2008) for example posit that better inventory technology could influence firm volatility. As a robustness check to Prediction 4, I run the same specifications where I replace the sales of a firm by the sum of its sales and variations in inventories. This should help to capture the quantities produced in a more realistic way. Unreported results show that the results are barely affected by this change in definition.

6.3 Controlling for multinationals

The analysis has up to now distinguished exporters from non exporters while leaving aside another important dimension of the internationalization of a

[40]It is impossible from the data to separate the employment or the value added of an exporter between a part assigned to export and a part assigned to the domestic market.

firm: its multinational character. These firms, which I define as those having at least one foreign subsidy or a foreign parent, are particular in many dimensions. They may for example be integrated in a global chain of production, affected by shocks in many countries, but which is not captured by the present model. I use the ownership database of Amadeus in order to determine which firms in the sample are multinationals. A substantial drawback of the data is that they only include the ownership structure of each firm at one point in time, between 2004 and 2007. Though the information on the international character of firms is only partial, it provides suggestive evidence as to whether the results may be driven by multinationals.

Of the 69638 firms in the sample: 4.07% have at least partial ownership of one foreign subsidy or have one foreign parent. 0.3% of continuous non-exporters and 13.9% of continuous exporters are multinationals in this sense. As a robustness check, I run the whole analysis of section 5 again on the sub-sample of firms which are not part of multinationals. Unreported results show no major change to the results of section 5.

7 Conclusion

This paper looks at the relationship between trade openness and volatility at the firm level, both from a theoretical and empirical point of view.

The analysis builds on a two-country monopolistic competition model of trade in which firms face demand uncertainty on their domestic and export markets. Due to long term differences in demand parameters, exporters have heterogeneous openness levels, defined as the ratio of exports to global sales. In the short run, firms face convex costs of production. For this reason, an increase in the production for one market affects marginal costs, and therefore sales on both markets. I show how the production and export decision of firms in this setup provide a channel through which foreign shocks affect domestic sales and their volatility. I generate a number of predictions for the link between trade openness and volatility which I test using French firm-level data from the Amadeus dataset between 1998 and 2007.

The paper has three main conclusions: (i) exporting firms substitute sales in the short run between their domestic and export markets. This effect is empirically robust to a variety of controls and holds both for firms which continuously export and for those which occasionally export. (ii) the higher the openness level of an exporter, the higher the volatility of its domestic sales and the lower the volatility of its exports. It is a direct consequence of the market substitution highlighted above: demand shocks induce a sales substitution which is proportionally small for the larger market and large for the smaller market. The empirical analysis confirms the quantitative importance of this effect, which suggests to interpret simple comparative statics on the volatility of exports with caution. The instrumental variable strategy confirms the causality of the effect from the openness level to the volatility. (iii) exporting firms with an openness level above 10% are more volatile than comparable non exporters, suggesting that the exporting activity is inherently volatile. Firms with an openness level below 10% are, on the other hand, less volatile than comparable non-exporters, which is consistent with a standard diversification argument according to which selling to uncorrelated markets reduces volatility.

I show that the results are robust to controlling for the multinational ownership structure of firms, to changes in inventories as well as to using alternative measures of volatility based on value added and employment.

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8 Appendix

8.1 Proof of Proposition 1

The optimal capital level of a firm is determined by solution of the maximization of (19). To simplify notation, define:

$$\gamma(k) \equiv \left(\int_{\underline{\beta}_H}^{\overline{\beta}_H} \left(\int_{\underline{\beta}_F}^{\beta_F^I(\beta_H)} (\chi_H\beta_H)^{1-C} + \int_{\beta_F^I(\beta_H)}^{\overline{\beta}_F} \left(\chi_H\beta_H + \tau^{1-\epsilon}\chi_F\beta_F\right)^{1-C} dG(\beta_F) \right) dG(\beta_H) \right) \tag{43}$$

The first order condition for the maximization of expected profits (19) is given by:

$$C\lambda k^{C-1}\gamma(k) + \lambda k^C \frac{\partial \gamma}{\partial k} + f_x \int_{\underline{\beta}_H}^{\overline{\beta}_H} \frac{\partial \beta_F^I(\beta_H, k)}{\partial k} g(\beta_F^I(\beta_H, k)) dG(\beta_H) = r \tag{44}$$

where the first part of the left hand side corresponds to the direct effect of an increase in k, which raises variable profits whatever the short run shocks. The second and third terms on the left hand side stand for the fact that if a firm has more capital, it may[41] find it profitable to export for more realizations of the short run shocks, thereby raising the profits.

If $\underline{\beta}_F < \beta_F^I < \overline{\beta}_F$, the envelope theorem shows that the combined effect of the second and third terms on the left hand side is zero, as β_F^I is defined as making firms indifferent between exporting or not. Otherwise, $\frac{\partial \beta_F^I}{\partial k} = 0$, so that $\frac{\partial \gamma}{\partial k}$ and $\frac{\partial \beta_F^I(\beta_H,k)}{\partial k}$ are equal to zero. The optimal capital level k^* is therefore the solution to:

$$k^* = \left(\frac{C\lambda}{r}\right)^{\frac{1}{1-C}} \gamma(k^*)^{\frac{1}{1-C}} \tag{45}$$

and the maximized expected profits can be rewritten as:

$$E(\pi) = \lambda^{\frac{1}{1-C}} \left(\frac{C}{r}\right)^{\frac{C}{1-C}} (1-C)\gamma(k^*)^{\frac{1}{1-C}} - f - f_x \left(\int_{\underline{\beta}_H}^{\overline{\beta_H}} (1 - G_F(\beta_F^I(\beta_H))) dG_H(\beta_H) \right) \tag{46}$$

I now turn to the second derivative of expected profits in order to determine whether there exists a unique capital level maximising expected profits. If β_F^I is constant, as is the case when it is equal to one of the boundaries of the support of β_F, the only impact of k on expected profits is through the direct effect, reflected by the first term in (44). This effect is concave, and the whole problem is therefore concave if $\beta_F^I = \overline{\beta}_F$ or if $\beta_F^I = \underline{\beta}_F$. For intermediate values of β_F^I, however, an increase in capital raises the probability with which it exports, and therefore its profits. If this dominates the last effect, the objective function may not be concave for all k.

The second derivative of expected profits is given by:

$$\frac{\partial^2 E(\pi)}{\partial^2 k} = C\lambda(C-1)k^{C-2}\gamma(k) + C\lambda k^{C-1} \frac{\partial \gamma(k)}{\partial k} \tag{47}$$

[41] as long as $\underline{\beta}_F < \beta_F^I < \overline{\beta}_F$

where

$$\frac{\partial \gamma(k)}{\partial k} = -\frac{f_x k^{-C}}{\lambda}\left(\int_{\underline{\beta}_H}^{\overline{\beta}_H} g_F\left(\beta_F^I(\beta_H,k)\right)\frac{\partial \beta_F^I(\beta_H,k)}{\partial k} dG_H(\beta_H)\right) \tag{48}$$

$$= \frac{C}{1-C}k^{-2C-1}\left(\frac{f_x}{\lambda}\right)^2\frac{1}{\tau^{1-\epsilon}\chi_F}\left[\int_{\underline{\beta}_H}^{\overline{\beta}_H}\left(\frac{f_x k^{-C}}{\lambda}+(\chi_H\beta_H)^{1-C}\right)^{\frac{C}{1-C}} dG(\beta_H)\right] \tag{49}$$

There will be a unique profit-maximizing capital level if $\frac{\partial^2 E(\pi)}{\partial^2 k} < 0$, i.e. if $\frac{\partial \gamma(k)}{\partial k} < (1-C)\frac{\gamma(k)}{k}$, which states that the indirect effect of capital on expected profits be weaker than the direct effect.

The analysis is only concerned with firms which do find it profitable to produce, as non producers choose a capital level of zero. The present maximization problem applies to producing firms, i.e. firms for which:

$$\lambda k^C\gamma(k) > rk + f + fx\left(\int_{\underline{\beta}_H}^{\overline{\beta}_H}(1-G(\beta_F^I(\beta_H)))dG(\beta_H)\right) \tag{50}$$

and

$$\gamma(k) > \frac{fk^{-C}}{\lambda} \tag{51}$$

is therefore a necessary condition for a firm to produce.

From (47), (49) and (51), a sufficient condition for the second order condition of a producing firm to be negative is that:

$$\frac{(1-C)^2}{C}\frac{f}{f_x} > \frac{f_x k^{-C}}{\lambda}\frac{1}{\tau^{1-\epsilon}\chi_F}\left[\int_{\underline{\beta}_H}^{\overline{\beta}_H}\left(\frac{f_x k^{-C}}{\lambda}+(\chi_H\beta_H)^{1-C}\right)^{\frac{C}{1-C}} dG(\beta_H)\right] \tag{52}$$

This condition can be rewritten as:

$$\frac{(1-C)^2}{C}\frac{f}{f_x}\tau^{1-\epsilon}\chi_F > \int_{\underline{\beta}_H}^{\overline{\beta}_H}\left(\left(\frac{f_x k^{-C}}{\lambda}+(\chi_H\beta_H)^{1-C}\right)^{\frac{1}{1-C}}-\chi_H\beta_H\right)dG_H(\beta_H) \tag{53}$$

$$+ \int_{\underline{\beta}_H}^{\overline{\beta}_H}\left(\chi_H\beta_H-(\chi_H\beta_H)^{1-C}\left(\frac{f_x k^{-C}}{\lambda}+(\chi_H\beta_H)^{1-C}\right)^{\frac{C}{1-C}}\right)dG_H(\beta_H) \tag{54}$$

where the second line of the right hand side is negative (it would be zero if $\frac{f_x k^{-C}}{\lambda}$ were equal to zero).

From the definition of β_F^I, it is sufficient that:

$$\frac{(1-C)^2}{C}\frac{f}{f_x} > \int_{\underline{\beta}_H}^{\overline{\beta}_H}\beta_F^I(\beta_H)g(\beta_F^I(\beta_H))dG_H(\beta_H) \tag{55}$$

which is guaranteed by Assumption 1.

Q.E.D.

8.2 Proof of Proposition 2

8.2.1 Proof of Part 1

A firm is indifferent between selling only on its domestic market and not producing at all if its χ_H is such that its maximized expected profits, which are given by (46), are equal to zero. I denote the home demand level that fulfills this condition as χ_H^*:

$$\lambda^{\frac{1}{1-C}}\left(\frac{C}{r}\right)^{\frac{C}{1-C}}(1-C)\chi_H^*\left(\int_{\underline{\beta}_H}^{\overline{\beta}_H}\beta_H^{1-C}\right)^{\frac{1}{1-C}}=f \tag{56}$$

All firms with $\chi_H \geq \chi_H^*$ produce in equilibrium. For χ_F small enough, $\beta_F^I = \overline{\beta}_F$ for all β_H and the firm never exports. For sufficiently high χ_F, $\beta_F^I = \underline{\beta}_F$ for all β_H and the firm always exports, while it is a switcher for intermediate values of χ_F.

8.2.2 Proof of Part 2

The proof of part 2 consists of two parts. I show that the higher the χ_H of a firm (i) the lower is the required χ_F to be a switcher and (ii) the higher the required χ_F to be a continuous exporter.

- Limit between non-exporters and switchers

Conditional on producing, a firm is indifferent between switching and not exporting if:

$$\lambda^{\frac{1}{1-C}}\left(\frac{C}{r}\right)^{\frac{C}{1-C}}\left[\int_{\underline{\beta}_H}^{\overline{\beta_H}}(\chi_H\beta_H)^{1-C}dG_H(\beta_H)\right]^{\frac{C}{1-C}}\left[\left(\chi_H\underline{\beta}_H+\tau^{1-\epsilon}\chi_F\overline{\beta}_F\right)^{1-C}-(\chi_H\underline{\beta}_H)^{1-C}\right]=f_x \tag{57}$$

The above condition implies that the firm would consider exporting only in the most favorable conditions (for $\underline{\beta}_H$ and $\overline{\beta}_F$). This defines an indifference schedule between never exporting and switching:

$$\chi_F^{NS}(\chi_H)=\frac{\chi_H\underline{\beta}_H}{\tau^{1-\epsilon}\overline{\beta}_F}\left(\left(\frac{A\underline{\beta}_H^{C-1}}{\chi_H}+1\right)^{\frac{1}{1-C}}-1\right) \tag{58}$$

where I define: $A \equiv f_x\lambda^{-\frac{1}{1-C}}\left(\frac{C}{r}\right)^{\frac{C}{C-1}}\left[\int_{\underline{\beta}_H}^{\overline{\beta_H}}\beta_H^{1-C}dG_H(\beta_H)\right]^{\frac{C}{C-1}}$ to simplify notation.

The first derivative of $\chi_F^{NS}(\chi_H)$ with respect to χ_H can be shown to be negative (noting that the second derivative is positive, and that the limits for $\chi_H \to 0$ and for $\chi_H \to \infty$ are respectively $-\infty$ and 0). The larger the χ_H, the lower the χ_F for which firms are indifferent between being a switcher and a non-exporter. The reason is that firms with high χ_H have a higher capital level and therefore lower marginal costs of production, allowing them to make profits more easily on the export market. Furthermore, using L'Hopital's rule:

$\lim_{\chi_H\to\infty}\chi_F^{NS}(\chi_H) = \frac{1}{1-C}\frac{A\underline{\beta}_H^C}{\tau^{1-\epsilon}\underline{\beta}_F} > 0$. There exists a critical level of χ_F below which firms never export, regardless of their domestic demand level χ_H.

- Limit between continuous exporters and switchers

Conditional on producing, a firm is indifferent between switching and continuously exporting if:

$$\lambda^{\frac{1}{1-C}} \left(\frac{C}{r}\right)^{\frac{C}{1-C}} \chi_H \left[\int_{\underline{\beta}_H}^{\overline{\beta}_H} \int_{\underline{\beta}_F}^{\overline{\beta}_F} \left(\beta_H + \frac{\tau^{1-\epsilon}\chi_F \beta_F}{\chi_H}\right)^{1-C} dG_F(\beta_F) dG_H(\beta_H)\right]^{\frac{C}{1-C}} \left[\left(\overline{\beta}_H + \frac{\tau^{1-\epsilon}\chi_F \underline{\beta}_F}{\chi_H}\right)^{1-C} - \overline{\beta}_H^{1-C}\right] = f_x \quad (59)$$

which is the case if the firm is indifferent between exporting or not in the most unfavorable case ($\overline{\beta}_H$ and $\underline{\beta}_F$) for exporting. The above equation defines an indifference schedule $\chi_F^{ES}(\chi_H)$ between continuously exporting and switching.

The derivative of the left hand side with respect to χ_F is clearly positive, as it both raises the capital level and the returns to exporting. The derivative of the left hand side with respect to χ_H is on the other hand negative. This can be shown by noting that the derivative is proportional to: $\frac{C}{1-C}\tilde{x}(1 - x^{1-C}) + (x - x^{1-C})$ with $0 < \tilde{x} < x < 1$, where:

$$x = \frac{\chi_H \overline{\beta_H}}{\chi_H \overline{\beta_H} + \tau^{1-\epsilon}\chi_F \underline{\beta}_F}$$

$$\tilde{x} = \frac{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \int_{\underline{\beta}_F}^{\overline{\beta}_F} (\chi_H\beta_H + \tau^{1-\epsilon}\chi_F\beta_F)^{1-C} \frac{\chi_H\beta_H}{\chi_H\beta_H + \tau^{1-\epsilon}\chi_F\beta_F} dG_F(\beta_F)dG_H(\beta_H)}{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \int_{\underline{\beta}_F}^{\overline{\beta}_F} (\chi_H\beta_H + \tau^{1-\epsilon}\chi_F\beta_F)^{1-C} dG_F(\beta_F)dG_H(\beta_H)}$$

The derivative of $\chi_F^{ES}(\chi_H)$ with respect to χ_H is therefore positive: the higher the χ_H of a firm, the larger the required χ_F for it to be a continuous exporter. The reason is that the home market is important in the sales of a firm with a large χ_H. Such a firm is therefore more sensitive to shocks on the home market than a firm with a lower χ_H and it may find it profitable to stop exporting when the demand shock is very good on the home market.

Using the property that the limit of a product is equal to the product of the limit, the limit of the right hand side above can be rewritten as:

$$\lim_{\chi_H \to \infty} f_x A^{-1} \chi_H \left(\left(\overline{\beta}_H + \frac{\tau^{1-\epsilon}\chi_F \underline{\beta}_F}{\chi_H}\right)^{1-C} - \overline{\beta}_H^{1-C}\right)$$

Using l'Hopital's rule yields: $\lim_{\chi_H \to \infty} \chi_F^{ES}(\chi_H) = \frac{1}{1-C} \frac{A\overline{\beta}_H^C}{\tau^{1-\epsilon}\underline{\beta}_F} > 0$

All firms having a χ_F above this limit value are continuous exporters, regardless of their χ_H.

8.2.3 Proof of Part 3

It follows immediately from the definition of χ_H^* in (56) that a firm with $\chi_H < \chi_H^*$ would rather not produce at all than be a non-exporter.

8.3 Proof of Corollary 1

From (45), the optimal capital level of a firm is:

$$k^* - \left(\frac{C\gamma}{r}\right)^{\frac{1}{1-C}} \gamma(k^*, \chi_H, \chi_F) \tag{60}$$

Consider two firms with the same χ_H but different χ_F. Totally differentiating the above equation yields:

$$dk^* \left(1 - \frac{k^*}{\gamma(k^*)} \frac{\partial \gamma}{\partial k^*}\right) - \left(\frac{C\lambda}{r}\right)^{\frac{1}{1-C}} \frac{\partial \gamma}{\partial \chi_F} d\chi_F \tag{61}$$

8.4 Proof of Prediction 1

Noting that $\frac{\partial g_{Git}(\mu_H,\mu_f)}{\partial \beta_{Ht}} = -\frac{\partial g_{Git}(\mu_H,\mu_f)}{\partial \beta_{Ht-1}} \equiv g_i^H$ and $\frac{\partial g_{Git}(\mu_H,\mu_f)}{\partial \beta_{Ft}} = -\frac{\partial g_{Git}(\mu_H,\mu_f)}{\partial \beta_{Ft-1}} \equiv g_i^F$, the first order Taylor expansion of g_{Git} is given by:

$$g_{Git} \approx g_i(\mu_H, \mu_F) + g_i^H(\beta_{Ht} - \beta_{Ht-1}) + g_i^F(\beta_{Ft} - \beta_{Ft-1}) \tag{62}$$

The covariance between the growth of domestic sales g_{GH} and the growth of exports of an exporter g_{GF} can therefore be approximated as follows:

$$\begin{aligned} Cov(g_{GH}, g_{GF}) &= E[(g_{GH} - E(g_{GH}))(g_{GF} - E(g_{GF}))] \\ &\approx E[(\beta_{Ht} - \beta_{Ht-1})^2 g_H^H g_F^H + (\beta_{Ft} - \beta_{Ft-1})^2 g_H^F g_F^F] \\ &+ E\left[(\beta_{Ht} - \beta_{Ht-1})(\beta_{Ft} - \beta_{Ft-1})(g_H^H g_F^F + g_F^H g_H^F)\right] \end{aligned}$$

Since β_H and β_F are i.i.d., the above expression reduces to:

$$Cov(g_{GH}, g_{GF}) \approx 2g_H^H g_F^H \sigma_H^2 + 2g_H^F g_F^F \sigma_F^2 < 0 \tag{63}$$

where the inequality comes from (23) and (24), and their counterparts for g_{GF}. This proves that the approximations of the growth rates of domestic sales and of exports are negatively correlated.

8.5 Proof of Lemma 1

The expected growth rate of domestic sales of a switcher which starts exporting can be rewritten as:

$$\begin{aligned} E_{DX}(g_{GHt}^{DX}) = (1-C) &\left(\frac{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \left(1 - G_F\left(\beta_F^I(\beta_H)\right)\right) log(\chi_H \beta_H) dG_H(\beta_H)}{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \left(1 - G_F\left(\beta_F^I(\beta_H)\right)\right) dG_H(\beta_H)} - \frac{\int_{\underline{\beta}_H}^{\overline{\beta}_H} G_F\left(\beta_F^I(\beta_H)\right) log(\chi_H \beta_H) dG_H(\beta_H)}{\int_{\underline{\beta}_H}^{\overline{\beta}_H} G_F\left(\beta_F^I(\beta_H)\right) dG_H(\beta_H)} \right) \\ +C &\left(\frac{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \left(1 - G_F\left(\beta_F^I(\beta_H)\right)\right) log(\chi_H \beta_H) dG_H(\beta_H)}{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \left(1 - G_F\left(\beta_F^I(\beta_H)\right)\right) dG_H(\beta_H)} - \frac{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \int_{\beta_F^I(\beta_H)}^{\overline{\beta}_F} log\left(\beta_H \chi_H + \tau^{1-\epsilon} \chi_F \beta_F\right) dG_F(\beta_F) dG_H(\beta_H)}{\int_{\underline{\beta}_H}^{\overline{\beta}_H} \left(1 - G_F\left(\beta_F^I(\beta_H)\right)\right) dG_H(\beta_H)} \right) \end{aligned} \tag{64}$$

The first line reflects the difference in average β_H between the cases in which a switcher exports and does not export. Since $\beta_F^I(\beta_H)$ is increasing in β_H, the first line is negative and reflects that if a switcher starts exporting, it is likely that he received a lower domestic demand shock than before, inducing him to export.

The second line, which is also negative as long as $\chi_F > 0$ reflects that the switcher now sells part of its production on the export market, and therefore sells less on the domestic market due to the convexity of short run costs of production.

Note that $E_{XD}(g_{GHt}^{XD}) = -E_{DX}(g_{GHt}^{DX})$ and that the reverse argument holds for the case of a firm which stops exporting.

8.6 Construction of the instruments

To be added.

8.7 Extension to many markets

To be added.

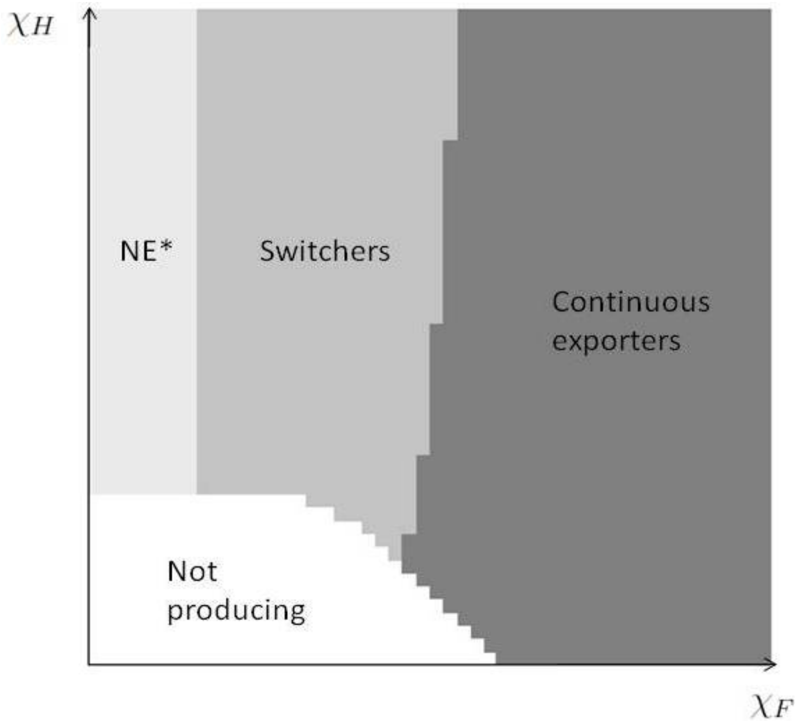

Figure 2: Optimal export strategies. Optimal strategies as a function of the χ_H and χ_F parameters. NE refers to the non exporting strategy. For the simulation, β_H and β_F are drawn independently from a uniform distribution with lower bound 0.5 and upper bound 1.5. Furthermore, I assume $A = 1$, $C = 0.2$, $\lambda = 1$, $r = 0.2$, $fx = 1$, $f = 1$. The picture is qualitatively robust to changing any of these parameters.

Table 3: Test of Prediction 1. Dependent variable: log growth of exports.

	POLS1	POLS2	FE1	FE2	FD1	FD2
growth rate of dom. sales	**-0.080*** **	**-0.079*** **	**-0.164*** **	**-0.151*** **	**-0.208*** **	**-0.188*** **
	(0.023)	(0.028)	(0.024)	(0.031)	(0.026)	(0.034)
age	-0.001***	-0.001***				
	(0.000)	(0.000)				
leverage	-0.000**	-0.000*				
	(0.000)	(0.000)				
log(mean sales)	-0.022***	-0.015**				
	(0.006)	(0.007)				
log(mean ta. fixed assets)	0.006	0.001				
	(0.005)	(0.006)				
mean openness	-0.450***	-0.421***				
	(0.017)	(0.019)				
growth rate of ta. fixed assets		0.075***		0.052***		0.014**
		(0.012)		(0.013)		(0.006)
growth rate of employment		0.000*		0.000**		0.000**
		(0.000)		(0.000)		(0.000)
Constant	0.607***	0.430***	0.228***	0.336***	-0.029	-0.036
	(0.066)	(0.069)	(0.010)	(0.015)	(0.020)	(0.025)
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
sector dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	68821	46606	68867	46621	68867	42259
R-squared	0.020	0.021	0.003	0.003	0.002	0.002

Robust s.e. in brackets. * indicates significance at the 10%, ** at the 5% and *** at the 1% levels

Table 4: Test of Prediction 3.

Dep. variable	Log(VARD)	Log(VARD)	Log(VARX)	Log(VARX)
log(mean sales)	-0.137***	-0.120***	-0.223***	-0.176***
	(0.018)	(0.019)	(0.022)	(0.022)
age	-0.004***	-0.002***	-0.005***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
log(mean ta. fixed assets)	-0.042***	-0.044***	-0.023	-0.033*
	(0.015)	(0.015)	(0.018)	(0.017)
log(mean leverage)	0.047***	0.043***	0.061***	0.056***
	(0.009)	(0.009)	(0.011)	(0.011)
mean openness	**2.511*** **	**2.420*** **	**-7.208*** **	**-5.917*** **
	(0.175)	(0.181)	(0.232)	(0.233)
mean openness squared	**-0.347**	**-0.549** **	**4.911*** **	**4.018*** **
	(0.217)	(0.227)	(0.291)	(0.289)
paris	0.112*	0.112*	0.029	0.032
	(0.057)	(0.059)	(0.074)	(0.073)
log(mean intang. fixed assets)		-0.015**		-0.028***
		(0.006)		(0.008)
lnmgdturn		2.695***		
		(0.153)		
lnmgexpt				1.350***
				(0.063)
Constant	-2.954***	-3.184***	1.480***	0.792***
	(0.175)	(0.171)	(0.227)	(0.208)
sector dummies	Yes	Yes	Yes	Yes
N	10617	9747	10617	9747
R-squared	0.259	0.302	0.334	0.431

Robust s.e. in brackets. * indicates significance at the 10%, ** at the 5% and *** at the 1% levels

Table 5: Test of Prediction 3 - Robustness

Dependent variable	Log(VARD)	Log(VARX)
log(mean sales)	-0.140***	-0.156***
	(0.025)	(0.027)
age	-0.001	-0.000
	(0.001)	(0.001)
log(mean ta. fixed assets)	-0.051***	-0.047**
	(0.018)	(0.019)
log(mean leverage)	0.038***	0.047***
	(0.011)	(0.012)
log(mean intang. fixed assets)	-0.008	-0.016*
	(0.008)	(0.008)
mean openness	2.436***	-5.273***
	(0.389)	(0.420)
mean openness squared	-0.758***	3.684***
	(0.272)	(0.318)
mean openness*log(mean sales)	0.026	-0.017
	(0.042)	(0.044)
paris	0.129*	-0.018
	(0.072)	(0.081)
lnmgdturn	0.305***	
	(0.014)	
lnmgexpt		0.515***
		(0.015)
Constant	-1.850***	1.976***
	(0.229)	(0.265)
sector dummies	Yes	Yes
N	6888	7883
R-squared	0.343	0.495

Robust s.e. in brackets. * indicates significance at the 10%, ** at the 5% and *** at the 1% levels

Table 6: Test of Prediction 3 - 2SLS stage 1

Dep. variable	Mean openness
dist. to border (in hundred km)	**-0.028*** **
	(.004)
log(mean sales)	.018***
	(.003)
log(mean ta. fixed assets)	.012***
	(.002)
age	-.000***
	(.000)
log(mean leverage)	.003**
	(.001)
mean growth of ta. fixed assets	-.002
	(.005)
Paris	.085***
	(.009)
Constant	-.011***
	(.019)
sector dummies	Yes
N	10475
R-squared	.204

Robust s.e. in brackets. * indicates significance at the 10%, ** at the 5% and *** at the 1% levels

Table 7: Test of Prediction 3 - 2SLS stage 2

Dep. variable	Log(VARD)	Log(VARX)
mean openness	**1.570****	**-2.472****
	(0.744)	(1.005)
log(mean sales)	-0.126***	-0.258***
	(0.022)	(0.027)
log(mean ta. fixed assets)	-0.036**	-0.025
	(0.017)	(0.022)
age	-0.004***	-0.005***
	(0.001)	(0.001)
mean growth of tang. fixed assets	0.151***	0.129***
	(0.036)	(0.044)
log(mean leverage)	0.048***	0.056***
	(0.009)	(0.012)
Paris	0.211***	-0.034
	(0.081)	(0.108)
Constant	-3.432***	1.159***
	(0.168)	(0.223)
sector dummies	Yes	Yes
N	10475	10475
R-squared	0.231	0.295

Robust s.e. in brackets. * indicates significance at the 10%, ** at the 5% and *** at the 1% levels

Table 8: Test of Prediction 4. Dependent variable: Log(VAR)

log(mean sales)	-0.154***
	(0.011)
age	-0.010***
	(0.001)
log(mean ta. fixed assets)	0.027***
	(0.009)
log(mean intang. fixed assets)	-0.047***
	(0.004)
log(mean leverage)	0.073***
	(0.005)
continuous exporter dummy	-0.109***
	(0.028)
mean openness	1.588***
	(0.189)
mean openness squared	-0.789***
	(0.255)
paris	0.233***
	(0.041)
lnmgturn	
Constant	-2.987***
	(0.108)
sector dummies	Yes
N	27210
R-squared	0.203

Robust s.e. in brackets. * indicates significance at the 10%, ** at the 5% and *** at the 1% levels