Are Liquidity Constraints Irrelevant After All? *

Kaveh Majlesi †

February 19, 2010

Abstract

By deriving new implications from Chaney (2005), "Liquidity Constrained Exporters", and applying an empirical methodology never used before in the international trade literature I have tried to test this model for the first time. Chaney (2005) is the first heterogeneous firms model that explains the relationship between liquidity constraint of firms and their export behavior and claims that liquidity constraints are a key determinant of the export status of firms. This result contrasts with a part of the empirical literature (e.g. Greenaway et al. (2007)) which claims that level of ex-ante liquidity constraint has nothing to do with becoming an exporter. A direct implication of the model, which has not been stated in the paper, is that after controlling for the productivity level and given that firms have not been exporters in the previous period if we compare different groups of firms with different levels of liquidity-constraint, then a larger appreciation of the real exchange rate should have a larger effect on the probability of a firm being an exporter in the group with lower level of liquidity-constraint. I test the model, using a panel data of the Mexican manufacturing firms in the period of 1986-1990, and find robust evidence in its support.

1 Introduction

One of the most important observations made by trade economists in the past two decades is that exporters and non-exporters are different in various aspects. Examples are that exporters are more productive and larger than non-exporters. Almost all of the recent models of international trade acknowledge firm heterogeneity and try to account for these existing differences. Some studies have shown that it is the characteristics of the firms that form the export status and not vice versa. Using data from U.S. manufacturing sectors, Bernard and Jensen (1999) show causality goes from productivity to exporting but not the reverse.

*I am grateful to Natalia Ramondo for providing me with data, and to Jason Abrevaya, Thomas Chaney, Natalia Ramondo, and an anonymous referee for their helpful suggestions and comments. All remaining errors are mine.

†Department of Economics, The University of Texas at Austin. email: kaveh.majlesi@mail.utexas.edu

On the other hand, it is an established fact now that exporting to foreign markets involves fixed cost. This includes setting up distribution networks, acquiring information about the new market, etc. Recent studies show that these costs are substantial and should mostly be paid up-front. Having these two themes of literature in mind, a hypothesis could be that one of the characteristics forming the export status of firms is access to liquidity and only firms with enough liquidity to pay for the fixed cost, can start exporting.

The role of financial constraint in trade has been studied in the past couple of years (Beck (2002), Matsuyama (2005), Becker and Greenberg (2007), Manova (2006, 2008)) but only a few studies have focused on the relationship between financial constraint and export behavior at the firm level (Campa and Shaver (2001), Greenaway et al. (2007)). The first theoretical paper which has modeled how liquidity-constraint affects the ability of firms to export is Chaney (2005). The model follows this point of view that it is the characteristics of the firms which form their export status and builds on Melitz (2003) model of international trade. He adds another element of heterogeneity, access to liquidity, to the Melitz model and predicts that liquidity constraints are a key determinant of the export behavior of firms.

Although Chaney (2005) is the most influential model that explaining the relationship between liquidity-constraint and the export behavior of firms, it has not been tested before. Testing the model is especially important since the recent empirical literature is not in consensus about the role of financial constraints at the firm level. Greenaway et al. (2007), using data from UK manufacturing firms, find no evidence that firms enjoying better ex-ante financial health (measured by liquidity ratio or leverage) are more likely to start exporting.

For a long time, when thinking about the effects of exchange rate fluctuations on trade, researchers used to think only about the competitiveness effect. It says that an exchange rate appreciation makes the existing exporters less competitive abroad and they lose market share. The opposite should happen when facing depreciation. However, data tells us that even wide fluctuations of the exchange rate have not had significant effects on trade patterns.

Chaney (2005) explains and models this puzzle through extensive margin of trade, the entry and exit of firms into the export market. The scenario is that when the exchange rate appreciates some of the firms which could profitably export but they were held back because of not having enough liquidity to pay the fixed cost start exporting. The reason is that the value of domestic assets relative to the foreign market goes up. Basically, it means that for firms with high productivity which do not export, an exchange rate appreciation could play the role of having access to more liquidity. This can offset the competitiveness effect and therefore we do not see a significant change in the volume of export.

In this paper I use this line of reasoning to arrive at testable implications. If the model's predictions are correct I prove that after controlling for the productivity level and given that the firms have not been exporters in the previous period, the effect of a larger appreciation of exchange rate (more negative change in the real exchange rate) on the probability of being an exporter should have two characteristics:

- It needs to be negative.

- In absolute values, this effect should not be smaller for the less liquidity-constrained group.

I test these implications, using data from the manufacturing plants in Mexico in the period of 1986-1990 period and applying the methodology introduced by Chamberlain (1980)-Mundlak (1978) for estimating the average partial effects in binary choice environments, and find robust evidence in their support.

The remainder of this paper is organized as follows. Section 2 introduces Chaney (2005). Section 3 discusses the new implications that I can derive from the model and take to data. Section 4 describes the data. Section 5 provides the test and empirical analysis. Section 6 concludes.

2 Chaney (2005)

Chaney (2005) follows this point of view that it is the characteristics of the firms which shape their export status. This model basically adds a liquidity dimension to Melitz (2003) in a way that firms which are not liquidity constrained can potentially export. There are two sources of acquiring liquidity in the model. One is gaining profit in the domestic market, which is a function of the firm's productivity, and the other is inheriting from past activities.

Model consists of two countries, home and foreign. The only factor of production is labor and there are two sectors; one produces a freely tradable homogeneous good and the other supplies a continuum of differentiated goods. The homogeneous good is used as the numeraire, its price is set equal to 1, and it is produced under CRS. The labor requirement for producing one unit of the homogeneous good at home is $\frac{1}{w}$ ($\frac{1}{w^*}$ abroad). Assuming that each country produces the homogeneous good, the wages will be w and w^*. As in Melitz model, each firm is a monopolist for the variety it produces.

2.1 Demand

The only consumers are the workers and each is endowed with one unit of labor. The agent's utility is defined by U:

$$U \equiv q_0^{1-\mu}\Big(\int_{x\in X} q(x)^{(\frac{\sigma-1}{\sigma})}dx\Big)^{\frac{\sigma}{\sigma-1}\mu} \tag{1}$$

with $\sigma > 1$. σ is the elasticity of substitution between two varieties of the differentiated good.

In (1) q_0 represents units of the homogeneous good, $q(x)$ units of variety x of the differentiated good, and X the set of the differentiated goods which is determined in equilibrium.

The following price index is defined for differentiated goods:

$$P = \Big(\int_{x\in X} p(x)^{1-\sigma}dx\Big)^{\frac{1}{1-\sigma}} \tag{2}$$

The representative agent spends $r(x)$ on each variety x:

$$r(x) = \mu w L \Big(\frac{p(x)}{P}\Big)^{1-\sigma} \tag{3}$$

$\mu w L$ is what spent on differentiated goods.

2.2 Production and Trade

In order to start exporting, firms have to pay a fixed cost of C_f in terms of foreign labor, which is $w^* C_f$ in terms of the numeraire. The usual iceberg cost is also in play. From one unit of a differentiated good shipped to the foreign market, only the fraction $1/\tau$ arrives. In the domestic market, in order to start production, a firm must pay an entry cost of C_d in terms of domestic labor, which is wC_d in terms of the numeraire.

For a firm with productivity x, the cost of producing q_d units of good for the domestic market is

$$c_d(q_d) = q_d \frac{w}{x} + wC_d$$

and the cost of producing q_f units for the foreign market is

$$c_f(q_f) = q_f \frac{\tau w}{x} + w^* C_f$$

The optimal prices of the goods at home and abroad would be given by

$$p_d(x) = \frac{\sigma}{\sigma - 1} \frac{w}{x}, p_f(x) = \frac{\sigma}{\sigma - 1} \frac{\tau w}{x}$$

A firm with productivity x potentially generates profits $\Pi_d(x)$ in the domestic market, and $\Pi_f(x)$ in the foreign market:

$$\Pi_d(x) = \frac{r_d(x)}{\sigma} - wC_d = \frac{\mu}{\sigma} w L \Big(\frac{\sigma}{\sigma - 1} \frac{w}{xP}\Big)^{1-\sigma} - wC_d$$

$$\Pi_f(x) = \frac{r_f(x)}{\sigma} - w^* C_f = \frac{\mu}{\sigma} w^* L^* \Big(\frac{\sigma}{\sigma - 1} \frac{\tau w}{xP^*}\Big)^{1-\sigma} - w^* C_f$$

Given the profit functions, implicitly two productivity thresholds, $\overline{x}_d$ for survival in the domestic market, and $\overline{x}_f$ for profitable entry into the foreign market, can be defined through:

$$\Pi_d(\overline{x}_d) = 0 \text{ and } \Pi_f(\overline{x}_f) = 0$$

Before introducing any other constraint (namely, the liquidity constraint here), any firm with a productivity above $\overline{x}_f$ would export.

2.3 Liquidity constraints

A fundamental difference between this model and related previous models is that all previous models assume that there is a perfect financial market and therefore all firms with productivity above the threshold can export. However, for different reasons it seems like a false assumption, especially in under-developed financial markets.

In this model firms can only use their own existing liquidity to pay for the fixed entry costs into export markets. It is assumed that firms inherit an exogenous amount of liquidity which may be thought of as a trustworthiness capital that gives access to financial markets. In the model each firm is endowed with a random liquidity shock A. (A, x) are drawn from a joint distribution with c.d.f. $F(A, x)$. It is clearly a simplified view of liquidity constraints, however it serves two important features which can be seen in the real world; one is that liquidity constraints are more severe for exporting than for domestic activity. The other one is that there is heterogeneity among firms in terms of available liquidity and the level of constraint is not perfectly correlated with productivity.

As mentioned before, to be able to export, a firm must have enough liquidity to cover the entry cost. Therefore, the liquidity constraint is:

$$\Pi_d(x) + wA \geq w^* C_f$$

An important point to get from this is that firms with higher productivity generate larger profits in the domestic market, and therefore are less dependent on external finance.

$\overline{x}(A)$ is defined as the productivity level below which firms with liquidity A cannot acquire enough liquidity to pay the fixed cost of exporting and it is given by the following equation:

$$\Pi_d(\overline{x}(A)) + wA = w^* C_f \tag{4}$$

2.4 Open economy equilibrium

Chaney makes one additional assumption for this section of the model. Price indices only depend on prices set by local firms and therefore the new price index is given by the following approximation:

$$P \approx \Big(\int_{x \geq \overline{x}_d} p_d(x)^{1-\sigma} L dF_x(x) \Big)^{\frac{1}{1-\sigma}}$$

For the convenience of analysis $g(.)$ is defined as:

$$g(\cdot) : \overline{x}^{\sigma-1} = \Big(\frac{\sigma}{\mu} \int_{x \geq \overline{x}} x^{\sigma-1} dF_x(x) \Big) C \Leftrightarrow \overline{x} = g(C) \tag{5}$$

Rearranging the profit functions and Eq. (4), we have,

$$\overline{x}_f = \Big(\frac{\tau w}{w^*} \Big) \Big(\frac{C_f}{C_d^*} \Big)^{(\frac{1}{\sigma-1})} g(C_d^*) \tag{6}$$

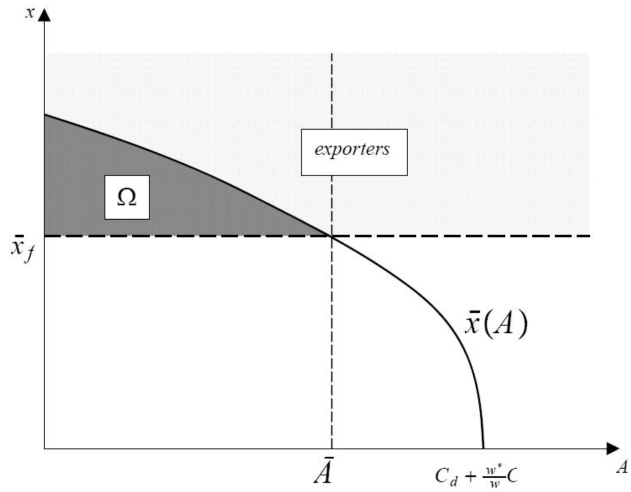

Figure 1: Liquidity Constrained exporters

$$\overline{x}(A) = \Big(\frac{C_d + \frac{w^*}{w}C_f - A}{C_d}\Big)^{(\frac{1}{\sigma-1})} g(C_d) \tag{7}$$

These thresholds shape the basis for what I am interested to analyze.

Figure (1) shows how the two thresholds work out in hindering some firms from exporting. Firms identified by the set Ω are the ones that could potentially export but are liquidity-constrained i.e. $\overline{x}_f < x < \overline{x}(A)$. Theoretically, under a simple condition described in Proposition (1) of Chaney (2005) we always have firms that are liquidity constrained.

Similar to Atkeson and Burstein (2005), exchange rate shocks is modeled as a shock to relative wages. An exchange rate appreciation is defined as an increase in the productivity of the domestic homogeneous sector. This will increase the domestic wage w. Therefore, given (6) and (7), when appreciation happens $\overline{x}_f \nearrow$ and $\overline{x}(A) \swarrow$ (given that the fixed costs of operating in domestic and foreign market do not change).

In the eyes of Chaney's model what it means is that some of the firms which were liquidity-constrained start exporting, but the status of productivity-constrained firms does not change. Figure (2) illustrates this phenomenon.

The traditional competitiveness theory tells us that when appreciation happens existing exporters lose market share abroad. The argument above claims that new firms start exporting, which diminishes the negative competitiveness effect. Therefore the net effect of an appreciation depends on the sensitivity of the extensive margin of trade to exchange rate appreciation. An appreciation may even have a positive impact on total amount of exports if goods imported in the foreign market are not too substitutable.

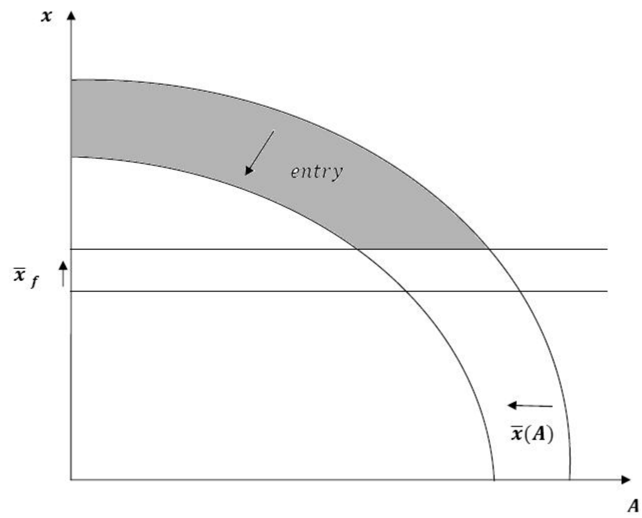

Figure 2: Some of the liquidity constrained firms start exporting following an exchange rate appreciation

3 New implications of Chaney's model

The gray area of figure (2), i.e. firms that where not exporters before and enter the export market after the appreciation, reveals an interesting observation.

Proposition 1 *If we fix the level of productivity (x) in the liquidity constrained area, then a firm with larger A (less liquidity constraint) is equally or more likely to start exporting following the appreciation than a firm with smaller A (more liquidity constraint).*

Proof. See appendix A.

Therefore, for a given level of productivity, if we compare different groups of firms with different levels of liquidity-constraint (so that all firms in one group are either more or less constrained than the firms in another group) which have representation in the gray area, then a larger appreciation of the exchange rate would have an equal or larger effect on the probability of a firm being an exporter in the group with lower level of liquidity-constraint given that it has not been an exporter in the previous period.

Based on this analysis, here is what I can take to data and test in section 5. If the model's predictions are correct, then after controlling for the productivity level and given that the firms have not been exporters in the previous period, the effect of a larger appreciation of exchange rate (more negative change in the real exchange rate) on the probability of being an exporter should have two characteristics[3]:

- It needs to be negative. A larger appreciation means a more negative change of real exchange rate and since it should have a positive effect on the probability of being an exporter, the effect should be negative.

[3]Since Chaney (2005) focuses on appreciation of exchange rate, I do the same here. However, both the theoretical and empirical analysis of a depreciation is discussed in Appendix C.

- In absolute values, this effect should not be smaller for the less liquidity-constrained group[4].

One consideration here could be that how we can be sure that the firms in the gray area represent all groups that we form and study. The answer will be clear in the empirical analysis. If we have firms in a group that change status and become exporters, after we control for other variables, then for the purpose of this argument here that group has representation in the gray area.

One should notice that what that matters is the effect of *change* in the exchange rate in different groups and not the exchange rate itself. It is the change in the value of domestic assets in the foreign markets that make some liquidity-constrained firms new exporters. This change in value happens because of change in the exchange rate in two consecutive periods.

4 Data description

The results in the next section of this paper are based on a panel survey conducted annually by Mexico's Instituto Nacional de Estadisticas Geografia e Informacion (INEGI), The Mexican government statistical branch. Dataset that I have available covers the period 1984-1990, and includes data for 3216 firms. The export data, which is crucial to my analysis, is missing for 1984 and 1985, therefore my analysis will be based on the period 1986-1990 [1].

Table (1) reports summary statistics for some of the variables [2]. This dataset follows the observations made in the recent literature about the structural differences between exporters and non-exporters. Exporters are larger in terms of employment and total sales and pay higher wages (Bernard and Jensen (1999) made the same observation in U.S. data). Also exporters have higher share of foreign ownership and benefit from more assets.

Explanatory variable	Non-exporters	Exporters	All firms
$total\ sales$	18125.5	67115.1	22343.1
$employment$	221.9	551.2	293.2
$blue-collar\ wage$	4.4	6.2	4.9
$white-collar\ wage$	9.3	14.6	10.8
$foreign\ ownership$	14.2	32.0	19.3
$assets$	10346.3	45482.9	20330.3

Table 1: Summary statistics by export status

[4]As mentioned in 2.4, an implicit assumption would be that the fixed costs of operation did not change during the period of my study. Although Mexico went through trade reforms in 80's but it involved reducing different kinds of import tariffs and there is no reason to believe that C_d and C_f changed for Mexican firms.

[1]Recently, there have been studies working with the panel data that covers until 2001. However, for using that dataset you have to go to the INEGI offices in Aguascalientes and work with them over there.

[2]Verhoogen (2008) provides statistics for these plus some other variables for the 1993-2001 panel

Using data from Mexico has a big advantage for doing this study. More than 80 percent of the Mexican export goes to U.S. Therefore using variations in a single exchange rate (between Mexico and U.S.) seems to be an almost perfect proxy for variations in the exchange rate values that could potentially affect firms in the home country in Chaney's model.

The real exchange rate data is downloaded from the Data and Statistics division of IMF. Data is monthly but since my analysis is annual, I have taken the average value of the exchange rate over months of a year and used it as the annual exchange rate.

5 Empirical analysis

What I want to achieve in this section is to estimate the effect of a change in appreciation of real exchange rate (more negative Δe) on the probability of being an exporter for different groups and check if the two characteristics, explained at the end of section 3, hold. For any group of firms (defined later), what I am interested to measure is the average value of the expression below:

$$\frac{\partial Pr(EX_{ik,t} = 1 | EX_{ik,t-1} = 0)}{\partial \Delta e_{t-1}} \tag{8}$$

The reason for why using $\Delta e_{t-1} = e_{t-1} - e_{t-2}$ and not Δe_t is going to be explained along with the rationale behind other variables used in the empirical model later.

Without making any further assumption at the moment, I am going to use a probit model to estimate the probability of being an exporter[5]. A linear probability model does notwork very well here since in my dataset most of the firms always or never export throughout the period, and this kind of model is problematic in the proximity of 0 and 1.

To form the probability function, I exactly follow Chaney's theory; the probability of being an exporter is a function of previous TFP, liquidity constraint and the changes in the exchange rate.

$$\begin{aligned} Pr(EX_{ik,t} = 1) = \Phi(&\beta_1 TFP_{i,t-1} + \beta_2 d_{il,t-1} + \beta_s d_{is,t-1} \Delta e_{t-1} + \beta_l d_{il,t-1} \Delta e_{t-1} \\ &+ c_i + industry\ dummies + \beta_t Year_t) \end{aligned} \tag{9}$$

where the subscript i indexes firms, k the industries, and t the time. $TFP_{i,t-1}$ denotes the firm's productivity in the previous period and is estimated by the Levinshon-Petrin (2003) method.[6] As explained before, the theoretical model needs us to control for productivity and that is why I am using the TFP measure here.

d_l is a dummy variable equal to 1 if the firm is large. The large firms are the ones which are less constrained than the small ones. The large-small terminology comes from the measure used in Gertler and Gilchrist (1994) in which they argued less assets means a higher level of liquidity-constraint. Since, during this study I make comparisons with Greenaway et

[5]I could use a logit model but for the reasons explained shortly, it would not be a smart choice.

[6]In appendix B I have explained the method and production function coefficients.

al. (2007), I am going to use the same measure they used for the level of liquidity-constraint which is the liquidity ratio, defined as $\frac{assets-debt}{assets}$. Being large or small here is determined using the median level of liquidity ratio (LR) in each industry. If a firm has a LR larger than the median firm, in the four-digit industry it is active in, then that firm is categorized as large. This takes into account the differences in the level of liquidity required for working in different industries.

The reason why I use d_l instead of the actual level of liquidity ratio, as the second term of the probability function, is that the coefficient of LR does not provide any useful information. It just says how much the value of the term inside Φ changes if LR increases by one. However, since the range of LR values varies a lot among different industries, a fixed increase in the value of LR might have very different results in different sectors. On the other hand going from small to large has a very clear meaning, since large/small is defined in each four-digit industry[7]. Similarly, d_s is the dummy to indicate if the firm is small.

The reason for interacting the change in exchange rate and the group of liquidity constraint is that I want to compare the effect of change in exchange rate in different groups and at this stage we are not interested in the aggregate effect of Δe_{t-1} [8]. In the model above, c_i is the firm fixed effect and $Year_t$ is the time dummy.

The rationale behind using lagged time-varying regressors has been explained in the literature (Roberts and Tybout, 1997; Bernard and Jensen, 1999, 2004). However, it is also in line with the timing in Chaney's model. In the model, a firm can start exporting after paying the fixed cost. Therefore, if a firm is exporting in this period, it means that it has already paid the entrance cost (it could have happened at the beginning of this period or the end of last period). Firms can pay this fixed cost either through the profit gained in the domestic market, which is a function of productivity, or the available liquidity. That is why the productivity and liquidity-constraint levels show up in the model as lagged variables[9].

Running Lagrangian multiplier test allows me to reject the Random Effects specification for model (9). Therefore, there should be a relationship between the fixed effects and explanatory variables. It is intuitive since it can easily be thought that the productivity of the firm or level of access to financial resources is correlated with for example managerial abilities or firm's location.

Estimating average partial effects (APE) in the binary fixed effects setting is not trivial and, when possible, needs further assumptions. The reason is that to obtain consistent partial effects we need a consistent estimator of c_i values and getting that is not achievable under all circumstances.

An established method for estimating the APE in the case of probit fixed effects specification is Chamberlain (1980)-Mundlak (1978). A restrictive feature of this method is that we can only estimate the effects of time-varying elements in x_{it}. If our original model contains

[7]section 5.1.3 provides a sensitivity analysis for using LR instead of d_l.

[8]An alternative way is to estimate the aggregate effect of Δe_{t-1} and then in the next stages, estimate the average effects for different groups.

[9]Although the timing of the model is consistent with using lagged regressors but the results are robust to using contemporaneous variables instead. Robustness analysis will be provided later in the paper.

a time-constant explanatory variable (we have industry dummies here) it can be included among the explanatory variables, but we cannot distinguish its effect from c_i.

This method can be performed under different sets of assumptions but since the generality of my results is important, I will do the estimations using the most general case possible. The assumptions in this case are:

$$Pr(EX_{ik,t} = 1|x_i, c_i) = Pr(EX_{ik,t} = 1|x_{it}, c_i) = \Phi(x_{it}\beta + c_i) \tag{10}$$

$$c_i|x_i \sim Normal(\psi + \overline{x_i}\xi, \sigma_a^2) \tag{11}$$

x_i contains x_{it} for all t. Assumption (10) says that x_{it} is strictly exogenous conditional on c_i i.e. once c_i is conditioned on, only x_{it} appears in the response probability at time t. Keeping in mind that we are trying to test Chaney's model, this assumption makes sense since the model actually claims that whether a firm is exporter or not is explained by the variables we have included in the regressors of (9).

$\overline{x_i}$ in assumption (11) is the average of x_{it}, $t = 1, ..., T$ and σ_a^2 is the variance of a_i in the equation (12):

$$c_i = \psi + +\overline{x_i}\xi + a_i \tag{12}$$

While assumption (11) is restrictive in that it specifies a distribution for c_i given x_i, it allows for some dependence between c_i and x_i [10].

Under assumptions (10) and (11), we can estimate scaled versions of ψ, β, and ξ. Under these assumptions we have:

$$Pr(EX_{ik,t} = 1|x_i) = \Phi[(\psi + x_{it}\beta + \overline{x_i}\xi).(1 + \sigma_a^2)^{-0.5}] \equiv \Phi(\psi_a + x_{it}\beta_a + \overline{x_i}\xi_a) \tag{13}$$

Here the subscript "a" means that a parameter has been multiplied by $(1 + \sigma_a^2)^{-0.5}$. We can consistently estimate ψ_a, β_a, and ξ_a in (13) using a pooled probit regression of $EX_{ik,t}$ on 1, x_{it}, and $\overline{x_i}$, $t = 1, ..., T$, $i = 1, ..., N$.

Table (2) summarizes some of the estimated variables. The standard errors are robust and clustered at the firm level.

Explanatory variable	The coefficient	Robust standard error
$TFP_{i,t-1}$	0.00002	0.00017
$d_{l,t-1}$	-0.17282	0.05265
$d_{s,t-1}\Delta e_{t-1}$	-0.00744	0.00486
$d_{l,t-1}\Delta e_{t-1}$	-0.03215	0.00629
$constant$	0.00368	0.26387

Table 2: Estimating the scaled coefficients of the probit model using Chamberlain-Mundlak method

[10] Another option is to use a fixed effect logit model which allows to estimate β's without any assumption about how c_i is related to x_i. However, in that case we cannot estimate the partial effects unless we plug in a value for c. Because the distribution of c_i is unrestricted it is difficult to know what to plug in for c.

The coefficients for both $d_{s,t-1}\Delta e_{t-1}$ and $d_{l,t-1}\Delta e_{t-1}$ are significant.

Given the estimations above, in the second step, I estimate $\Phi(\hat{\psi_a} + x_{it}\hat{\beta_a} + \overline{x_i}\hat{\xi_a})$ for each observation. Having this, enables me to estimate the partial effect

$$\frac{\partial \Phi(\hat{\psi_a} + x_{it}\hat{\beta_a} + \overline{x_i}\hat{\xi_a})}{\partial x_{itj}} \tag{14}$$

for all of the observations.

Chamberlain-Mundlak prove that we can consistently estimate the APE of the variable x_{itj}, by evaluating the expression:

$$\frac{1}{\Sigma_{i=1}^{N} T_i} \Sigma_{i=1}^{N} \Sigma_{t=1}^{T_i} \hat{\beta_{aj}} \phi(\hat{\psi_a} + x_{it}\hat{\beta_a} + \overline{x_i}\hat{\xi_a}) \tag{15}$$

In expression (15), T_i represents the number of observations for agent i. This is not the end of my estimation since what I am interested to estimate is the APE of $d_{s,t-1}\Delta e_{t-1}$ and $d_{l,t-1}\Delta e_{t-1}$ conditional on that the firms have not been exporters in the previous period. Therefore, after doing all of the estimations above, I drop the observations in which a firm has been an exporter in the previous period and take the average (15) for the remaining observations. Given that this average has a negative value, its absolute value tells us how much the probability of becoming an exporter goes up on average in each group if the lagged change in real exchange rate Δe_{t-1} changes by one unit.

After doing all this, based on 7231 observations, the APE for $d_{s,t-1}\Delta e_{t-1}$ is -0.0047 with the standard error of 0.000023. Also, the APE for $d_{l,t-1}\Delta e_{t-1}$ is -0.0082 with the standard error of 0.000039. The p-value of 0.0000 strongly rejects the hypotheis that the two averages are equal. These variables satisfy the two characteristics the model imlpies. They are both negative and, in absolute values, the effect is larger for the less liquidity-constrained group.

On the economic significance of these estimates, notice that from January 1987 to Decemeber 1990 Mexico faced a 6 unit appreciation of real exchange rate. What it means is that, on average, the probability of large liquidity-constrained firms becoming exporters changed by about 5 percent.

5.1 Sensitivity analysis

In this part I am going to test the sensitivity of the results in three directions. One important extension of the model is to increase the number of groups and investigate if we see the same pattern among our variables.

Although the TFP obtained from Levinshon-Petrin (2003) method is a better measure of productivity, in the literature the ratio of sales per worker has also been used. I am going to use sales per hour of working and see if, and how, the results change. The last sensitivity analysis is about using the actual value of liquidity constraint instead of the large group dummy as a control variable.

5.1.1 Increasing the number of groups

To answer this, I divided the firms in each four-digit industry to three groups: small, medium, and large (one third of firms in each) and did the same kind of analysis as above. Table (3) summarizes the scaled coefficients that I get from estimating this model.

Explanatory variable	The coefficient	Robust standard error
$TFP_{i,t-1}$	0.00003	0.00016
$d_{m,t-1}$	-0.00410	0.02302
$d_{l,t-1}$	0.02232	0.03854
$d_{s,t-1}\Delta e_{t-1}$	-0.02134	0.00425
$d_{m,t-1}\Delta e_{t-1}$	-0.02171	0.0035882
$d_{l,t-1}\Delta e_{t-1}$	-0.02337	0.00666
$constant$	-0.46652	0.05251

Table 3: Scaled coefficients of the probit model using three groups of firms

The coefficients for $d_{s,t-1}\Delta e_{t-1}$, $d_{m,t-1}\Delta e_{t-1}$, and $d_{l,t-1}\Delta e_{t-1}$ are all significant. Now using the same procedure as above, I am interested to estimate the APE of $d_{s,t-1}\Delta e_{t-1}$, $d_{m,t-1}\Delta e_{t-1}$, and $d_{l,t-1}\Delta e_{t-1}$ given that the firms have not been exporters in the previous period.

The APE for $d_{s,t-1}\Delta e_{t-1}$ is -0.0073 (s.e. 0.0000066), for $d_{m,t-1}\Delta e_{t-1}$ is -0.0075 (s.e. 0.0.0000067), and for $d_{l,t-1}\Delta e_{t-1}$ is -0.0081 (s.e. 0.0000072). The p-value strongly rejects that the APE's are equal. Similar to the previous estimation, these variables are negative and in absolute values, the effect is larger for the less liquidity-constrained group. I attribute the smaller difference between the APE's here to the fact that we have increased the number of groups, and therefore the neighbor groups are more similar to each other.

5.1.2 Changing the measure of productivity

Using sales per hour of working as the measure of productivity and following the same procedure will get us to the value of -0.0062 for the APE of $d_{s,t-1}\Delta e_{t-1}$ (s.e. 0.000014), and -0.0092 for the APE of $d_{l,t-1}\Delta e_{t-1}$ (s.e. 0.00002)[11]. Although, in absolute values, our estimates have increased, they follow the desired features.

5.1.3 Liquidity Ratio instead of group dummy

Another possibility is to use the actual level of Liquidity Ratio instead of the group dummy. It is to use the following instead of equation (9):

$$Pr(EX_{ik,t} = 1) = \Phi(\beta_1 TFP_{i,t-1} + \beta_2 LR_{i,t-1} + \beta_s d_{is,t-1}\Delta e_{t-1} + \beta_{il} d_{l,t-1}\Delta e_{t-1} + c_i + industry\ dummies + \beta_t Year_t) \quad (16)$$

[11] The p-value of 0.0000 strongly rejects that the APE's are equal throughout the paper and I do not repeat this finding any more.

The APE for $d_{s,t-1}\Delta e_{t-1}$ is -0.0055 (s.e. 0.000005) and for $d_{l,t-1}\Delta e_{t-1}$ is -0.0070 (s.e. 0.000006).

5.2 Robustness analysis

5.2.1 Adding explanatory variables used in Greenaway et al. (2007)

In addition to the lagged TFP and LR, Greenaway et al. (2007) use three other variables as explanatory variables in their estimations. They are lagged wage, a dummy variable which shows if foreigners are among the owners or not, and a dummy illustrates if a firm has subsidiaries. To make this study more comparable with theirs, I use two of those three variables here (I don't have access to subsidiaries data) and see if that affects the results.

The estimate for the APE of $d_{s,t-1}\Delta e_{t-1}$ is -0.0037 (s.e. 0.000021) and for the APE of $d_{l,t-1}\Delta e_{t-1}$ is -0.0064 (s.e. 0.000038). Being foreign-owned has a large effect in the first stage of the estimation. The scaled coefficient is 0.46 with the standard error of 0.064.

5.2.2 Sources of RER fluctuation and the validity of estimations

In late 1987 Mexico entered a phase of real exchange rate appreciation which continued until 1995. It is important to know the cause(s) behind this since it might independently affect the export status of firms and therefore make my estimations biased.

In the literature different factors have been claimed to be the causes for the real exchange rate fluctuations. Monetary shocks to money supply and demand (Clardia and Gali 1994), expansive macroeconomic policies like higher deficits or excess supply of domestic credit (Edwards 1994), terms-of-trade shocks (Mendoza 1995 and Edwards 1994), productivity shocks (Mendoza 1995), and capital inflow (Edwards 1994, 1998) are a few to name.

Dabos and Juan-Ramon (2000) specifically study the causes of exchange rate fluctuation in Mexico in the period of 1982-1994 and show that there is a long-run relationship between the real exchange rate and the capital flows, terms of trade, and productivity. They claim that the ratio of net capital inflow to the quarterly (annualized) GDP is the most important factor in describing the variability of the real exchange rate and a unit increase shock to this ratio leads to a 12 percent appreciation.

What I should be worried about is that the causes of real exchange rate fluctuation might independently affect the probability of being an exporter at the same time and make my estimations biased. The productivity shock does not concern me since I control for it in the empirical models. Capital inflow can affect the probability of being an exporter but the channel through which it works is that average percentage of foreign ownership goes up. If we control for the level of foreign ownership (percentage of foreign ownership), my results hold; the APE of $d_{s,t-1}\Delta e_{t-1}$ is -0.0024 (s.e. 0.000055) and for the APE of $d_{l,t-1}\Delta e_{t-1}$ is -0.0125 (s.e. 0.000073). Therefore, not including capital inflow does not affect the characteristics that we are looking for in our estimations.

To analyze the effect of changes in terms-of-trade I would need the price index for Mexican exports and imports, which I cannot build up from the available dataset. However, I use the $\frac{CPI(US)}{CPI(Mexico)}$ as a proxy for terms-of-trade and add it to the explanatory variables of (9). After going through all of the steps, the estimate for the APE of $d_{s,t-1}\Delta e_{t-1}$ is -0.0028 (s.e. 0.000034) and for the APE of $d_{l,t-1}\Delta e_{t-1}$ is -0.0113 (s.e. 0.000062). The estimates follow the desired characteristics and therefore it does not seem that the changes in terms-of-trade affect the claims of this study.

Controlling for all three causes at the same time does not affect the APE of $d_{s,t-1}\Delta e_{t-1}$ and the APE of $d_{l,t-1}\Delta e_{t-1}$ changes a little bit to -0.0117.

5.2.3 Using contemporaneous variables

My results are also robust to using contemporaneous variables instead of the lagged ones. the APE of $d_{s,t-1}\Delta e_{t-1}$ in this case is -0.011 (s.e. 0.000013) and for $d_{l,t-1}\Delta e_{t-1}$ is -0.013 (s.e. 0.000015).

5.3 Sector-level analysis

In the last part of this paper, grounding on the support I have found for Chaney (2005), I am going to identify the manufacturing sectors in Mexico with non-exporters distributed denser behind the minimum level of liquidity required for exporting.

The analysis in the previous part suggests that, if we control for the level of productivity and liquidity in the previous period, then sectors with a higher percentage of non-exporting firms close to the $\overline{x}(A)$ border should respond more to an exchange rate appreciation. To identify these sectors, I base the analysis on the following probit model:

$$Pr(EX_{ik,t}=1)=\Phi(\beta_1 TFP_{i,t-1}+\beta_2 d_{il,t-1}+\Sigma_{m=1}^{9}\beta_m\Delta e_{t-1}d_{im}+c_i \\ +industry\ dummies+\beta_t Year_t) \quad (17)$$

in which m represents the nine sectors we have here and d_{im} is a dummy equal to 1 if firm i belongs to sector m. Then I come up with average value of the following for each sector:

$$\frac{\partial Pr(EX_{ik,t}=1|EX_{ik,t-1}=0)}{\partial\Delta e_{t-1}} \quad (18)$$

I will follow the same steps used in the estimations in section 5 of this paper to estimate (18). Table (4) summarizes the results of these estimations. In the last step of the estimation I drop observation with $EX_{t-1}=1$ and then take the average of the partial effects. Column (3) shows the number of observations that I take average for in each sector.

The β_{am} coefficients for textile industry and other manufactures are not significant. In other sectors, from the table above, I conclude that chemical industry and paper and paper products, are the sectors in Mexico with non-exporters distributed denser behind the minimum level of liquidity required for exporting. Metal products, non-metallic products, and woods products come after. Also it can be concluded that textile industry and other manufactures sectors are the ones with the least density of firms behind $\overline{x}(A)$.

Manufacturing sector	APE	Manufacturing sector	APE
Paper and paper products	-0.0073 (0.000009)	*Chemical industry*	-0.0104 (0.000013)
Metal products	-0.0108 (0.000014)	*Food products*	-0.0032 (0.000004)
Wood products	-0.0030 (0.000004)	*Iron and Steel*	-0.0112 (0.000015)
Non − metallic minerals	-0.0061 (0.000008)		

Table 4: Estimating the APE of Δe in different manufacturing sectors

This finding can be used for formulating more efficient export-promoting policies. Given the scarcity of goverment's financial resources, my analysis suggests that providing more liquidity to the firms active in chemical industry and paper and paper products sector has the higher probability of generating exporters than other sectors.

6 Conclusion

In this paper by looking at Chaney (2005) from a new angle, deriving new implications of the model, and using a panel data from the Mexican manufacturing firms in the period of 1986-1990, I tested the model for the first time. My results provide support for the model by confirming the new implications.

My empirical analysis confirms that, for a fixed level of productivity and given that firms have not been exporters in the previous period, a larger appreciation of the exchange rate has a positive effect on the probability of a firm being an exporter and if we compare different groups of firms with different levels of liquidity-constraint, then this effect is larger in the group with lower level of liquidity-constraint. This result is not sensitive to the number of groups and the measure of productivity.

The analysis is robust to the inclusion of two other explanatory variables used in Greenway et al. (2007); foreign-ownership and wages and also to using contemporaneous explanatory variables instead of lagged ones. Including the sources of RER fluctuations in the analysis and using them as separate explanatory variables does not change the results.

An extension to my test which would make it more realistic is to build and use industry-specific exchange rates and follow the same steps.

Another experiment that I can run using this model is to evaluate the intensive margin of trade; the effect of an exchange rate appreciation on the volume of incumbent firms' exports. However, to do that I would need to calibrate some of the parameters of the model first.

References

[1] Beck, T., 2002. Financial Development and International Trade. Is There a Link? Journal of International Economics 57, 107-131

[2] Becker, B., Greenberg, D., 2007. Financial Development, Fixed Costs and International Trade. Harvard Business School mimeo.

[3] Bernard, A., Jensen, J., 1999. Exceptional exporter performance: cause, effect, or both? Journal of International Economics 47, 1-25.

[4] Bernard, A., Jensen, B., 2004. Why some firms export. Review of Economics and Statistics 86, 561-569.

[5] Campa, J.-M., Shaver, J.-M., 2002. Exporting and capital investment: on the strategic behavior of exporters. Discussion Paper No. 469. IESE Business School, University of Navarra.

[6] Chaney, T., 2005. Liquidity constrained exporters. Working Paper, University of Chicago.

[7] Clardia, R.-H., Gali, J., 1994. Sources of Real Exchange Rate Fluctuations: How Important are Nominal Shocks? NBER Working Paper No. 4658

[8] Dabos, M., Juan-Ramon, V.-H., 2000. Real Exchange Rate Response to Capital Flows in Mexico: An Empirical Analysis. IMF Working Paper WP/00/108

[9] Edwards, S., 1994. Real and Monetary Determinants of Real Exchange Rate Behavior: Theory and Evidence from Developing Countries. in Estimating Equilibrium Exchange Rates. ed. by Williamson, J. (Peterson Institute).

[10] Edwards, S., 1998. Capital Flows, Real Exchange Rates, and Capital Controls: Some Latin American Experiences. in Capital Flows to Emerging Markets. ed. by Edwards, S. (University of Chicago Press).

[11] Gertler, M., and Gilchrist, S., 1994. Monetary Policy, Business Cycles and the Behavior of Small Manufacturing Firms. Quarterly Journal of Economics 109, 309-340.

[12] Greenaway, D., Guariglia, A., Kneller, R., 2007. Financial factors and exporting decisions. Journal of International Economics 73, 377-395.

[13] Levinsohn, J., Petrin, A., 2003. Estimating Production Functions Using Inputs to Control for Unobservables. Review of Economic Studies 70, 317-342.

[14] Manova, K., 2008. Credit Constraints, Equity Market Liberalizations and International Trade. Journal of International Economics 76, 33-47.

[15] Manova, K., 2006. Credit Constraints, Heterogeneous Firms and International Trade. Working Paper, Stanford University..

[16] Matsuyama, K., 2005. Credit Market Imperfections and Patterns of International Trade and Capital Flows. Journal of the European Economic Association 3, 714-723.

[17] Melitz, M., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71, 1695-1725.

[18] Mendoza, E.,1995. The Terms of Trade, The Real exchange Rate, and Economic Fluctuations. International Economic Review 35, 101-137.

[19] Roberts, M., Tybout, J., 1997. The decision to export in Colombia: an empirical model of entry with sunk costs. American Economic Review 87, 545-564.

[20] Verhoogen, E., 2008. Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector. Quarterly Journal of Economics 123, 489-530.

[21] Wooldridge, J., 2002. Econometric Analysis of Cross Section and Panel Data. MIT Press

Appendix

A Proof of proposition 1

Proposition 1 (reminded) *If we fix the level of productivity (x) in the liquidity constrained area, then a firm with larger A (less liquidity constraint) is equally or more likely to start exporting following the appreciation than a firm with smaller A (more liquidity constraint).*

Proof. Suppose that subscript b points to the value of a variable before appreciation and subscript a indicates the value after appreciation.

From section 2.4 we know that following an appreciation we have $\overline{x}_{fa} > \overline{x}_{fb}$. From the set Ω (the liquidity-constrained firms) those with productivity levels $x < \overline{x}_{fa}$ clearly cannot export because they do not pass the productivity threshold and therefore the probability of them become exporter is zero.

In Ω, set a productivity level $x > \overline{x}_{fa}$. What I want to show is:

$$Pr(x > \overline{x}_a(A_1)) \geq Pr(x > \overline{x}_a(A_2))$$

Given that $A_1 > A_2$, $(x, A_1) \in \Omega$, and $(x, A_2) \in \Omega$

This is equivalent to proving that:

$$1 - F(\overline{x}_a(A_1)) \geq 1 - F(\overline{x}_a(A_2))$$

in which $F(.)$ is the c.d.f. of variable x. Alternatively, I can show that:

$$F(\overline{x}_a(A_1)) \leq F(\overline{x}_a(A_2))$$

However, if we write down the expression for $x_a(A)$ from (7) we have:

$$\overline{x}_a(A) = \Big(\frac{C_d + \frac{w_a^*}{w_a}C_f - A}{C_d}\Big)^{(\frac{1}{\sigma-1})} g(C_d)$$

This expression is clearly non-increasing in A, and the proposition has been proved. ■

B Productivity estimation

The important obstacle in estimating productivity is that input levels are correlated with unobserved productivity shocks. This phenomenon makes the OLS estimation biased. The Levinsohn-Petrin method emerged as a substitute for Olley-Pakes method in which investment is used as a proxy for unobservable shocks. Levinsohn-Petrin show that investment is very lumpy and does not respond smoothly to the productivity shocks. Instead they discuss the conditions under which using the intermediate variables can solve the simultaneity problem. This avoids truncating all of the zero investment firms, which is very usual when working with datasets from developing countries.

To use the Levinsohn-Petrin method, I have assumed a production function of the Cobb-Douglas form:

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \epsilon_t \tag{19}$$

in which y_t is the logarithm of firm's output and most of the times it is measured by gross revenue or value added of the firm. In my estimation, I have used the logarithm of total product sales. k_t is the logarithm of capital for which I have used the logarithm of machinery and equipment value. m_t is the logarithm of the intermediate variable. This paper uses the electricity purchased by the firm as the intermediate input. l_t is the logarithm of the labor input which is measured by the total hours worked in my paper.

In STATA the estimation looks like this:

levpet dependent-var free(labor var) proxy(intermediate var) capital(capital var) revenue justid grid

predict TFP, omega

The word "revenue" indicates that the dependent variable is a revenue variable and not a value-added one. Table below summarizes the coefficients and their standard errors:

	Coefficient	Standard error
Labor	0.2237	0.001
Capital	.21	0.019
Intermediate input	0.44	.0242975

Table 5: Production function estimation using Levinsohn-Petrin method

C Theoretical and empirical analysis of RER depreciation

When depreciation happens we face the following incidents $\overline{x}(A) \nearrow$ and $\overline{x}_f \swarrow$. In the eyes of Chaney's model what it means is that some of the firms which where productivity-constrained start exporting, but the status of liquidity-constrained firms does not change. The symmetric effect of this phenomenon in the context of my paper is that for a given level of liquidity-constraint, if we compare different groups of firms with different levels of productivity which have representation in the group of new-entrants, then a larger depreciation of the exchange rate would have an equal or larger effect on the probability of a firm being an exporter in the group with higher level of productivity given that it has not been an exporter in the previous period.

If the model's predictions are correct, then after controlling for the level of liquidity constraint and given that the firms have not been exporters in the previous period, the effect of a larger depreciation of exchange rate on the probability of being an exporter should have two characteristics:

- It needs to be positive.
- It should not be larger for the lower-productivity group.

Corresponding to the equation (9) in the text of paper, the model in mind is

$$Pr(EX_{ik,t} = 1) = \Phi(\beta_1 LR_{i,t-1} + d_{il,t-1} + \beta_s d_{is,t-1} \Delta e_{t-1} + \beta_l d_{l,t-1} \Delta e_{t-1} + c_i + industry\ dummies + \beta_t Year_t) \tag{20}$$

d_{il} is a dummy variable equal to 1 if the firm is large and 0 otherwise. A large firm is defined as the one whose TFP is bigger than the median TFP in its own four-digit industry.

I follow the same steps as in section 5 of the paper to obtain our measure of interest. The coefficients for both $d_{s,t-1}\Delta e_{t-1}$ and $d_{l,t-1}\Delta e_{t-1}$ are significant. Based on 11955 observations, the APE for $d_{s,t-1}\Delta e_{t-1}$ is 0.0141 and for $d_{l,t-1}\Delta e_{t-1}$ is .0151089. It is very interesting to see that appreciation of the exchange rate shows a symmetric effect.

Something that should be mentioned here is that I ran the regression over an over for this section and the coefficients of $d_{s,t-1}\Delta e_{t-1}$ and $d_{l,t-1}\Delta e_{t-1}$ kept changing in an interval of [0.035 to 0.50]. The results that I am reporting here is based on coefficients 0.0426 for $d_{s,t-1}\Delta e_{t-1}$ and 0.0458 for $d_{l,t-1}\Delta e_{t-1}$. Statistically, I could not reject that the two APE's are different, but it is still in agreement with our hypothesis.