# Export Growth and Credit Constraints

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**Abstract:**

This paper investigates the role of credit constraints on the growth of exports at the micro level. We develop a model showing credit constraints play a role in determining the value of exports, while their role on the growth rate of exports is the strongest in early stages of either positive or negative growth. Our empirical results using data on exports to the U.S. at the product level largely confirm the model's predictions.

JEL Classification: F1, F12
Key Words: export growth, trade, credit constraints

# 1. Introduction

To be completed

# 2. Theoretical Framework

*2.1 Assumptions and Equilibrium Conditions*

The world consists of $E$+1 countries: a country named Importer (indexed by *i*) and $e = 1, 2, ..., E$ small open economies. Small open economies can export differentiated goods to the Importer in $s = 1, 2, ..., S$ differentiated sectors and in return import a numeraire good, which can be traded at zero cost. The production technology in a given country and sector is symmetric across differentiated goods. In particular, an exporting country *e*, sector *s* firm's cost function of producing $q_{esg}$ units of the differentiated good *g* is given by $f_{es} + c_{es} q_{esg}$. At any given time, there are up to $n_{es}$ firms attempting to produce new differentiated goods in country *e* and sector *s*. Importer's demand for a new differentiated good $q_{esg}$ is given by $q_{0esg} = D_{0esg} p_{0esg}^{-\sigma_s}$, where subscript 0 indicates that this product was not previously on the market, $\sigma_s > 1$ is a constant price elasticity of demand in sector *s*, $p_{0esg}$ is the price, and $D_{0esg}$ is an exogenously given demand parameter. The firm faces uncertainty about the demand parameter $D_{0esg}$: with probability $\alpha_{0es}$ $(0 < \alpha_{0es} < 1)$ the firm faces a positive demand, $D_{0esg} = \lambda_{0es} > 0$, while with probability $(1 - \alpha_{0es})$ the there is no demand for the firm's product, $D_{0esg} = 0$. If a firm chooses to produce after $t \geq 1$ successful periods, its probability of facing positive demand in period $(t+1)$ is equal to $\beta_{tis} > \alpha_{0es}$. Note that the probability of the positive demand in the very first period is assumed to be exporter-specific, while after at least one successful period it becomes importer-specific.

In each period a firm has to incur the production cost before it observes the demand parameter. A firm finances a part of the production cost with its own resources and borrows the rest from banking sector which lends at the profit-free interest rate. The share of production costs financed by the loan, denoted by $\eta_s$, is sector specific, but constant across countries and over time. From a bank's perspective the firm will repay the loan with probability $\alpha_{0es}$, and will default with probability $(1-\alpha_{0es})$. Assessing the risk and servicing the loan is costly. The cost is proportional to the amount of the loan: for each dollar of the loan the servicing cost is given by $\phi_e$. This sets the banking loan interest rate $r_{es}$ at

$$(1) \qquad (1+r_{es}) = (1+\phi_e)/\alpha_{0es}.$$

The first period expected profit is given by:

$$E(\pi_{0esg}) = \alpha_{0es}\left(q_{0esg}\left(p_{0esg}/\tau_{es} - c_{es}\eta_s(1+r_{es}) - c_{es}\frac{1-\eta_s}{\alpha_{0es}}\right) - f_{es}\eta_s(1+r_{es}) - f_{es}\frac{1-\eta_s}{\alpha_{0es}}\right)$$
$$= \alpha_{0es}\left(q_{0esg}\left(p_{0esg}/\tau_{es} - c_{es}\frac{1+\eta_s\phi_e}{\alpha_{0es}}\right) - f_{es}\frac{1+\eta_s\phi_e}{\alpha_{0es}}\right),$$

where $\tau_{es} > 1$ is the Samuelson iceberg transportation cost of shipping industry s goods from exporter *e*. The profit maximizing price for active firms is given by:

$$(2) \qquad p_{0esg} = \frac{\sigma}{\sigma-1}\frac{c_{es}(1+\eta_s\phi_e)\tau_{es}}{\alpha_{0es}}.$$

If the demand parameter is positive, the resulting revenue (or the value of exports in the first year, $V_{1es}$) is given by:

$$(3) \qquad q_{0esg}\,p_{0esg} = \lambda_{es}\left(\frac{\sigma_s-1}{\sigma_s}\frac{\alpha_{0es}}{c_{es}(1+\eta_s\phi_e)}\right)^{\sigma_s-1}\tau_{es}^{-\sigma}.$$

$$(3) \qquad V_{0es} = \alpha_{0es} n_{es} q_{0esg} p_{0esg} = \alpha_{0es} n_{es} \lambda_{es} \left( \frac{\sigma_s - 1}{\sigma_s} \frac{\alpha_{0es}}{c_{es}\left(1+\eta_s \phi_e\right)} \right)^{\sigma_s - 1} \tau_{es}^{-\sigma}$$

Thus, the f.o.b. value of exports in the first year increases in:

i) the value of the positive realization of the demand parameter, $\lambda_{es}$ (which may be a function of sector, importer and exporter sizes),

ii) the probability of success $\alpha_{0es}$ (which is a function of economic development, stability, etc., and is negatively correlated with the domestic interest rate of lending),

and decreases in:

i) the elasticity of substitution,

ii) the trade cost,

iii) the production cost,

iv) the share of external credit in a given industry,

v) the cost of providing credit or the inefficiency of the financial system.

After the first successful year of exporting, a firm has sufficient resources to fund its production and does not depend on external sources of financing. After $t > 1$ successful years a firm's profit maximizing price and corresponding revenue are given by:

$$(4) \qquad p_{tesg} = \frac{\sigma}{\sigma - 1} \frac{c_{es}\tau_{es}}{\beta_{tes}} \qquad \text{and} \qquad q_{tesg} p_{tesg} = \lambda_{es} \left( \frac{\sigma}{\sigma - 1} \frac{c_{es}}{\beta_{tes}} \right)^{1-\sigma_s} \tau_{es}^{-\sigma}$$

A firm makes an entry/exit decision based on the stream of expected future profits, and it will enter the market if and only if the stream of future profits is non-negative:

$$(5) \qquad \text{Entry condition: } \sum_{t=0}^{\infty} E\left(\pi_{tes}\right) \geq 0$$

We assume that the probability of survival is non-decreasing in the number of successful years of exporting:

$$\text{(6)} \qquad \beta_{tis} \geq \beta_{(t-1)is} \geq \ldots \geq \beta_{1is} > \alpha_{0es}\,.$$

This condition guarantees that if a firm has a non-negative expected profit in period 0, it will have a non-negative profit in all subsequent periods and will continue to export as long as it demand for its output is positive. The value of country *e*, industry *s* exports in period *t* can be calculated as:

$$\text{(7)} \qquad V_{Tes} = n_{es}\lambda_{es}\alpha_{0es}\tau_{es}^{-\sigma}\left(\frac{\sigma c_{es}}{\sigma-1}\right)^{1-\sigma_s}\left[\left(\frac{\alpha_{0es}}{1+\eta_s\phi_e}\right)^{\sigma_s-1} + \sum_{t=1}^{T}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T}\beta_{tes}\right)\right].$$

Note that the value of the exports is sector specific and it combines export by new firms (first term in square brackets) and by old firms (summation in square brackets).

The growth rate in exports can be calculated as

$$\text{(8)} \qquad \frac{V_{Tes}}{V_{(T-1)es}} = 1 + \frac{\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T}\beta_{tes}}{\left(\frac{\alpha_{0es}}{1+\eta_s\phi_e}\right)^{\sigma_s-1} + \sum_{t=1}^{T}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T}\beta_{tes}\right)}$$

As long as the production cost, demand, and transportation cost parameters remain unchanged, we can formulate several properties of the growth rate.

### *2.2 Comparative Statics and Empirically Testable Hypotheses*

We proceed by formulating several empirically testable hypotheses pertaining to the relationship between the rate of growth of exports and conditions in financial markets.

**Definition 1:** For a given industry in country *i* we define the *market conditions* by the industry's production and transportation costs parameters, as well as by the demand parameter for its exports.

**Lemma** 1: Assume that in period $t = 1, 2, \ldots, T$ the export growth rate is positive. Then, if market conditions do not worsen, the export growth rate will remain positive in period $t$=$t$+1.

We can then derive the following propositions pertaining to positive growth rates and constant market conditions for a given exporter.

**Proposition 1:** *The growth rate increases in:*

*i) the probability of success in the current year,*

*ii) the share of external financing in the first year,*

*iii) the lending rate in the first year or the inefficiency of the exporter's financial system,*

*while it decreases in:*

*i) the probability of success in the first year and consequently in the volume of export in the first year normalized for country and industry size and/or interest rate in the exporter's own market*

ii) *the number of successful exporting years or the age of an export relationship.*

**Proposition 2:**

*i) For every exporter the growth rate decreases over time.*

*ii) Across exporters growth rates converge over time.*

**Proposition 3:** *The growth rate does not depend on the:*

*i) size of the exporter,*

*ii) industry size of a given exporter.*

The proof of all of the above propositions follows directly from equation (8).

### *2.3 What About Negative Growth?*

Propositions derived above assumed the growth rate of exports is positive. However, not every firm's export grow continuously. Therefore, a question arises as to whether these propositions hold when a firm's exports begin to diminish. The relationship between negative growth and credit constraints depends on how worse the conditions for country *e*'s exporters became. As potential reasons for this change consider lower demand from Importer (lower λ), higher trade costs, of higher credit interest rate) For example, assume there are no new entrants, while all incumbents continue to produce (but export less).

The value of exports in the first year of negative growth is given by:

$$(9) \qquad V_{1Tes} = n_{es}\lambda_{es}\alpha_{0es}\tau_{es}^{-\sigma}\left(\frac{\sigma c_{es}}{\sigma-1}\right)^{1-\sigma_s}\left[\sum_{t=1}^{T+1}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T+1}\beta_{tes}\right)\right],$$

where the subscript 1*Tes* refers to the first year of negative growth after T years of positive growth. The value of exports in the second year of negative growth is given by:

$$(10) \qquad V_{2Tes} = n_{es}\lambda_{es}\alpha_{0es}\tau_{es}^{-\sigma}\left(\frac{\sigma c_{es}}{\sigma-1}\right)^{1-\sigma_s}\left[\sum_{t=2}^{T+2}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T+2}\beta_{tes}\right)\right].$$

Taking the ratio of the value of exports in the first year of the decline of exports, equation (9), and the last year of the increase of exports, equation (7), results in the following expression for the growth rate in the first year of the decline of exports:

$$\frac{V_{1Tes}}{V_{Tes}} = \frac{\sum_{t=1}^{T+1}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T+1}\beta_{tes}\right)}{\left(\frac{\alpha_{0es}}{1+\eta_s\phi_e}\right)^{\sigma_s-1}+\sum_{t=1}^{T}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T}\beta_{tes}\right)}$$

Thus, in the first year of negative growth, the growth rate is increasing in the "worse conditions" of the domestic credit markets, such as dependency on the external finance conditions and higher domestic interest rate. However, starting with the second year of negative growth, the growth rate equals:

$$(11) \qquad \frac{V_{2Tes}}{V_{1Tes}} = \frac{\sum_{t=2}^{T+2}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T+2}\beta_{tes}\right)}{\sum_{t=1}^{T+1}\left(\beta_{tes}{}^{\sigma_s-1}\prod_{t=1}^{T+1}\beta_{tes}\right)}$$

Implying it should be independent of conditions on domestic credit markets.

In addition, proposition derived in section 2.2 pertain to negative growth as well. The rate of decline decreases over time for each exporter and converges over time across exporters. It does not depend on the size of the exporter nor the industry size of the exporter. Finally, it increases in the probability of success in the current year, the share of external financing in the first year, the lending rate in the first year (or inefficiency of the exporter's financial system) and decreases in the probability of success in the first year and the number of years of exporting.

## 3. Data

We examine the validity of our model using data on exports to the United States at the product level between 1989 and 2007. We use annual data reported by the U.S. Census Bureau on U.S. imports at the 10-digit HS level. The basic unit of account is an export relationship to the U.S. which captures exports of a particular product, e.g. 'wooden kitchen cabinets designed for permanent installation' (HS=9403409060) or 'ski, cross-cty, and snowboard boots with rubber or plastic' (HS=6402120000), by a particular country to the U.S., e.g. Canada, China, the Czech Republic, France, Italy, Japan, and Spain, all of which exported the two aforementioned products to the U.S. in 2002. This is the same definition used by Besedeš and Prusa (2006a,b) and other papers in the duration of trade literature.[1] The U.S. International Trade Commission, which administers U.S. import HS codes, adjusts the definition of product codes on an annual basis. As described by Pierce and Schott (2009) adjustments come in three flavors: (1) a simple renumbering of a product swapping one code for another, (2) splitting an old product code into

[1] See Besedeš and Prusa (2010) for a survey.

several new ones to reflect the growing amount of trade, and (3) eliminating old codes with diminishing amount of trade and merging them into a single code. Since we are interested in growth rates of exports at the product level it is important to concord the HS codes across time. As Pierce and Schott (2009) indicate between 1989 and 2004 49 percent of import codes and 62 percent of import value was involved in some type of a code adjustment. To concord the data we use the algorithm developed by Pierce and Schott (2009).

In the eighteen years of data there are 3,601,465 annual observations. Since growth rates of exports to the U.S. are the focal point of interest, we use data on trade relationships which last at least two years allowing us to calculate at least one growth rate for a relationship. There are a total of 992,425 trade relationships of various duration in the data, of which 536,948 are only one year long and provide no opportunity for growth. We use the remaining 455,477 observations to calculate 6,056,838 growth rates. Since the predictions of our model depend on a clear observation of the start of a particular trade relationship, we eliminate all relationships for which we cannot with certainty determine the start. This implies dropping all relationships observed in 1989, the first year in our data, as there is no information as to the exact starting point of those relationships. This reduces the number of observations on growth rates to 2,767,508.

We use four variables to measure the conditions in country *e*'s domestic credit markets. Following Manova (2010) we regress the two quantities of interest, the value of first-year exports and the growth rate on country-level measures of financial development and sector-level measures of financial vulnerability or reliance on external financing. The main variable measuring the level of financial development (the efficiency of a financial system) is the share of private credit in GDP, measuring the relative amount of credit extended by banks and other financial intermediaries to the private sector. It was introduced by Beck et al. (2000) and has been used as the main indicator of financial development in the credit constraints in trade literature (see Manova 2010) as well as in the finance and growth literature (see Rajan and Zingales 1998, Braun 2003, Aghion et al. 2004). It is an outcome based measure of the size of the financial system reflecting the actual use of external funds.

The second country level variable pertaining to credit markets is the prevailing lending rate as reported by IMF's *International Financial Statistics* (2009). This is a direct measure of the cost of borrowing external finance. However, we use it as an additional control, rather as the main variable indicating the level of financial development. We do so because the sheer level of the lending rate does not necessarily indicate the true level of development of the financial system. Two countries may have the same cost of borrowing, but have rather different lending rates.

To measure financial vulnerability we use measures of external finance dependence and asset tangibility. Both come from Braun (2003) and are based on Compustat's annual industrial files on publically owned U.S. companies. External finance dependence measures the share of capital expenditures not financed with cash flows from operations for the median firm in each industry. Asset tangibility is defined as the share of net property, plant, and equipment in total book-value assets for the median firm in a sector. Both are averaged for the 1986-1995 period and appear very stable over time when compared to 1966-1975 and 1976-1985 values.

As argued by Manova (2010), while these measures do not specifically measure the use of external capital for international trade activity, they are a good proxy for three reasons. First, as assumed in our model, firms incur production costs producing both for domestic and foreign markets, often being significantly larger than other costs relating to exporting activities.

Second, products which involve large fixed costs (R&D, marketing research, and distribution) likely do so for both domestic and foreign markets, implying that a firm is likely to use external finance for both domestic and foreign markets. Third, the empirical measure is based on large U.S. firms which are usually large exporters reflecting their use of external finance for both domestic and foreign activities.

Using the measures of external financing for U.S. firms is necessitated by a lack of similar data across the spectrum of countries. However, as argued by Manova (2010), the U.S. is characterized by one of the most advanced and sophisticated financial systems, making it reasonable that the measure reflects firms' true demand for external finance and tangible assets. In addition, the use of U.S. data eliminates the possibility for the measure to endogenously respond to a country's level of financial development. The coefficient on external finance dependence variables would be underestimated if sectors with high dependence in the U.S. rely more on internal financing in less financially developed countries. Similarly, the coefficient on asset tangibility will be underestimated if sectors in other countries compensate with more tangible assets for a lower level of financial development.

As argued by Manova (2010), it is not necessary that sectors have the same level of external finance dependence and asset tangibility across countries, but that their ranking within each country is relatively stable. Rajan and Zingales (1998) and Braun (2003) argue these measures are a good proxy for ranking industries in all countries because they capture a large technological component which is innate to a sector. They show these measures vary more across sectors than across firms in a sector

## 4. Results

Our empirical investigation proceeds in several steps. We first examine equation (3) relating the value of exports in the first year to finance variables. We then proceed to examine the proposition pertaining to positive and negative growth rates.

### *4.1 First-year Exports*

Our primary goal when examining first-year export values is to ensure that our assumptions leading to equation (3) and the resulting implications are in accordance with data. To that end we first regress the value of first-year exports on financial variables: the level of financial development, external finance dependence, asset tangibility, and the lending rate. In the second column we add information on trade costs – transportation costs, tariff rate, exchange rate – and elasticity of substitution – proxied by product type dummies using the Rauch (1999) classification. Since the first-year value of exports is independent of the size of the exporting country and its industry, we normalize all first year export values by the exporting country's GDP.

We expect first-year exports to be decreasing in the share of external credit in a given industry (measured by external finance dependence) and the cost of credit (measured by asset tangibility) and increasing in the efficiency of the financial system. The share of external credit is measured by external finance dependence and as Table 1 indicates first-year export values are lower for product which rely more on external finance. The cost of credit is proxied by asset tangibility. Firm with more tangible assets have more resources as collateral when obtaining a loan and can thus receive a lower price for it. Our results indicate first-year exports are decreasing in asset tangibility, opposite of what we expect. Exports from more developed financial systems are lower, contrary to our expectations. Lending rate, as a direct measure of the cost of credit does not have an economically meaningful impact, though it is estimated with a negative sign, as expected.

Table 1 - First-year Export Values

| | | |
|---|---|---|
| Financial Development | -1.575*** | -1.675*** |
| | (0.005) | (0.006) |
| External Finance Dependence | -0.073*** | -0.063*** |
| | (0.008) | (0.011) |
| Asset Tangibility | -0.156*** | -0.483*** |
| | (0.021) | (0.026) |
| Lending Rate | -0.000*** | -0.000*** |
| | (0.000) | (0.000) |
| Ad-valorem transportation cost | | -0.297*** |
| | | (0.002) |
| Tariff rate | | -0.155*** |
| | | (0.003) |
| Relative real ex rate | | 0.051*** |
| | | (0.001) |
| Homogeneous good dummy | | 0.323*** |
| | | (0.032) |
| Reference priced good dummy | | 0.222*** |
| | | (0.011) |
| Constant | -14.778*** | -14.011*** |
| | (0.015) | (0.019) |
| Observations | 1,153,335 | 698,774 |
| R-squared | 0.101 | 0.156 |
| Calendar year FE | N | Y |

NOTE: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

In the second column of Table 1 we add trade cost variables as well as dummies for reference priced and homogenous goods which are proxies for the elasticity of substitution. First-year exports should be decreasing in both trade costs and the elasticity of substitution. Higher transportation costs and higher tariffs, both indicators of higher costs of trade, result in lower first-year exports. A higher relative real exchange rate, indicating the exporter's currency is weaker vis-à-vis the U.S. dollar relative to other currencies results in higher exports. A weaker currency reduces costs of trade and should increase first-year exports. Finally, in the absence of data on elasticity of substitution at the product level we use dummies for reference priced and homogeneous goods as proxies. Both types of products should have a higher elasticity of substitution than differentiated goods and should as a result start with lower first-year values. We find the opposite.

### *4.2 Export Growth Rates*

We begin the analysis of growth rates by providing some descriptive statistics in Table 2. We examine several cuts of the data. We separate growth rates into positive and negative ones, as we will examine them separately. We also report the distribution of growth rates for all relationships and only those used in the analysis below (all relationships with clearly observed starts). The distribution of growth rates for all relationships is nearly identical for positive and negative growth, while there are small differences for relationships we use in our analysis. Positive growth rates tend to be slightly larger than negative growth rates (in absolute sense) for relationships we analyze.

Table 2 - Summary Statistics on Growth Rates

| | All Growth Rates | | Used Growth Rates | |
|---|---|---|---|---|
| | Positive | Negative | Positive | Negative |
| 1% | 0.010 | -4.539 | 0.014 | -4.893 |
| 25% | 0.248 | -1.296 | 0.382 | -1.618 |
| 50% | 0.604 | -0.608 | 0.874 | -0.830 |
| 75% | 1.288 | -0.242 | 1.683 | -0.351 |
| 99% | 4.544 | -0.008 | 5.037 | -0.010 |
| Mean | 0.937 | -0.937 | 1.199 | -1.148 |
| Std. Dev. | 0.986 | 0.986 | 1.110 | 1.081 |
| Obs | 3,196,795 | 2,860,043 | 1,481,204 | 1,286,304 |

We examine several implications pertaining to growth rates. We first examine Proposition 1 which states that growth rates, both positive and negative, are increasing in the share of external financing and credit cost and decreasing in the level of financial development, the normalized (by GDP) value of exports in the first year, and the age of a relationship. Results for both positive and negative growth rates are shown in Table 2.

Table 3 - Growth Regressions Across All Ages

| | Positive | Negative |
|---|---|---|
| Normalized First-year Exports | -6.983*** | -5.033*** |
| | (0.135) | (0.158) |
| Financial Development | -10.807*** | -12.203*** |
| | (0.838) | (0.863) |
| External Finance Dependence | -0.061 | -3.362*** |
| | (0.590) | (0.619) |
| Asset Tangibility | -3.333* | 8.878*** |
| | (1.905) | (2.011) |
| Lending Rate | 0.006 | -0.008 |
| | (0.015) | (0.015) |
| Age | -5.743*** | -3.489*** |
| | (0.426) | (0.351) |
| Constant | 58.035*** | -194.246*** |
| | (3.149) | (3.455) |
| Observations | 345960 | 298376 |
| Number of Export Relationships | 94472 | 90867 |
| R-squared | 0.062 | 0.041 |
| Relationship Length FE | Y | Y |
| Calendar Year FE | Y | Y |

NOTE: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

In the first column we regress the positive growth rate on the four measures of the financial system as well as the age of the relationship. Growth rates are decreasing in initial normalized exports, as expected, with every one percent higher exports reducing the growth rate by roughly 7 percentage points. The growth rate is decreasing in the level of financial development as expected – exporters from less developed financial systems see their exports grow faster. For every one percentage point higher level of private credit, the growth rate decreases by almost 11 percentage points.

Although we expect that exports of firms from sectors with a higher dependence on external financing will grow faster, the estimated coefficient is negative, though small and not statistically significant. Exports of firms with more tangible assets and hence lower credit cost will grow slower, as expected, by more than 3 percentage points for every one percent larger tangible assets. Higher lending rate for all practical purposes does not have an impact, though it is estimated with a positive sign, as expected. As expected, growth decreases with the age of an export relationship.

In the second column we report the results form a corresponding regression on negative growth rates. Similar to positive growth rates, negative growth rates are decreasing in normalized exports and the level of financial development. One must be careful how to interpret the negative growth rate results. Since negative growth rates are negative, these coefficients indicate that the rate of decline in exports is *larger* the larger the initial starting point and the more developed the financial system. Larger relationships at the start of their decline (negative growth) will decline faster, because they are starting with a larger base. In addition, larger relationships are more likely to be composed of old firms and new entrants, and it is precisely the new entrants that do not exist when the value of exports starts to decrease. The signs on external finance dependence and asset tangibility are reversed. Exports of products from sectors more reliant on external financing will see a faster decrease in their exports, while those with more tangible assets will see a smaller rate of decline. The lending rate again is not significant, while the rate of decrease becomes larger with the age of the export relationship.

*4.3 Export Growth Convergence*

We next verify Proposition 2 that the growth rate is decreasing over time for each exporter and that it converges over time across exporters. We first note that the first part of this proposition that the growth rate is decreasing over time is confirmed by the results in Table 2 which show that the growth rate is decreasing in the age of a relationship. In order to examine the second part of the proposition we perform a different regression. We first calculate the standard deviation of growth rates at every age and regress it against age. We expect the coefficient on age to be negative. Results are presented in Table 4.

We calculate the standard deviation of growth rates in two ways. In column (1) for positive growth and column (4) for negative growth the calculation is based on having at least 5 growth observations of every age over the entire lifespan of export relationships for each product. This results in 637 HS codes with the requisite number of growth observations resulting in a total of 6,421 observations. In columns (2) and (3) for positive growth and (5) and (6) for negative growth we impose a more restrictive condition. We now require there be at least 5 growth observations at every age of a relationship for every calendar year. The more restrictive calculation reduces the number of product codes to 258 and total observations to 11,448. For negative growth rates the corresponding values are 615 product codes and 6,167 observations and 260 codes and 10,447 observations with the more restrictive calculation. We should note that even though the latter calculation is more restrictive, it actually results in more annual observations because the standard deviation of growth rates is calculated for each age-calendar year pair.

Table 4 - Convergence of Growth Rates

| | Positive growth | | | Negaitve Growth | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Age | -0.051*** | -0.019*** | -0.020*** | -0.040*** | -0.012*** | -0.013*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Constant | 1.198*** | 0.359*** | 0.352*** | 0.654*** | 0.272*** | 0.241*** |
| | (0.313) | (0.048) | (0.059) | (0.003) | (0.027) | (0.039) |
| Observations | 6,421 | 11,448 | 11,448 | 6,167 | 10,447 | 10,447 |
| No of HS Codes | 637 | 258 | 258 | 615 | 260 | 260 |
| R-squared | 0.279 | 0.043 | 0.045 | 0.242 | 0.025 | 0.027 |
| Sector FE | Y | Y | Y | Y | Y | Y |
| Calendar Year FE | N | N | Y | N | N | Y |

NOTE: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

As results in Table 4 clearly indicate growth rates across exporters converge over time, both for positive and negative growth rates, as expected. We examine specifications with sector fixed effects and with calendar year fixed effects when possible. Across all specifications, the coefficient on age is negative, indicating convergence, albeit slower when the standard deviation of growth rates is calculated for each age-calendar year pair.

In Table 5 we examine differences in the rate of convergence between positive and negative growth rates. As opposed to regressing the standard deviation of positive and negative growth rates on age separately, we regress them jointly on age and a dummy for positive growth rate standard deviation. Our expectation is that the variation across positive growth rates will be larger than across negative growth. Differences across starting values for positive growth will be larger than for negative growth, as negative growth tends to occur after some period of positive growth (though in some cases it occurs immediately after entry). As a result, the spread of growth rates will be larger for positive than negative growth. This is indeed what Table 5 shows. The deviation of positive growth rates is larger than for negative growth rates. In the first column we include relationships of all ages (and again confirm convergence across age by including age as a regressor), while in the remaining columns we run the regression for each age separately. Positive growth rates vary more for almost all ages (the only exceptions are ages 9 and 10), and vary more in a statistically significant sense through age 5.

Table 5 - Differences in Convergence

| | All Ages | Age=2 | Age=3 | Age=4 | Age=5 | Age=6 |
|---|---|---|---|---|---|---|
| Positive Growth Dummy | 0.053*** | 0.104*** | 0.044*** | 0.011 | 0.054*** | 0.005 |
| | (0.005) | (0.010) | (0.012) | (0.013) | (0.016) | (0.018) |
| Age | -0.020*** | | | | | |
| | (0.001) | | | | | |
| Constant | 0.512*** | 0.461*** | 1.208*** | 0.309*** | 0.757*** | 0.134* |
| | (0.018) | (0.020) | (0.034) | (0.061) | (0.043) | (0.069) |
| Observations | 36,020 | 12,459 | 6,341 | 4,099 | 2,795 | 2,148 |
| No. Subjects | 4,111 | 3,832 | 2,148 | 1,385 | 861 | 643 |
| R-squared | 0.259 | 0.170 | 0.211 | 0.222 | 0.224 | 0.218 |
| Sector FE | Y | Y | Y | Y | Y | Y |
| Calendar Year FE | Y | Y | Y | Y | Y | Y |

| | Age=7 | Age=8 | Age=9 | Age=10 | Age=11 |
|---|---|---|---|---|---|
| Positive Growth Dummy | 0.014 | 0.015 | -0.000 | -0.014 | 0.015 |
| | (0.017) | (0.018) | (0.022) | (0.017) | (0.020) |
| Constant | 0.145*** | 0.208** | 0.013 | 0.064 | 0.078 |
| | (0.053) | (0.096) | (0.049) | (0.042) | (0.053) |
| Observations | 1,642 | 1,359 | 1,112 | 908 | 764 |
| No. Subjects | 463 | 398 | 348 | 302 | 254 |
| R-squared | 0.194 | 0.198 | 0.190 | 0.187 | 0.085 |
| Sector FE | Y | Y | Y | Y | Y |
| Calendar Year FE | Y | Y | Y | Y | Y |

NOTE: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

### *4.4 Does the Role of Credit Constraints Decrease with Age?*

Our final investigation consists of examining our growth regression not across all ages, but for each age specifically. Equation (8) states that the positive growth rate in any year T, while still depending on financial constraints, will do so to a lesser extent the larger the T. This is because in any year T after the first year, exports of a particular product are composed of incumbents and new entrants. Only new entrants depend on external finance (incumbents are assumed to have sufficient internal funds) and over time their contribution to growth decreases. Thus, we should expect to find a decreased role of financial constraint variables on the growth when regressed on growth for each age. Although equation (11) for negative growth indicates no such relationship, this is a consequence of our assumption that once negative growth commences a part of it is due to the absence of new entrants. The model can be augmented such that in periods of negative growth, there are new entrants, but their contribution to total export value is not sufficient to offset the decline among the incumbents. Thus, we should expect similar results for positive and negative growth.

Table 6 reports the results from our growth regression performed for each age separately. Our results largely conform to our model's predictions. The level of financial development plays a significant role in year two through five, with the coefficient decreasing progressively across those years (except the last one). External finance dependence is significant only in ages five and seven, and in the way our model predicts, that products more dependent on external finance grow faster. Asset tangibility is significant in ages two and six, with the latter's large effect being a result of potential outliers.

Table 7 reports similar results for negative growth regressions. Financial development plays a significant, but decreasing role in years two through five, while external finance dependence is significant in years two, four and five. Asset tangibility is significant in years two, three, and five, and is largely decreasing in size. The largest difference between the two sets of regressions is that starting export value is significant in every year but the last for positive growth, but loses importance for negative growth by age 6 (and changes the sign by age 5, reverting back in age 9).

Table 6 - Positive Growth by Age

| | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 |
|---|---|---|---|---|---|
| Normalized First-year Exports | -10.271*** | -5.747*** | -3.951*** | -3.024*** | -3.480*** |
| | (0.201) | (0.264) | (0.356) | (0.481) | (0.596) |
| Financial Development | -18.544*** | -7.043*** | -5.503** | -7.553** | -2.655 |
| | (1.250) | (1.620) | (2.250) | (3.296) | (3.578) |
| External Finance Dependence | -1.310 | 0.069 | 2.236 | 3.730* | 1.276 |
| | (0.908) | (1.126) | (1.527) | (2.071) | (2.696) |
| Asset Tangibility | -0.420 | -6.011* | -5.506 | -0.341 | -19.673** |
| | (2.899) | (3.590) | (4.852) | (6.977) | (7.894) |
| Lending Rate | 0.014 | 0.025 | -0.059 | -0.023 | -0.111** |
| | (0.021) | (0.033) | (0.039) | (0.065) | (0.044) |
| Constant | -9.716** | 83.981*** | 115.978*** | 136.602*** | 138.121*** |
| | (3.868) | (5.132) | (6.956) | (12.578) | (18.652) |
| Observations | 177931 | 96456 | 41966 | 17250 | 6988 |
| Number of Export Relationships | 70903 | 38140 | 16636 | 6834 | 2762 |
| R-squared | 0.045 | 0.063 | 0.104 | 0.127 | 0.165 |
| Sector FE | Y | Y | Y | Y | Y |
| Calendar Year FE | Y | Y | Y | Y | Y |

| | Age 7 | Age 8 | Age 9 | Age 10 | Age 11 |
|---|---|---|---|---|---|
| Normalized First-year Exports | -2.524*** | -1.696** | 2.235** | -2.782** | -0.060 |
| | (0.791) | (0.853) | (0.974) | (1.339) | (1.556) |
| Financial Development | -7.471 | 2.517 | 9.254 | 0.316 | -12.538 |
| | (4.886) | (5.378) | (12.768) | (8.537) | (8.377) |
| External Finance Dependence | 6.150* | 2.438 | 4.299 | -2.037 | -2.149 |
| | (3.647) | (3.166) | (4.369) | (3.496) | (5.305) |
| Asset Tangibility | -5.714 | 14.352 | -7.131 | 16.992 | -5.694 |
| | (11.557) | (13.243) | (17.584) | (17.185) | (19.528) |
| Lending Rate | -0.173 | 0.274 | 0.363 | -0.014 | 0.102 |
| | (0.141) | (0.238) | (0.279) | (0.943) | (1.133) |
| Constant | 210.214*** | 62.850 | 91.791*** | 5.885 | 15.192 |
| | (36.167) | (51.711) | (25.285) | (30.631) | (31.998) |
| Observations | 2974 | 1283 | 591 | 267 | 105 |
| Number of Export Relationships | 1171 | 487 | 226 | 99 | 39 |
| R-squared | 0.193 | 0.178 | 0.181 | 0.293 | 0.519 |
| Sector FE | Y | Y | Y | Y | Y |
| Calendar Year FE | Y | Y | Y | Y | Y |

NOTE: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 7 - Negative Growth by Age

| | Age 2 | Age 3 | Age 4 | Age 5 | Age 6 |
|---|---|---|---|---|---|
| Normalized First-year Exports | -10.977*** | -3.386*** | -0.755* | 0.300 | 1.652* |
| | (0.241) | (0.295) | (0.390) | (0.525) | (0.891) |
| Financial Development | -21.994*** | -9.076*** | -9.022*** | -8.278*** | 0.129 |
| | (1.286) | (1.701) | (2.284) | (3.067) | (5.106) |
| External Finance Dependence | -3.134*** | -1.116 | -5.845*** | -6.613*** | -4.691 |
| | (0.917) | (1.197) | (1.647) | (2.310) | (3.423) |
| Asset Tangibility | 12.371*** | 8.356** | 5.156 | 12.990* | -6.750 |
| | (3.027) | (3.853) | (5.378) | (7.147) | (10.632) |
| Lending Rate | 0.023 | -0.042 | -0.051 | 0.034 | -0.025 |
| | (0.018) | (0.036) | (0.044) | (0.049) | (0.086) |
| Constant | -289.635*** | -195.647*** | -141.938*** | -103.776*** | -56.259*** |
| | (4.571) | (5.780) | (7.531) | (9.475) | (13.556) |
| Observations | 128026 | 83408 | 44018 | 21939 | 10562 |
| Number of Export Relationships | 50710 | 33110 | 17473 | 8671 | 4107 |
| R-squared | 0.075 | 0.048 | 0.041 | 0.031 | 0.017 |
| Sector FE | Y | Y | Y | Y | Y |
| Calendar Year FE | Y | Y | Y | Y | Y |

| | Age 7 | Age 8 | Age 9 | Age 10 | Age 11 |
|---|---|---|---|---|---|
| Normalized First-year Exports | 0.768 | 0.462 | -0.733 | -1.081 | 1.471 |
| | (1.094) | (1.164) | (1.749) | (1.784) | (3.781) |
| Financial Development | 0.397 | -0.349 | 7.813 | -16.140 | 17.215 |
| | (6.674) | (8.104) | (11.149) | (14.306) | (24.425) |
| External Finance Dependence | -11.243** | -2.113 | -5.872 | 4.778 | -1.893 |
| | (4.907) | (5.722) | (7.929) | (9.095) | (11.820) |
| Asset Tangibility | -14.128 | 23.554 | -37.311 | -24.680 | -58.436 |
| | (14.998) | (15.596) | (23.892) | (30.588) | (52.440) |
| Lending Rate | -0.255 | -0.378 | -0.486 | 0.130 | -0.956 |
| | (0.271) | (0.342) | (0.523) | (0.409) | (1.142) |
| Constant | -60.533*** | -47.527** | -69.357 | -15.448 | -40.909 |
| | (21.235) | (23.229) | (43.911) | (29.924) | (60.932) |
| Observations | 5008 | 2524 | 1395 | 675 | 410 |
| Number of Export Relationships | 1959 | 987 | 513 | 243 | 143 |
| R-squared | 0.021 | 0.050 | 0.075 | 0.217 | 0.140 |
| Sector FE | Y | Y | Y | Y | Y |
| Calendar Year FE | Y | Y | Y | Y | Y |

NOTE: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

## 5. Conclusion

To be completed

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