

EXPORTER DYNAMICS AND INVESTMENT UNDER UNCERTAINTY

Nicolas BERMAN* Vincent REBEYROL†

Preliminary draft

Abstract

This paper studies the way in which the dynamics of exports affect investment. We first develop a simple model to study the investment behavior of firms when both domestic and export sales are uncertain. We emphasize the consequences a decrease in uncertainty as firms gain experience in foreign markets. Two main testable predictions emerge: (i) if foreign markets are inherently more uncertain than the domestic market - due for instance to longer time-to-ship, exchange rate volatility or trade policy - investment should be less responsive to export sales than domestic sales; (ii) if experience in the export market reduces uncertainty about future sales, positive shocks affecting exports may trigger more investment some time after entry. These predictions are supported on a panel of French firms over the period 1993-2001. We also find that exporting experience and uncertainty interact with each other: experience matters more for the most volatile markets, and uncertainty matters more at low levels of experience. In general, these results can be interpreted as evidence supporting the presence of a strong uncertainty associated with entry into foreign markets that eventually vanishes as exporters gain experience on this market.

JEL classification:

Keywords: Export dynamics, uncertainty, investment, productivity

*Graduate Institute of International and Development Studies (IHEID). Address: Case Postale 136, CH - 1211, Geneva 21 - Switzerland. Tel: (0041) 22 908 5935. E-mail: nicolas.berman@graduateinstitute.ch.

†Toulouse School of Economics. Address: Manufacture des Tabacs, 21, Allée de Brienne, 31000 Toulouse France. E-mail: vincent.rebeyrol@tse-fr.eu

1 Introduction

Recent literature in international trade has documented the fact that new exporters start small and that their exit rate is high in the first years.¹ This has been interpreted as reflecting the high uncertainty associated with entry into new markets. On the other hand, firms that manage to remain exporters grow quickly after entry and their exit rate decreases dramatically three to four years after entry (Eaton *et al.*, 2007). These dynamics of successful exporters suggest that uncertainty is progressively resolved as firms gain experience in the foreign market.

Since the early contribution of Arrow (1968), uncertainty is recognized to play an important role on the investment behavior of firms, as long as those investments are at least partly irreversible. Higher uncertainty should lead firms to delay investment because of the existence of a positive “option value of waiting” (McDonald and Siegel, 1986, Dixit and Pindyck, 1994). In addition, uncertainty makes investment behavior more cautious and less responsive to sales variations (Pindyck, 1988, Bloom *et al.*, 2007).

This paper relates these two strands of the literature by studying the impact of domestic and foreign demand uncertainty on the investment behavior of new exporters. We first develop an illustrative model of irreversible investment under uncertainty, in line with the literature, to highlight how a possible different level of uncertainty in the domestic and in the export market affects the investment behavior of exporters. Our model has some clear testable implications. First, if foreign markets are inherently more uncertain than the domestic one - due for instance to longer time-to-ship, exchange rate volatility or trade policy - investment should be less responsive to shocks on export sales than on domestic sales. Second, if we assume that experience in the export market softens the uncertainty problem, a positive shock on foreign demand should lead to higher investments some time after entry. This implies that the export dynamics affects the dynamics of investment, but in a different way than domestic sales do.

The main predictions of the model are tested using firm-level data on French firms over the period 1993-2001. Among others, our dataset contains balance-sheet information on both export and domestic sales, as well as capital stock and investment. For a significant share of the observations, investment is zero, which allows to test our theoretical predictions not only on the size, but also on the existence of investment. Our theory is supported by the data: investment is more responsive to changes in exports when export uncertainty (as proxied by a sector-specific

¹For instance, Eaton *et al.* (2007) found using Colombian data that only 30 to 35% of entrants are still exporting the second year. See also Albornoz-Crespo *et al.* (2010)

measure of growth volatility) is lower, and as the firm gains experience on the foreign markets. This is true both for the investment rate and the investment probability. Finally, export experience and uncertainty interact with each other: experience matters more for the more volatile markets, and uncertainty matters more at low levels of experience. In general, these results can be interpreted as evidence supporting the presence of a strong uncertainty associated with entry into foreign markets that eventually vanishes as exporters gain experience on this market. They also suggest an effect of the export dynamics on firm-behavior and characteristics.

Our paper first relates to the real options literature, which suggests that investment reacts less to demand shocks at higher levels of uncertainty, as firms place a greater value on the option of waiting. The main idea of these papers is to outline the additional value for the firm of being able to choose when to invest, rather than being in a "now-or-never" situation with respect to a possible investment. If a firm can wait for new information to arrive before deciding to pursue an irreversible investment, it can avoid potentially large losses by foregoing the investment when the outcome is unfavorable. Hence, a result from option-pricing applies to irreversible investments: the greater the uncertainty in an investment's expected future cash flows, the more valuable is the option to delay the investment. This literature both considers the timing and the size of investments (and so the evolution of the optimal capital stock) under uncertainty.² This issue is closely related to our paper as we study the reaction of the investment rate of new exporters to demand shocks at home and abroad.³

On the empirical side, the real option literature has also generated a lot of attention.⁴ Our paper is methodologically close to Bloom *et al.* (2007), who investigate the firms' investment rate response to demand shocks for different level of uncertainty. Using a panel of U.K. publicly traded manufacturing companies, they find that a moving from the bottom to the top quartile of uncertainty halves the sensitivity of investment to sales variations. Our results on uncertainty are in line, and quantitatively similar to theirs.

²See Pindyck (1988), Abel and Eberly (1998) and Abel *et al.* (1996) for a simple finite-horizon framework.

³An important contribution is Pindyck (1988). He presents the firm's problem as a decision to invest in the marginal unit of capital which is valued as a real option. The firm's objective is to choose its optimal capital stock that maximizes firm value. It firm evaluates a succession of options to invest in each additional unit of capital. The firm exercises each investment option consecutively until it reaches its optimal capital stock. When uncertainty is greater, the value of the option to invest in the additional unit of capital increases, which leads to a lower optimal capital stock. Uncertainty therefore makes investment behavior more cautious and less responsive to sales variations. Our model follows this line of research and adapts a simplified version of Abel *et al.* (1996) to the case of new exporters.

⁴See for instance Guiso and Parigi (1999), Ghosal and Loungani (2000) or Boyle and Guthrie (2003).

Our paper is also related to the strand of international trade literature documenting the relationships between exporting activities, investment and TFP growth. Exporters have been shown to be larger and more productive than non-exporters, mainly because of a self-selection process, but also, to a lesser extent, to export-related productivity gains.⁵ To explain this exporters' performance premium, the literature more recently focused on the complementarity between export market participation and investment. Recent theoretical contributions show that access to foreign markets provides incentives for firms to make productivity-enhancing investments.⁶ Empirically, Lileeva and Trefler (2010) found evidence in favor of this hypothesis, especially for small firms, using data on Canadian plants.⁷ Our paper complements this literature by showing that the way in which investment (and potentially TFP) reacts to entry into foreign markets may depend on the degree of success and on the length of export market participation.

Finally, our study also relates to a recent paper by Handley and Limao (2011) who show that uncertainty about trade policy may negatively affect investment and export participation. Their paper however mainly focuses on entry into export markets, while ours looks at investment decisions, and considers both general uncertainty and the role of exporting experience.

Our results have several implications. The general message of the literature dealing with the effect of uncertainty on investment is that firms are less responsive to monetary or fiscal policies in the presence of uncertainty, for instance in times of crisis. Similarly, our results imply that shocks affecting the export market - aggregate demand shocks, trade policies or exchange rate changes - may have a lower impact on investment in more volatile markets, or in more uncertain times. A second implication is that a positive effect of exporting on investment and ultimately on productivity may be observed, but with a lag: while an increase in market size is complementary to (potentially cost-reducing) investment, this complementarity may be guaranteed for the firm only after some time, once uncertainty has sufficiently vanished. Finally, the effect of exporting on investment, and in turn productivity, may be higher in less volatile sectors, markets, or more during stable periods.

⁵A plethora of literature has tried to identify the effect of exporting on TFP - the so-called learning-by-exporting hypothesis-, with mixed results. See Wagner (2007) for a survey. Evidence in favor of learning by exporting effect has been found by Aw *et al.* (2003) for Korea and Taiwan, De Loecker (2007) or Van Biesebroeck (2005) for Sub-Saharan African countries.

⁶See Costantini and Melitz (2009), Atkeson and Burstein or Burstein and Melitz (2011).

⁷Similarly, Verhoogen (2008) found that firms entering foreign markets in Mexico simultaneously upgrade the quality of their products.

The next section presents our model of firm investment under uncertainty in the export market, and derive a number of testable predictions. Section 3 presents the empirical methodology and estimation issues, and section 4 describe the data used to test our main theoretical predictions. Finally, section 5 contains the empirical results and section 6 concludes.

2 Theory: Firm investment behavior under uncertainty in the domestic and export markets

2.1 General assumptions

We model the investment behavior of a firm selling a good in its domestic market and in the export market. We further consider that the firm just entered the export market while it has been operating in its domestic market for some time. We therefore concentrate on the investment behavior of a firm conditional on its entry in the export market.

The firm faces an isoelastic demand in market i ($i = D, X$) at time t :

$$Q_{it} = A_{it}P_{it}^{-\varepsilon} \quad (1)$$

where $\varepsilon > 1$ is the price elasticity of demand, assumed to be identical across markets.⁸ A_{it} is a scale demand parameter. The production function of the firm is assumed to be Cobb-Douglas⁹ with constant returns to scale:

$$Y_t = K_t^\beta L_t^{1-\beta} \quad (2)$$

where L denotes labor, K capital and $1 - \beta$ the labor share, with $\beta < 1$. The output is non storable. The firm's profit function writes:

$$\pi_t = P_{Dt}Q_{Dt} + P_{Xt}Q_{Xt} - wL_t - kK_t \quad (3)$$

The assumption of constant returns to scale together with isoelastic demands leads the firm to only adjust quantities to a demand shock in each market, its optimal price being constant.

⁸Introducing different elasticities doesn't add to the model, as long as price elasticities are constant.

⁹All our qualitative results carry through the assumption of a CES production function with constant returns to scale.

Using the fact that $Q_{Dt} + Q_{Xt} = Y_t = (A_{Dt} + A_{Xt}) P_t^{-\varepsilon}$, we can rewrite the profit function as:

$$\pi_t = Y_t^{1-1/\varepsilon} (A_{Dt} + A_{Xt})^{1/\varepsilon} - wL_t - kK_t \quad (4)$$

The firm can purchase capital at a constant price k but is unable to sell capital (i.e. the selling price of capital is 0). The capital stock is thus perfectly irreversible.¹⁰ We also assume that the capital stock does not depreciate. Therefore, the evolution of the capital stock K_t depends only on the firm's purchases of capital. On the other hand, labor is assumed to be a completely flexible and reversible factor of production with a price w . In each period, the firm observes demand at home (A_{Dt}) and abroad (A_{Xt}) and then decides its level of investment. We denote I_t the purchase of capital at time t . Therefore, $K_t = K_{t-1} + I_t$. The profit function, where labor has been maximized out, is given by:

$$\begin{aligned} \pi_t &= a (A_{Dt} + A_{Xt})^{1-\alpha} (K_{t-1} + I_t)^\alpha - kI_t \\ \text{with } \alpha &= \frac{\beta(1-1/\varepsilon)}{1-B} < 1, a = \left(\frac{B}{w}\right)^{\frac{B}{1-B}} (1-B) \text{ and } B = (1-\beta)(1-1/\varepsilon) \end{aligned} \quad (5)$$

Equation (5) shows that domestic and foreign demand scale parameters enter the profit function symmetrically¹¹ Hence, for expositional convenience, we first focus on the aggregate demand term the firm is facing and label $A_t = A_{Dt} + A_{Xt}$.

A first important remark has to be made here. As $\alpha \neq 0$, a change in the variance of expected demand A_t will also affect the expectation of future profits. In our case, $\alpha < 1$, a decrease in the variance of A_t would increase expected profits and investments. This is a consequence of Jensen's inequality. In order to ensure that our results are not driven by this effect¹², we assume that the log of demand is stochastic rather than the level, i.e. we consider uncertainty about $A_t^{1-\alpha} \equiv \widetilde{A}_t$ rather than A_t . With this assumption, expectation of future

¹⁰Introducing partial irreversibility, with a selling price of capital lower than k , would not alter our main results.

¹¹It is worth to note that the optimal capital stock the firm chooses in this model could be easily reinterpreted as a choice of a performance measure, would it be productivity or quality. Considering 1 period only for clarity and calling $\varphi \equiv K^{1/\alpha}$, we would get:

$$\pi_t' = a (A_{Dt} + A_{Xt})^{1-\alpha} \varphi - k\varphi^{\frac{1}{\alpha}}.$$

In that case, sales increase with φ , the performance measure of the firm. To increase φ , the firm would however to incur convex adjustment costs ($\frac{1}{\alpha} > 1$).

¹²See Bloom (2000), among others, for a discussion about the role of the Jensen's inequality

profits depends only on the expectation of A_t and not its variance.¹³

To keep the model as simple as possible, we assume that uncertainty in each period is reflected by only two states of nature/demand: "good" (\widetilde{A}_t^+) with probability p or "bad" (\widetilde{A}_t^-) with probability $(1 - p)$. We further assume that demand shocks are proportional to \widetilde{A}_t . This assumption is in line with most of the literature modeling uncertainty in continuous time using geometric Brownian motions. Hence, we get:

$$\widetilde{A}_{t+1} = \begin{cases} \widetilde{A}_{t+1}^+ = \widetilde{A}_t(1 + \theta + \frac{\lambda}{p}) & \text{with proba } p \\ \widetilde{A}_{t+1}^- = \widetilde{A}_t(1 + \theta - \frac{\lambda}{1-p}) & \text{with proba } (1 - p) \end{cases}, \quad (6)$$

where θ is the expected growth rate of total demand and $\lambda > 0$ is the uncertainty parameter. The higher λ the higher uncertainty about future demand: with our formulation, an increase in λ induces a mean preserving spread of \widetilde{A}_{t+1} .

2.2 Equilibrium: two-period case

In this section we build on existing work on the theory of irreversible investments to show how experience of the export market, through its effect on uncertainty, can affect investment decisions. The simple theory we present here can be thought as a simple extension of Abel *et al* (1996) on optimal capacity choice under irreversibility and uncertainty. While they focus on the case of partial reversibility and partial expendability, we consider only perfect irreversibility to focus on different levels of uncertainty in the domestic and export market as well as the impact of a decreasing uncertainty due to export experience.

Following Abel *et al.* (1996), we use a simple 2 period framework. We think about the first period as the years around entry in the export market, and the second as being some time after entry. In period t , the firm is endowed with a capital stock K_{t-1} and is present in both domestic and foreign markets. The firm observes the current demand it faces in both markets and therefore total demand \widetilde{A}_t . It then decides whether to purchase capital and how much, while facing uncertainty on the next period's demand. In period $t + 1$, the second and final period, the firm does not face anymore uncertainty by construction.¹⁴ We therefore concentrate

¹³This change of variable allows to consider symmetric demand shocks on \widetilde{A}_t , while we would have had to consider asymmetric demand shocks on A_t to keep expected future profits constant.

¹⁴A 3-period version of this model, available upon request, shows that if uncertainty is substantial, investment decisions in each period solely depend on next period uncertainty.

on the possible investment decisions at time t .

The main advantage of considering a finite time horizon is that it allows to solve the model backwards. In period $t + 1$, the firm chooses the level of $I_{t+1}^* \geq 0$ which maximizes its profits:

$$\begin{aligned} \max_{I_{t+1}} \pi_{t+1} &= a\widetilde{A}_{t+1} (K_t + I_{t+1})^\alpha - kI_{t+1} \\ \Rightarrow I_{t+1}^* &= \widetilde{A}_{t+1}^{\frac{1}{1-\alpha}} \left(\frac{\alpha a}{k} \right)^{\frac{1}{1-\alpha}} - K_t \text{ if } I_{t+1} \geq 0 \end{aligned}$$

The firm chooses I_{t+1} to equalize the marginal revenue of capital ($\frac{\partial(a\widetilde{A}_{t+1}(K_t+I_{t+1})^\alpha)}{\partial I_{t+1}}$) with the user cost of capital (k). This investment rule has been first emphasized by Jorgenson (1963) in a dynamic context. The firm therefore makes a positive investment only if the capital stock K_t is not too large (i.e. if the marginal revenue of capital is not already lower than the user cost). This decision obviously depends on the realization of \widetilde{A}_{t+1} .

In period t , the firm chooses I_t to maximize its net present value at time t (NPV_t). This corresponds to the current profits, plus the uncertain profits in period $t+1$. A major issue raised by the literature on irreversible investments under uncertainty is that the correct expression of the net present value (NPV) should not just take into account (discounted) future expected profits flows, which would be the "naive" way of computing the NPV (see Abel *et al* 1996). The correct NPV should incorporate the optimal firm behavior in the future conditional on the realized future state of nature/demand. Put differently, the NPV should incorporate the option for the firm to make additional investments in the future if the "good" state is realized, or none if the "bad" one occurs.

The optimal investment in period $t + 1$ (I_{t+1}^*) depends both on the realized demand at time $t + 1$ (\widetilde{A}_{t+1}) and on the capital stock at the beginning of the period (K_t), which itself depends on the investment decision at time t (I_t). The correct NPV should therefore distinguish the impact of the current decision (I_t) on the future decision (I_{t+1}^*), for any possible realization of demand at time $t + 1$.

Hypothetically, 3 cases may arise. First, investment could be positive at time $t+1$, no matter the realized demand ($I_{t+1}^* > 0$ in all states). This case, however, can never be an outcome in our model, as we have assumed no time discounting and a constant user cost of capital. Indeed, it would mean that some units of capital are purchased with certainty at $t + 1$. It is however

always preferable for the firm to purchase those units at time t as they will also increase profits at time t .

Second, the firm may invest only if "good news" arrive: $I_{t+1}^* > 0$ if $\widetilde{A}_{t+1} = \widetilde{A}_{t+1}^+$ and $I_{t+1}^* = 0$ if $\widetilde{A}_{t+1} = \widetilde{A}_{t+1}^-$. This case is the most interesting as it highlights the value of new information in the future. Third, the firm may not invest at all, no matter the realized demand: $I_{t+1}^* = 0$ in all states. To foster intuition about the impact of uncertainty on firm's investment decisions, let us first assume that we are in the second situation. We will then check under which conditions this is indeed the case.

If the firm makes a positive investment at time $t + 1$ only when good news arrive, the firm has to maximize the following NPV:

$$\begin{aligned} \max_{I_t} NPV_t &= a\widetilde{A}_t (K_{t-1} + I_t)^\alpha - kI_t + p \left[a\widetilde{A}_{t+1}^+ (K_t + I_{t+1}^*)^\alpha - kI_{t+1}^* \right] + (1-p) \left[a\widetilde{A}_{t+1}^- (K_{t-1} + I_t)^\alpha \right], \\ &\text{if } I_{t+1}^* \geq 0 \text{ when } \widetilde{A}_{t+1} = \widetilde{A}_{t+1}^+ \end{aligned}$$

Which yields the following first order condition:

$$\frac{\partial NPV_t}{\partial I_t} = 0 \Leftrightarrow a\alpha (K_{t-1} + I_t)^{\alpha-1} \left[\widetilde{A}_t + (1-p) \widetilde{A}_{t+1}^- \right] = k \quad (7)$$

In order to stress the role of the option to invest in period 2, it is useful to rewrite the optimality condition as:

$$\frac{\partial NPV_t}{\partial I_t} = 0 \Leftrightarrow \underbrace{a\alpha (K_{t-1} + I_t)^{\alpha-1} \left(\widetilde{A}_t + E[\widetilde{A}_{t+1}] \right)}_{\text{expected MRK}} = \underbrace{k}_{\text{user cost of K}} + \underbrace{p \left(a\alpha (K_{t-1} + I_t)^{\alpha-1} \widetilde{A}_{t+1}^+ - k \right)}_{\text{option value}} \quad (8)$$

where $E[\widetilde{A}_{t+1}] = p\widetilde{A}_{t+1}^+ + (1-p)\widetilde{A}_{t+1}^- = (1+\theta)\widetilde{A}_t$ is the expected demand at $t + 1$. This optimality condition shows that the firm chooses the level of investment that equalizes the expected marginal revenue of capital to the user cost of capital, *plus* the value of the option to invest in period $t + 1$. Hence, the Jorgenson's rule of investment does not hold if the option to invest later once the demand level is known (i.e. new information has arrived) has a positive value. More precisely, the higher the option value, the lower the optimal investment compared to what would recommend a "naive" NPV (provided by the Jorgenson's rule). It appears in a straightforward way that the value of this option increases with uncertainty (an increase in

\widetilde{A}_{t+1}^+ keeping $E[\widetilde{A}_{t+1}]$ constant). Importantly, the option value also decreases with the capital stock $K_t = K_{t-1} + I_t$. This rule of investment yields the optimal investment at time t :

$$I_t^* = \left(\frac{\widetilde{A}_t + E[\widetilde{A}_{t+1}] - p\widetilde{A}_{t+1}^+}{(1-p)} \right)^{\frac{1}{1-\alpha}} \left(\frac{a\alpha}{k} \right)^{\frac{1}{1-\alpha}} - K_{t-1} \quad (9)$$

Investment in period t increases with the current level of demand \widetilde{A}_t and with the expected demand level at time $t+1$: $E[\widetilde{A}_{t+1}]$. But it also decreases with $p\widetilde{A}_{t+1}^+$, a measure of the option value of investing next period, or put differently a measure of uncertainty about future demand.

We have assumed that the firm invests at $t+1$ if "good news" arrive. We now have to check when this is indeed the case. In case of high demand realization in period $t+1$, we have:

$$\begin{aligned} I_{t+1}^* &= \left(\frac{\alpha a \widetilde{A}_{t+1}^+}{k} \right)^{\frac{1}{1-\alpha}} - \left(\frac{a\alpha \left(\widetilde{A}_t + E[\widetilde{A}_{t+1}] - p\widetilde{A}_{t+1}^+ \right)}{(1-p)k} \right)^{\frac{1}{1-\alpha}} \\ &\Rightarrow I_{t+1}^* \geq 0 \Leftrightarrow (1-p) \left(\widetilde{A}_{t+1}^+ - \widetilde{A}_{t+1}^- \right) \geq \widetilde{A}_t \Leftrightarrow \lambda \geq p \end{aligned}$$

This condition has a simple interpretation. Investment at $t+1$ will be positive with a high demand realization as long as the option value is positive. To see this, plug the optimal capital stock $K_{t-1} + I_t^*$ into the expression of the option value. The option value is positive only if $(1-p) \left(\widetilde{A}_{t+1}^+ - \widetilde{A}_{t+1}^- \right) \geq \widetilde{A}_t \Leftrightarrow \lambda \geq p$, i.e. if there is enough uncertainty. To understand this result, note that the firm faces a trade off at the margin, for a given capital stock. On the one hand, investing an extra unit of capital increases firm revenue at t with certainty. Waiting next period to invest this extra unit has therefore a cost. Call it the cost of waiting. On the other hand, not investing this extra unit today allows to keep alive the option to invest this unit tomorrow in case of good news and to avoid "regrets" in case of bad news. This is the value of waiting. The optimal strategy of the firm is to invest as long as the cost of waiting is larger than the value of waiting. But the larger the investment, the lower the option value. If $\lambda < p$, the cost of waiting, i.e. the revenue from an additional unit of capital invested at t (proportional to \widetilde{A}_t), is always higher than the possible revenue loss if bad news arrive (proportional to $(1-p) \left(\widetilde{A}_{t+1}^+ - \widetilde{A}_{t+1}^- \right)$) because uncertainty is small enough.

If this condition does not hold, i.e. we are in a situation where $\lambda < p$, the firm will never invest at $t+1$, no matter the level of the realized demand. We are thus back to the third of the cases listed above. The firm then maximizes the NPV which takes the following form:

$$\max_{I_t} NPV_t = a\widetilde{A}_t (K_{t-1} + I_t)^\alpha - kI_t + p \left[a\widetilde{A}_{t+1}^+ (K_{t-1} + I_t)^\alpha \right] + (1-p) \left[a\widetilde{A}_{t+1}^- (K_{t-1} + I_t)^\alpha \right],$$

if $I_{t+1}^* = 0$ in all states

The first order condition gives the optimal level of investment:

$$\begin{aligned} \frac{\partial NPV_t}{\partial I_t} = 0 &\Leftrightarrow \underbrace{a\alpha (K_{t-1} + I_t)^{\alpha-1} \left(\widetilde{A}_t + E[\widetilde{A}_{t+1}] \right)}_{\text{expected MRK}} = \underbrace{k}_{\text{user cost of capital}} \\ &\Rightarrow I_t^* = \left(\widetilde{A}_t + E[\widetilde{A}_{t+1}] \right)^{\frac{1}{1-\alpha}} \left(\frac{a\alpha}{k} \right)^{\frac{1}{1-\alpha}} - K_{t-1} \end{aligned}$$

If the firm never invests at $t + 1$, the firm is in a "now-or-never" situation with respect to its possible investment. We are then in a situation where the Jorgenson's rule of investment applies again: the firm chooses to invest up to the level where the expected marginal revenue of capital equalizes its cost.

Note that the two NPV_t expressions converge when either \widetilde{A}_t increases or $\left(\widetilde{A}_{t+1}^+ - \widetilde{A}_{t+1}^- \right)$ decreases. The latter unambiguously shows that a lower uncertainty leads the firm to invest more and more generally to obey to an investment rule closer to the traditional Jorgenson's rule. When the two NPV are equal (when $\lambda = p$), uncertainty plays no role anymore in the investment decision. This result comes from the fact that we consider a finite-time horizon. With an infinite-time horizon, each capital investment is used during the same time (either infinite or determined by the discount rate) and there is no more cost of waiting as defined above. We therefore concentrate on the case where uncertainty matters, when $\lambda > p$. Note also that if $\lambda \geq p$, the Jorgenson's rule of investment leads to a higher investment while the NPV is lower.

2.3 Demand shocks on domestic and foreign markets

Up to now we have concentrated on the role of aggregate demand uncertainty on firm's investment. We now decompose aggregate demand into its domestic and foreign components:

$$\widetilde{A}_t = \widetilde{A}_{Dt} + \widetilde{A}_{Xt}$$

In order to disentangle the impact of uncertainty in each market, we consider different uncertainty parameters on each market, λ_D and λ_X . Therefore, expected aggregate demand can be decomposed as:

$$\widetilde{A}_{t+1} = \begin{cases} \widetilde{A}_{Dt}(1 + \theta + \frac{\lambda_D}{p}) + \widetilde{A}_{Xt}(1 + \theta + \frac{\lambda_X}{p}) & \text{with proba } p \\ \widetilde{A}_{Dt}(1 + \theta - \frac{\lambda_D}{1-p}) + \widetilde{A}_{Xt}(1 + \theta - \frac{\lambda_X}{1-p}) & \text{with proba } (1 - p) \end{cases},$$

where we make the simplifying assumption that there is only one "good" state for both markets next period. Put differently, if "good news" arrive, this will true for both markets or none.¹⁵

Our main objective is to understand how firms' investments react to demands shocks, depending on whether they occur in the domestic or export market. Here, in light of recent empirical findings of international trade literature, we will make assumptions on λ_D and λ_X that have direct testable implications.

Recent empirical evidence shows that the exit rate of new exporters is very high in the first years and by far larger than the exit rate on the domestic market. This exit rate of the export market declines as firms gain experience in these market. For instance, in our data, the exit rate is around 60% one year after entry, but goes down to 15% or less the following years. Moreover, export growth tends to be high in the first years and declines as the firm gets older. In our data, export growth 31% on average the first year, 20% the second year, and around 7% after four year or more. These stylized facts have been interpreted as evidence of (i) a higher uncertainty in the export market compared to the domestic market and (ii) a decline a uncertainty in the export market for the firms that survive. Following this empirical evidence, we get the two following testable predictions about the probability of a positive investment and its size:

Testable Prediction 1. *If demand uncertainty is higher in the export market than in the domestic market for new exporters ($\lambda_X \geq \lambda_D$), the investment rate is less sensitive to demand shocks in foreign markets than in the domestic market.*

¹⁵This assumption is made to ease exposition only, i.e. to avoid the description of four possible states of aggregate demand next period. The impact of domestic and export uncertainty would however be similar to what we present here.

The proof is straightforward. We can show that:

$$\frac{\frac{\partial I_t^*}{\partial \widetilde{A}_{Dt}}}{\frac{\partial I_t^*}{\partial \widetilde{A}_{Xt}}} = \frac{1 + \theta - \frac{\lambda_D}{1-p}}{1 + \theta - \frac{\lambda_X}{1-p}} > 1 \text{ if } \lambda_X > \lambda_D$$

Testable Prediction 1'. *If demand uncertainty is higher in the export market than in the domestic market for new exporters ($\lambda_X > \lambda_D$), the probability of a positive investment is less sensitive to demand shocks in foreign markets than in the domestic market.*

Note that investment is positive only if:

$$I_t^* > 0 \Rightarrow \widetilde{A}_t > \bar{A}$$

$$\text{with } \bar{A} \equiv \frac{(1-p)kK_{t-1}^{1-\alpha}}{a\alpha} - \widetilde{A}_{Dt}(1 + \theta - \frac{\lambda_D}{1-p}) + \widetilde{A}_{Xt}(1 + \theta - \frac{\lambda_X}{1-p})$$

We get:

$$\frac{\partial \bar{A}}{\partial \widetilde{A}_{Xt}} < \frac{\partial \bar{A}}{\partial \widetilde{A}_{Dt}} < 0 \text{ if } \lambda_X > \lambda_D$$

Testable Prediction 2. *If demand uncertainty in the export market is higher for new exporters than for experienced ones (λ_X decreases with exporters' experience), the investment rate becomes more sensitive to demand shocks in the foreign market as firms become more experienced in those markets.*

To see that, note that:

$$\frac{\partial \left(\frac{\partial I_t^*}{\partial \widetilde{A}_{Xt}} \right)}{\partial \lambda_X} = -\frac{C^{\frac{\alpha}{1-\alpha}-1}}{(1-\alpha)(1-p)} \left(\frac{a\alpha}{k} \right)^{\frac{1}{1-\alpha}} \left(C + \frac{\alpha}{1-\alpha} \widetilde{A}_{Xt}(1 + \theta - \frac{\lambda_X}{1-p}) \right) < 0$$

$$\text{with } C = \frac{\widetilde{A}_t + \widetilde{A}_{Dt}(1 + \theta - \frac{\lambda_D}{1-p}) + \widetilde{A}_{Xt}(1 + \theta - \frac{\lambda_X}{1-p})}{(1-p)}$$

Testable Prediction 2'. *If demand uncertainty in the export market is higher for new exporters than for experienced ones (λ_X decreases with exporters' experience), the probability of a positive investment becomes more sensitive to demand shocks in the foreign market as firms become more experienced in those markets.*

Indeed, we get:

$$\frac{\partial \left(\frac{\partial \bar{A}}{\partial \widetilde{A}_{Xt}} \right)}{\partial \lambda_X} < 0$$

These predictions have different implications. The first is that policies that aiming at boosting exports, such as trade or exchange rate policies, may have less effect on investment than those targeting domestic demand. In general, changes in foreign market conditions may have a limited impact on investment, and in turn on TFP if the investment is productivity-enhancing. This is especially the case for the least experimented exporters, which may postpone their decisions until uncertainty is resolved. Note that there may be other - related - reasons why experienced exporters may react more to changes in exports. In particular, the fact that these firms typically serve more markets, and have therefore more diversified exports, may limit the overall uncertainty they perceive. Finally, these results have implication for the export-productivity relationship if one assumes that investment is cost-reducing: we should expect exporting activities to improve TFP only if the firm is successful on the export market, i.e. manages to remain an exporter for some time and to grow on the foreign markets.

3 Empirical Methodology

3.1 An error correction specification

Our empirical methodology follows existing literature, in particular on Bloom *et al* 2007 (see also Bond et al. 2003). We estimate a reduced form error correction model (ECM) to test the impact of export experience on investment's reaction to demand shock. The error-correction model was first introduced into the investment literature by Bean (1981). The idea of this specification is to allow for a flexible adjustment of the capital stock in the short-run while the capital stock converges towards its long-run equilibrium value. This suits particularly our hypothesis that uncertainty decreases with the firm export experience (and age): in the long run (second period in the model), the capital stock of the firm converges towards its optimal value in a frictionless world (without uncertainty nor irreversibility). Moreover, Bloom (2000) shows that the actual capital stock series chosen by a firm under partial irreversibility has a long run growth rate equal to that of the hypothetical capital stock series that the same firm would choose under costless reversibility, because the gap between these two series is bounded.

The hypothetical optimal capital stock with no uncertainty nor irreversibility can be ex-

pressed in log as:¹⁶

$$k_{it}^* = y_{it} + \Psi_i + d_t \quad (10)$$

where k_{it}^* denotes the natural log of the desired capital stock for firm i in period t , y_{it} the log of total output, and Ψ_i and Υ_t represent firm and time specific fixed effects. These in particular are supposed to capture the variations in the user cost of capital across firms and over time, as well as an heterogeneity in their mark-ups. This formulation is consistent with a frictionless demand for capital for a firm with a Cobb-Douglas production function and facing an iso-elastic demand, as assumed in our model.

The general idea of the ECM formulation is to nest this long run specification into a model that allows to study short-run dynamics. Following a Bloom et al. (2007), we will use a basic error correction formulation derived from an autoregressive distributed lag (ADL(1,1)) model¹⁷:

$$\Delta k_{it} = k_{it} - k_{it-1} = \beta \Delta y_{it} - \theta (y_{i,t-1} - k_{i,t-1}) + \Psi_i + \Upsilon_t \quad (11)$$

Where θ is expected to be positive, reflecting the fact that firm with a below target capital stock are supposed to adjust upwards. Our main theoretical predictions relate to the sensibility of investment to shocks on the export market. To disentangle the impact of domestic and export sales growth, we use the fact that:

$$\Delta y_{it} \approx \frac{Y_{it} - Y_{it-1}}{Y_{it-1}} = \underbrace{\frac{Q_{it}^D - Q_{it-1}^D}{Q_{it-1}^D} \frac{Q_{it-1}^D}{Y_{it-1}}}_{\Delta q_{it}^D} + \underbrace{\frac{Q_{it}^X - Q_{it-1}^X}{Q_{it-1}^X} \frac{Q_{it-1}^X}{Y_{it-1}}}_{\Delta q_{it}^X} \quad (12)$$

where Q_{it}^X and Q_{it}^D represent export and domestic sales respectively. We also make standard approximation that $\Delta k_{it} \approx \frac{I_{it}}{K_{it-1}} - \delta_i$ where δ_i is the depreciation rate, potentially specific to

¹⁶in our theoretical example above, we would get the following demand for capital:

$$K_t^* = \beta (1 - 1/\varepsilon) (A_{Dt} + A_{Xt})^{1/\varepsilon} Y_t^{1-1/\varepsilon} k^{-1}$$

which would yield in log:

$$k_t = \ln \beta (1 - 1/\varepsilon) + 1/\varepsilon \ln (A_{Dt} + A_{Xt}) + (1 - 1/\varepsilon) \ln y_t - \ln k$$

¹⁷The main reason why we only include one lag in our specification is that we want to study the dynamics of investment following entry on the export market. Adding additional lags to the specification would be restrictive, as we would keep only the firms with more than two years of experience on the export market.

the firm. To control for the possible role of financial constraints, we also introduce current and lagged cash flow (CF_{it}). Our basic specification takes the form:

$$\frac{I_{it}}{K_{it-1}} = \beta^D \Delta q_{it}^D + \beta^X \Delta q_{it}^X + \theta(y_{i,t-1} - k_{i,t-1}) + \pi_1 \frac{CF_{it}}{K_{it-1}} + \pi_2 \frac{CF_{it-1}}{K_{it-2}} + \Psi_i + \Upsilon_t + \varepsilon_{it} \quad (13)$$

To test the effect of uncertainty and experience on the way firms react to demand shocks on the export market, we will add to equation (13) interaction terms between Δq_{it}^X and firm-level experience on the export market (number of years since entry) or sector-specific measures of uncertainty. In the case of experience, our specification becomes:

$$\frac{I_{it}}{K_{it-1}} = \beta^D \Delta q_{it}^D + \beta^X \Delta q_{it}^X + \gamma \Delta q_{it}^X \times EXP + \eta EXP + \theta(y_{i,t-1} - k_{i,t-1}) + \dots + \Psi_i + \Upsilon_t + \varepsilon_{it} \quad (14)$$

and we expect γ to be positive if export experience act negatively on the uncertainty perceived by the firm. Finally, our data also allows us to test the effect of the above interaction on the investment probability, as around 12% of the observations in our sample are zeros. In this case, our estimated equation takes the form:

$$\begin{cases} \Pr(I_{it} > 0) = 1 & \text{if } \beta_p^D \Delta q_{it}^D + \beta_p^X \Delta q_{it}^X + \gamma_p \Delta q_{it}^X \times EXP + \dots + \Psi_k + \Upsilon_t + \mu_{it} > 0 \\ \Pr(I_{it} > 0) = 0 & \text{otherwise} \end{cases} \quad (15)$$

where "...” includes the same regressors as above, and Ψ_k is a full set of industry (3-digit, NES 114) dummies.

3.2 Estimation issues

Specification (13) may suffer from a number of biases, principally due to the presence of unobserved firm effects Ψ_i and of the simultaneous determination of investment rate and output variables. While firm effects can be accounted for by using a within estimator, this does not solve the simultaneity bias. The common practice is to use GMM estimator - either "first difference GMM" or "system GMM" - where the right hand side variables are instrumented by their

lagged values, and firm unobserved fixed effect wiped-out by first differencing. As emphasized among other by Mulkay *et al.* (2001), this type of estimation is however likely to suffer from weak instruments problems which makes the estimation more imprecise.

We will therefore show the results using both a within estimation and a system GMM estimation (Blundell and Bond, 1998¹⁸) close to the one used by Bloom *et al.* (2007). The results are qualitatively similar. We use the first and second order lags of the regressors as instruments in the first difference equation. Their exogeneity is assessed using a Sargan-Hansen test of overidentifying restrictions.

Finally, specification (15) will be estimated using a Probit estimator.

4 Data

Our empirical analysis relies on French firm level data over the period 1993-2001. Our dataset contains balance sheet information from the BRN (Bénéfice Réels Normaux), which relies on fiscal declarations by domestic French firms. The BRN database is constructed from mandatory reports of French firms to the tax administration, which are in turn transmitted to INSEE (the French Statistical Institute). This dataset reports information including firms' total turnover and export turnover, employment, capital stock, investment, value added, the industry, year, and other balance-sheet variables. It contains between 650,000 and 750,000 firms per year over the period - around 60% of the total number of French firms. Importantly, it is composed of both small and large firms, since no threshold applies. A more detailed description of the database is provided by Eaton *et al.* (2004).

As we are interested in the effect of foreign market experience on investment decisions, we keep in the sample only the firms that either export over the whole period or enter the export market at some point. An entrant is defined as a firm that did not export over the last year. We drop the firms that only serve the domestic market the entire period, or enter the export market more than once. Second, we exclude services from the analysis. This is in particular to exclude wholesalers. Finally, we clean the data from the top and bottom percentile of export and domestic sales growth, by sector and year. Our final sample includes around 18,000 firms per year on average, and a total of around 28,500 firms. These firms export on average 20% of

¹⁸The system GMM estimator, which combines a system of equations in first differences with equations in level, has been shown to be more efficient than the first difference estimator (Arellano and Bond, 1991) when the instruments are exogenous.

their total sales.

Table 1: Descriptive statistics

	Mean	S.D.	1 st Quartile	Median	3 rd Quartile
Number of employees	104.6	616.5	10.00	27.00	65.00
Export propensity	0.21	0.23	0.03	0.11	0.32
$\Delta \ln$ Export sales	0.07	0.84	-0.22	0.05	0.34
$\Delta \ln$ Domestic Sales	0.03	0.24	-0.07	0.03	0.14
Investment rate	0.12	0.19	0.02	0.07	0.15

Note: Source: authors' computation from BRN data. Number of observations is 128,930. Number of firms is 25,573. Export propensity corresponds to exports/total sales.

Table 1 contains some descriptive statistics. Our sample contains an important share of small and medium firms, as the first quartile of the number of employees is 10. Export sales growth is much higher than domestic sales growth on average, but also much more volatile. Note that, while unreported in the Table, export growth decreases quickly with experience: it is on average 28% the first year, 22% the second year, and around 7% after four years or more. Finally, as mentioned in the previous section that while more than 99% of the firms invest at least once during the period, 12% of the observations contain zero investment. Note that the presence of a relatively large number of observations with zero investment is a significant advantage of our data, as it allows us to test for the existence of a band of inaction in the presence of uncertainty. As mentioned earlier, this is a prediction of our model, but also a general conclusion of the option values theories of investment.

5 Results

5.1 Export experience and the sensibility of investment to demand shocks

Investment rate. Table 2 contains our baseline results. The upper panel of the table shows the within estimates, while the lower panel contains the GMM coefficients¹⁹. Exogeneity of the instruments cannot be rejected in all columns, as shown by the Sargan-Hansen p-value which is between 0.10 and 0.28 depending on the specification.

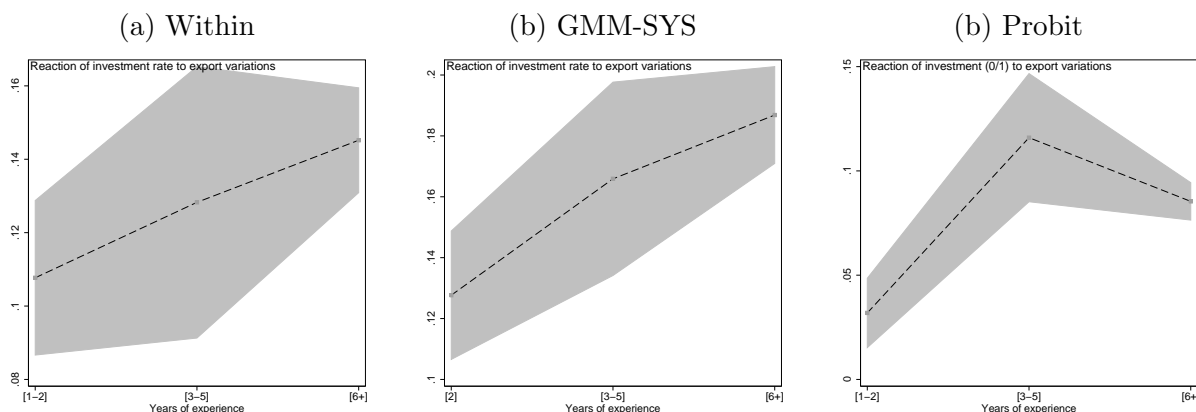
¹⁹The number of observations is lower in GMM estimation as we constrain the estimation to the existence of the first lag of each regressor.

The first column contains the basic ECM specification, with total sales growth. As expected, investment is found to react positively to an increase in total sales growth, with a coefficient close to the one found by existing literature. The cash flow variables (not reported in the table for clarity) are also found to have a positive impact, suggesting that investment is to some extent affected by the existence of financial constraints. More importantly, the coefficient on the long-run term $y_{t-1} - k_{t-1}$ is positive and significant as expected in both within and GMM specifications, suggesting that firm with a capital stock below desired level invest more.

Column (2) estimate specification (13), in which total sales growth is split into domestic and export sales growth. Both variables have a positive effect on investment rate, with a larger coefficient for domestic sales growth.²⁰ This is consistent with the idea that the foreign market is associated with higher uncertainty, making investment less reactive to changes in economic conditions.

Columns (3) includes export experience, and its interaction with export sales. If uncertainty decreases with experience, we expect the coefficient on this interaction term to be positive: exporter should react more to changes in foreign sales when they have some experience of the foreign market. This is confirmed by our results. The GMM coefficient are generally higher than the within ones, but also display higher standard errors. An additional year of experience increases the responsiveness of investment to export sales growth by 0.005 to 0.008 percentage point.

Figure 1: Effect of export growth on investment rate, by experience level



Another way to see this result is to split export experience into different categories, and

²⁰The difference between export and domestic sales coefficients is significant at the 1% level in both within and GMM specifications.

Table 2: Investment and export experience

Dep. Var.:	(1)	(2)	(3)	(4)
	I_{it}/K_{it-1}			
Within				
Δ total sales _{it}	0.170 ^a (0.007)			
Δ dom. sales _{it}		0.163 ^a (0.006)	0.162 ^a (0.006)	0.171 ^a (0.009)
Δ exports _{it}		0.138 ^a (0.007)	0.105 ^a (0.011)	0.105 ^a (0.011)
Δ exports _{it} \times Experience			0.005 ^a (0.002)	0.005 ^a (0.002)
Δ dom. sales _{it} \times Experience				-0.001 (0.002)
Experience			-0.003 ^a (0.001)	-0.004 ^a (0.001)
$y_{t-1} - k_{t-1}$	0.224 ^a (0.010)	0.226 ^a (0.010)	0.226 ^a (0.010)	0.216 ^a (0.009)
Observations	128496	128496	128496	128496
Adj. R^2	0.119	0.122	0.122	0.122
GMM-SYS				
Δ total sales _{it}	0.253 ^a (0.018)			
Δ dom. sales _{it}		0.224 ^a (0.016)	0.205 ^a (0.022)	0.220 ^a (0.025)
Δ exports _{it}		0.197 ^a (0.015)	0.124 ^a (0.026)	0.131 ^a (0.025)
Δ exports _{it} \times Experience			0.008 ^a (0.002)	0.008 ^a (0.002)
Δ dom. sales _{it} \times Experience				-0.001 (0.002)
Experience			-0.003 (0.002)	-0.002 (0.002)
$y_{t-1} - k_{t-1}$	0.253 ^a (0.020)	0.253 ^a (0.020)	0.224 ^a (0.031)	0.234 ^a (0.029)
Observations	98339	98339	98339	98339
Hansen p-value	0.27	0.12	0.10	0.18

Robust Standard errors, clustered by NACE 36 industry for within estimations, in parentheses. ^c significant at 10%; ^b significant at 5%; ^a significant at 1%. All estimations include firm fixed effects and year dummies. Δ exports_{it} = $\frac{X_t - X_{t-1}}{X_{t-1}} \times \frac{Y_{t-1}}{Y_{t-1}}$; Δ dom. sales_{it} = $\frac{D_t - D_{t-1}}{D_{t-1}} \times \frac{Y_{t-1}}{Y_{t-1}}$. Experience: number of years since entry on export market. GM-SYS: Blundell and Bond (1998) GMM estimator. Instruments used in these estimations are the first and second lags of all regressors. Coefficients on cash flow and its lag not reported.

to replace the above interaction with a set of interaction terms between export growth and dummies for different level of experience. Figure 1 show the coefficients for a specification with three interaction terms, together with 90% confidence bands. The three categories are: less than two years of experience²¹, between 3 and 5 years, and more than 5 years. Figures 1(a) and 1(b) contains respectively the results of the within and GMM estimates. Both figures exhibit a clear positive trend. The first coefficient on export growth is found to be between 0.11 and 0.12 for the first group of firms, and goes up to 0.14-0.18 for the third one.

Note that the role of experience is not significant when considering domestic sales, as shown in column (4) of table 2. This again suggests that export sales are associated with more uncertainty.

Investment probability. Table 3 contains the results of the Probit estimation of specification (15). Columns (1) to (3) mirrors columns (2) to (4) of Table 2. Marginal effects, computed at means, are reported. Column (4) shows the result of a fixed effect Logit estimation, for which the marginal effects cannot be computed. The coefficients of export and domestic sales growth, in the first three columns, are lower to the ones found for the investment rate. Our predictions are however still strongly supported. The probability to invest responds significantly more to changes in domestic sales than to changes in foreign conditions. Experience significantly increases the response to export growth. This can be also noted in Figure 1(c), where the coefficient on export growth goes up from 0.03 to 0.09 when increases from 1-2 years to 5 years or more.

5.2 Investment, uncertainty and export experience

Is the positive effect of export experience due to a decrease in uncertainty? Experience could affect the sensibility of investment to export sales through various channels. One could be the relaxation of liquidity constraints. However, this seems unlikely to explain our results as we control for the firm's cash flow in our estimation. In this section we further investigate the role of uncertainty on investment sensitivity to sales shocks.

In Table 4 we first study how uncertainty directly affect investment through export sales. We add to our baseline specification an interaction term between a sector-specific measure of

²¹In GMM estimations, this category includes only firms with two years of experience, due to the use of lags as instruments in the estimation.

Table 3: Export experience and the probability to invest

Dep. Var.:	(1)	(2)	(3)	(4)
	Pr($I_{it}/K_{it-1} > 0$)			
Δ dom. sales $_{it}$	0.114 ^a (0.003)	0.092 ^a (0.003)	0.089 ^a (0.006)	1.057 ^a (0.200)
Δ exports $_{it}$	0.072 ^a (0.004)	0.028 ^a (0.009)	0.027 ^a (0.009)	0.131 ^a (0.301)
Δ exports $_{it} \times$ Experience		0.005 ^a (0.002)	0.005 ^a (0.002)	0.117 ^a (0.044)
Δ dom. sales $_{it} \times$ Experience			0.001 (0.002)	0.045 (0.001)
Experience		0.007 ^a (0.000)	0.010 ^a (0.000)	-0.054 ^b (0.023)
$y_{t-1} - k_{t-1}$	-0.016 ^a (0.001)	-0.014 ^a (0.001)	-0.014 ^a (0.001)	0.719 ^a (0.062)
Estimator		Probit		FE-Logit
Observations	132198	132198	132198	22472

Robust Standard errors in parentheses. ^c significant at 10%; ^b significant at 5%; ^a significant at 1%. Marginal effect computed at means reported for probit estimations. All estimations include year dummies, and estimations (1) to (3) include sector (3 digit, Nes 114) dummies. Δ exports $_{it} = \frac{X_t - X_{t-1}}{X_{t-1}} \times \frac{Y_{t-1}}{Y_{t-1}}$; Δ dom. sales $_{it} = \frac{D_t - D_{t-1}}{D_{t-1}} \times \frac{D_{t-1}}{Y_{t-1}}$. Experience: number of years since entry on export market. Coefficients on cash flow and its lag not reported.

uncertainty and export sales. Our measure of uncertainty is the variance of the growth rate of export sales in the 3-digit (NES 114) sector to which the firm belongs, computed over the period 1993-2001 from our balance-sheet data.²² Columns (1), (2) and (3) show respectively the results of the within, GMM and probit estimations. In all estimations, uncertainty reduces significantly the sensitivity of investment to export sales variations. Note also that controlling for uncertainty decreases the size and significance of the interaction term between export growth and export experience.

Figure 2 shows this results for different categories of uncertainty. As before, we interact the export growth variable with bins of uncertainty, representing the quintiles of this variable. Results using each estimator (within, GMM, Probit) are shown. Uncertainty massively decreases the reaction of investment to changes export sales. For investment rate, the coefficient for firms belonging to the least volatile sectors is only around half of the coefficient of most volatile ones. Interestingly, this result is quantitatively similar to the one emphasized by Bloom et al. (2007) using a sample of UK publicly traded manufacturing companies. The exporting probability

²²Note that the number of observations is slightly lower than in Table 2. This is due to the fact that we drop the firm for which the sector changes over time.

Table 4: Investment, uncertainty, and export experience

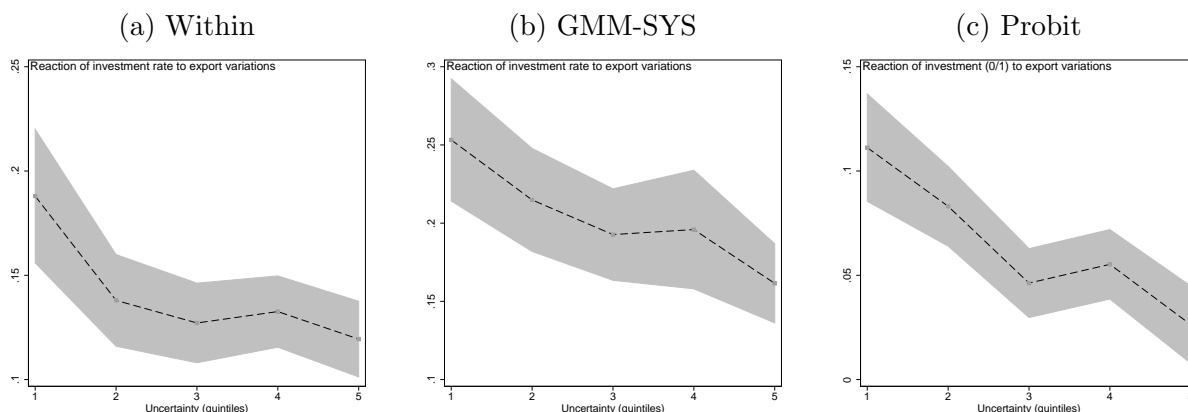
Dep. Var.:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			I_{it}/K_{it-1}					
Sample		All		Uncertainty		Experience		All
				High	Low	High	Low	
Δ dom. sales _{it}	0.162 ^a (0.006)	0.209 ^a (0.023)	0.090 ^a (0.003)	0.165 ^a (0.009)	0.158 ^a (0.009)	0.155 ^a (0.008)	0.197 ^a (0.008)	0.162 ^a (0.006)
Δ exports _{it}	0.134 ^a (0.016)	0.186 ^a (0.035)	0.067 ^a (0.014)	0.103 ^a (0.011)	0.140 ^a (0.024)	0.148 ^a (0.017)	0.183 ^a (0.020)	0.156 ^a (0.015)
Δ exports _{it} × Uncertainty	-0.050 ^c (0.026)	-0.087 ^a (0.027)	-0.088 ^a (0.026)			-0.038 (0.030)	-0.078 ^b (0.031)	
Δ exports _{it} × Experience	0.003 ^c (0.002)	0.005 ^c (0.003)	0.003 ^b (0.003)	0.005 ^b (0.002)	0.000 (0.003)			
Δ exports _{it} × Uncertainty (Young)								-0.097 ^a (0.033)
Δ exports _{it} × Uncertainty (Mature)								-0.059 (0.058)
Δ exports _{it} × Uncertainty (Old)								-0.039 (0.026)
Experience	-0.004 ^a (0.001)	-0.002 (0.002)	0.006 ^a (0.000)	-0.005 ^a (0.001)	-0.002 (0.002)			
$y_{t-1} - k_{t-1}$	0.226 ^a (0.011)	0.229 ^a (0.032)	-0.016 ^a (0.001)	0.237 ^a (0.016)	0.212 ^a (0.011)	0.204 ^a (0.010)	0.324 ^a (0.015)	0.226 ^a (0.011)
Observations	120200	91683	129290	64367	56151	86695	33505	120200
Estimator	FE	GMM- SYS	Probit			FE		

Robust Standard errors, clustered by NACE 36 industry, in parentheses. ^c significant at 10%; ^b significant at 5%; ^a significant at 1%. All estimations include year dummies. Probit estimates include sector (3 digit) dummies, and reported coefficients are marginal effects computed at means. Δ exports_{it} = $\frac{X_t - X_{t-1}}{X_{t-1}} \times \frac{Y_{t-1}}{Y_{t-1}}$; Δ dom. sales_{it} = $\frac{D_t - D_{t-1}}{D_{t-1}} \times \frac{Y_{t-1}}{Y_{t-1}}$. Experience: number of years since entry on export market. Exp. Uncertainty is the variance of the growth rate of export sales in the 3 digit sector to which the firm belongs, computed over the period 1995-2001. GM-SYS: Blundell and Bond (1998) GMM estimator. Instruments used in these estimations are the first and second lags of all regressors. Young: up to 2 years of export experience. Mature: between 3 and 5 years of export experience. Old: more than 6 years of export experience. Coefficients on cash flow and its lag not reported.

react even more negatively, as the coefficient goes down to 0.10 to almost zero.

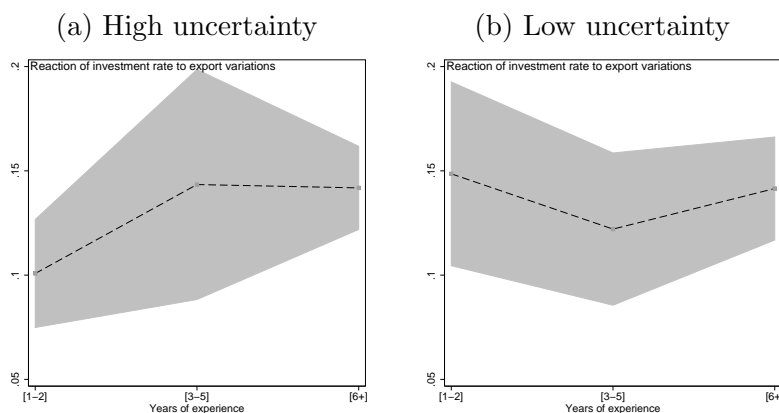
How does this relate to export experience. In columns (4) and (5) of Table 4 we find that the interaction term between experience and export sales is only significant in for firms belonging to the sectors that are the most volatile in terms of export sales. For firms below the median in terms of uncertainty, the coefficient on the interaction is close to zero and statistically insignificant. This clearly suggests that experience plays a role in diminishing uncertainty in the most volatile sectors. This can be seen in Figure 3, where we replicate Figure 1(a) for these

Figure 2: Effect of export growth on investment rate, by level of uncertainty



two groups of firms, above and below the median in terms of uncertainty. While the investment rate is increasingly reactive to export sales in the first case, no clear pattern emerges in the second one.

Figure 3: Effect of export variations on investment rate, by experience level



Similarly, experience on the export market makes uncertainty less relevant. Columns (6) and (7) of Table 4 shows the results of column (1) on two different samples: firms with less than 5 years of experience versus firms with more than 5 years. While uncertainty decreases investment sensitivity to export growth in the first case (column (7)), it has no effect on the most experimented firms (column (6)). This can also be seen in column (8), in which the interaction term between uncertainty and export growth is divided by two when we move from less than two years to more than five years of experience on the export market.

6 Conclusion

(to be completed)

References

- ABEL, A. B. and EBERLY, J. C. (1998), “An Exact Solution for the Investment and Market Value of a Firm Facing Uncertainty, Adjustment Costs, and Irreversibility”, NBER Working Papers 4412.
- ABEL, A. B., DIXIT, A., EBERLY, J. C. and PINDYCK, R. S. (1996), “Options, the Value of Capital, and Investment”, *The Quarterly Journal of Economics*, vol. 111 n° 3: pp. 753–77.
- ALBORNOZ-CRESPO, F., CALVO PARDO, H. F., CORCOS, G. and ORNELAS, E. (2010), “Sequential Exporting”, CEPR Discussion Papers 8103.
- ATKESON, A. and BURSTEIN, A. (), “Innovation, Firm dynamics, and International Trade”, *Journal of Political Economy*.
- AW, B. Y., CHUNG, S. and ROBERTS, M. (2003), “Productivity, output, and failure: a comparison of taiwanese and korean manufacturers”, *Economic Journal*, vol. 113 n° 491: pp. 485–510.
- BEAN, C. R. (1981), “An Econometric Model of Manufacturing Investment in the UK”, *Economic Journal*, vol. 91 n° 361: pp. 106–21.
- BLOOM, N. (2000), “The dynamic effects of real options and irreversibility on investment and labour demand”, IFS Working Papers W00/15.
- BLOOM, N., BOND, S. and REENEN, J. V. (2007), “Uncertainty and Investment Dynamics”, *Review of Economic Studies*, vol. 74 n° 2: pp. 391–415.
- BOYLE, G. W. and GUTHRIE, G. A. (2003), “Investment, Uncertainty, and Liquidity”, *Journal of Finance*, vol. 58 n° 5: pp. 2143–2166.
- BURSTEIN, A. and MELITZ, M. (2011), “Trade Liberalization and Firm Dynamics”, *mimeo*.
- COSTANTINI, J. and MELITZ, M. (2009), “The dynamic effects of real options and irreversibility on investment and labour demand”, in the organization of firms in a global economy. ed. e. helpman, d. marin & t. verdier. harvard university press.
- DE LOECKER, J. (2007), “Do exports generate higher productivity? Evidence from Slovenia”, *Journal of International Economics*, vol. 73 n° 1: pp. 69–98.

- DIXIT, A. and PINDYCK, R. (1994), *Irreversible Investment*, Princeton: Princeton University Press.
- EATON, J., KORTUM, S. and KRAMARZ, F. (2004), “Dissecting Trade: Firms, Industries, and Export Destinations”, *American Economic Review Papers and Proceedings*, vol. 94 n° 2: pp. 150–154.
- EATON, J., ESLAVA, M., KUGLER, M. and TYBOUT, J. (2007), “Export Dynamics in Colombia: Firm-Level Evidence”, NBER Working Papers 13531.
- GHOSAL, V. and LOUNGANI, P. (2000), “The Differential Impact of Uncertainty on Investment in Small and Large Businesses”, *The Review of Economics and Statistics*, vol. 82 n° 2: pp. 338–343.
- GUISSO, L. and PARIGI, G. (1999), “Investment And Demand Uncertainty”, *The Quarterly Journal of Economics*, vol. 114 n° 1: pp. 185–227.
- HANDLEY, K. and LIMA, N. (2011), “Trade and Investment under Policy Uncertainty: Theory and Firm Evidence”, mimeo.
- LILEVA, A. and TREFLER, D. (2010), “Improved Access to Foreign Markets Raises Plant-Level Productivity... for Some Plants”, *The Quarterly Journal of Economics*, vol. 125 n° 3: pp. 1051–1099.
- MCDONALD, R. and SIEGEL, D. (1986), “The Value of Waiting to Invest”, *The Quarterly Journal of Economics*, vol. 101 n° 4: pp. 707–27.
- MULKAY, B., HALL, B. H. and MAIRESSE, J. (2001), “Firm Level Investment and R&D in France and the United States: A Comparison”, NBER Working Papers 8048.
- PINDYCK, R. (1988), “Irreversible Investment, Capacity Choice, and the Value of the Firm”, *American Economic Review*, vol. 78 n° 5: pp. 969–85.
- VAN BIESEBROECK, J. (2005), “Exporting raises productivity in sub-Saharan African manufacturing firms”, *Journal of International Economics*, vol. 67 n° 2: pp. 373–391.
- VERHOOGEN, E. A. (2008), “Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector”, *The Quarterly Journal of Economics*, vol. 123 n° 2: pp. 489–530.

WAGNER, J. (2007), “Exports and Productivity: A Survey of the Evidence from Firm-level Data”, *The World Economy*, vol. 30 n° 1: pp. 60–82.