TRADE COSTS, FINANCIAL CONSTRAINTS, AND FIRM PERFORMANCE IN DEVELOPING COUNTRIES

Abstract:
This paper extends on work done in the heterogenous-firms trade literature by addressing both heterogeneity in trade costs at the firm level as well as the existence of financial constraints. These extensions to the heterogenous-firms models are also applied in the context of a developing country. Utilizing a framework that endogenizes technological choice, the analysis shows that falling trade costs and improving credit markets (or less financial constraints) improve firm performance. Also, firm-level trade costs are shown to impact a firm’s ability to enter the export market, implying heterogeneity in trade costs at the firm level. The current results show inconclusive evidence for the effect of industry-level trade costs and financial constraints on the ability to enter the export market, but future additions to the robustness of the data in this working paper will address this issue.

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I. Introduction

International economics has long been occupied with the question of whether international trade leads to growth and progress. One approach in the literature has utilized international data to assess the impact of trade on aggregate growth measures such as income. Another approach to evaluating these gains from trade assesses the impact of trade at the microeconomic level. This approach typically involves analyzing effects of changes in trade costs on productivity. With the heterogenous-firms models set out in Melitz (2003), Bernard et al. (2003), and Yeaple (2005), the emphasis on the impacts of changing trade costs falls on the reallocation of production and productivity within industries. Falling trade costs reallocate production within industries, wherein the most productive firms continue to produce and begin exporting, while less productive firms are forced out of the market, unable to compete.

Of the six major implications of the model, three involve the reallocation of production and productivity of firms: falling trade costs force less productive firms to exit, let more productive firms begin exporting goods, and lead to export growth. These changes in allocation also imply that firm-level productivity will increase. Previous studies such as Bernard, Jensen, and Schott (2006) have provided key evidence supporting the heterogenous-firms model. Given that their study analyzed United States firms only, numerous empirical studies have recently been done on firms in developing countries, such as Chile (Blyde and Iberti 2012, Alvarez and López 2005) and Colombia (Eslava et al. 2009). These studies in developing countries have tested the Melitz (2003) and Bernard et al. (2003) results to various degrees.

In addition, the heterogenous-firms literature has recently started to look at the role of financial constraints in a firm’s export decision-making process. One such example is Manova (2013), who applies financial constraints to a Melitz-like model and empirically tests the
implications of such a model. The cross-country model shows that financial constraints stunt the development of firms, preventing firms from entering production, entering the export market, and lowering the sales of exporters. Financial constraints are likely to have an even larger effect on developing countries, given the lack of their fully developed credit markets. I integrate financial constraints into my model to further examine this effect.

Therefore, I extend the Yeaple (2005) model to a developing-countries context to further test the heterogenous firms model. The model I develop follows closely, but it extends on the Yeaple (2005) model in that it accounts for firm heterogeneity in transport costs and the presence of borrowing and financial constraints. While trade costs are typically considered as industry-level trade costs, it is possible that firm-level trade costs exist and affect the export decision-making of these firms. Failing to account for these firm-level trade costs may lead to potential mis-specification and the presence of omitted variable bias in the results. Therefore, I modify the theoretical model to account for these firm-level trade costs and financial constraints, utilizing Enterprise Surveys data to provide measures of firm-level trade costs and financial constraints to test whether they are important in a firm’s decision-making.

Utilizing the Yeaple (2005) model allows me to empirically test three separate results: I test whether falling trade costs increase the amount of exporters in the market, leads to productivity growth, and leads to growth in revenue per worker. The analysis is structured as follows: first I set out the theoretical model, extending on work done in Yeaple (2005). Next, I provide background on the data and the construction of key variables for analysis. I then translate three implications of the model into empirical specifications for testing. After testing the three results from the model, I summarize and indicate the direction of possible future work.
II. Theoretical Specification

The model laid out in this section extends on the model found in Yeaple (2005). I heretofore augment the Yeaple model by adding in firm-level trade costs and financial constraints (such as in Manova 2013).

A. Setup

I begin by assuming that consumers have a constant elasticity substitution of \( \sigma = \frac{1}{1-\alpha} > 1 \) given log-linearized Cobb-Douglas utility, written as \( U = (1 - \beta) \ln(Y) + \beta \ln(X) \). Additionally, let there be workers with mass \( M \), skill (or productivity) level \( Z \), where \( Z \) is increasing, distributed along \( G(Z) \) with density \( g(Z) \) and support \( [0, \infty) \). Goods are produced with one input, labor, in markets with free entry, though firms may bear a fixed cost. Two goods may be produced: a single-technology good \( (Y) \), or a two-technology composite good \( (X) \). Firms, therefore, operate in a monopolistically competitive market.

Each worker produces \( \phi_j(Z) \) of a good, where \( \phi_j(Z) \) is increasing and continuous. Following Yeaple (2005), I define \( j \in \{Y, L, H\} \), where \( Y \) is the numeraire, \( L \) is the low-technology \( X \) good, and \( H \) is the high-technology \( X \) good. Lastly, assume the following is true regarding the productivity of workers:

\[
\phi_H(0) = \phi_L(0) = \phi_Y(0) = 1, \quad \text{and}
\]

\[
\frac{\partial \phi_H(Z)}{\partial Z} \frac{1}{\phi_H(Z)} > \frac{\partial \phi_L(Z)}{\partial Z} \frac{1}{\phi_L(Z)} > \frac{\partial \phi_Y(Z)}{\partial Z} \frac{1}{\phi_Y(Z)} > 0
\]

(1)

Note that this support, \([0, \infty)\), is theoretically finite, though can be a very large value. For the purposes of the theoretical portion, this large theoretical upper limit is represented as \( \infty \).
Equation (1) imposes skill-based comparative advantage for workers in the economy. Those workers with high \( Z \) values (i.e. the most skilled) have a comparative advantage producing in \( X \) good with the more productive technology, those with lower productivity \( Z \) values have a comparative advantage producing \( X \) with less productive technology, while those with the lowest \( Z \) values (i.e. the least skilled) have a comparative advantage in producing \( Y \).

Therefore, let \( Z_1 \) be the highest productivity associated with the production of good \( Y \), such that all workers with skill less than or equal to \( Z_1 \) produce good \( Y \). Let \( Z_2 \) be the lowest productivity associated with the production of \( X \) with high-technology, such that all workers with productivity higher than \( Z_2 \) produce high-technology \( X \). Then, workers with productivity in between \( Z_1 \) and \( Z_2 \) produce the low-technology \( X \).

**B. Closed Economy Equilibrium**

First, note that the revenue of any firm in the \( X \) industry is \( R_i = (\beta E P_{x}^{\sigma-1}) p_i^{1-\sigma} \). The unit cost of a particular \( Z \) can be written as \( C_j = \frac{W(Z)}{\phi_j(Z)} \), for all \( j \in \{Y, L, H\} \). Wages can thus be defined as:

\[
W(Z) = \begin{cases} 
C_Y \phi_Y(Z) & 0 \leq Z \leq Z_1 \\
C_L \phi_L(Z) & Z_1 \leq Z \leq Z_2 \\
C_H \phi_H(Z) & Z \geq Z_2 
\end{cases}
\]

Wages, then, simply reflect the unit cost of production and the skill of the worker. As long as workers with skill \( Z_1 \) are indifferent between producing \( Y \) and \( L \), and workers with skill \( Z_2 \) are indifferent between producing \( L \) and \( H \), normalizing \( MR_Y = P_Y = 1 \) implies that
Equations (2) and (3) imply a particular wage structure, wherein the wages move according to productivity but are segmented according to the good the worker produces. Ergo, workers producing $X$ are paid more than those producing $Y$, and those in $X$ producing at $H$ earn more than those producing at $L$.

To produce in $X$, firms must pay up-front fixed costs, such that $F_H > F_L$. Therefore, to produce in $X$, firms are required to borrow to enter. Up front, firms are only required to cover $(1-d_j)$ of their fixed costs, meaning that firms must borrow $d_j \in (0,1)$. In borrowing, firms put up a collateral portion $h_j \in (0,1)$, earning them a loan amount $\Phi(Z)$, which is bounded by $\Phi(Z) \leq R_j - C_j(x_j + (1-d_j)F_j)$. The $\Phi(Z)$ constraint implies that firms can only borrow up to their net revenue. $\lambda$ additionally represents the probability that the contract is enforced.

Therefore, the typical firm faces this profit maximization problem:

$$\pi_i = (\beta EP_X^{\sigma^{-1}}) p_k - C_j(x_j + (1-d_j)F_j) - \lambda_j \Phi(Z) - (1-\lambda_j)h_j C_j F_j$$

s.t. $\Phi(Z) \leq (\beta EP_X^{\sigma^{-1}}) p_k - C_j(x_j + (1-d_j)F_j)$

Free entry implies zero profits, which implies that

$$R_j = C_j(x_j + (1-d_j)F_j) + \lambda_j \Phi(Z) + (1-\lambda_j)h_j C_j F_j$$

For tractability, I assume that $\Phi(Z) = d_j C_j F_j$. This assumption is essentially one of “perfect borrowing,” in that firms borrow up to as much as they need to enter the market. This
assumption allows me to easily pin down the equilibrium. Note that with the assumption of
\[ \Phi(Z) = d_j C_j F_j, \]
\[ \frac{R_H}{R_L} = \left( \frac{C_H}{C_L} \right)^{\gamma - \delta} = \frac{\delta_H C_H F_H}{\delta_L C_L F_L}, \]
where \( \delta_j = 1 - (1 - \lambda_j) (h_j - d_j) \).

Utilizing \( \delta_j = 1 - (1 - \lambda_j) (h_j - d_j) \), \( \delta_j \in (0, 2) \) provides a relatively intuitive “scale” of financial constraints. Essentially, when \( \delta_j \in (0, 1) \), such that \( h_j - d_j > 0 \), a firm that proportionally borrows less than what they can provide as collateral will find it easier to enter the market. If \( \delta_j \in (1, 2) \), such that \( h_j - d_j < 0 \), a firm that is required to proportionally borrow more than what they can provide as collateral will find it more difficult to enter the market. If \( h_j - d_j = 0 \), then \( \delta_j = 1 \), which reduces the case down to the Yeaple (2005) model. In the context of the developing world, the case where \( h_j - d_j < 0 \) and therefore \( \delta_j \in (1, 2) \) is the most likely scenario.

By the imposed assumption of comparative advantage in (1) and some simplification, the ratio of unit costs for high and low technology can be expressed as:
\[ \frac{C_H}{C_L} = \frac{\phi_H(Z)}{\phi_L(Z)} = \left( \frac{\delta_H F_H}{\delta_L F_L} \right)^{\gamma - \delta} \]

Equation (6) pins down the threshold \( Z_2 \) in equilibrium. Notice that it is pinned down solely by the firm’s problem (and thus the zero-profit condition). The threshold is therefore unaffected by a multitude of country attributes, such as the quantity of workers in the population and the distribution of productivity \( Z \). Note that this threshold \( Z_2 \) increases when \( \delta_H \) or \( F_H \) increase, pushing firms out of the \( H \) technology. Conversely, if \( \delta_H \) or \( F_H \) decrease, more firms will begin producing with the \( H \) technology.
Next, by market clearing, \( Y = (1 - \beta)E = (1 - \beta)M\bar{W} \), where \( \bar{W} \) is the average wage.

Average wage can therefore be written as:

\[
\bar{W} = \int_{0}^{Z_1} \phi_1(Z) dG(Z) + C_L \int_{Z_1}^{Z_2} \phi_L(Z) dG(Z) + C_H \int_{Z_2}^{\infty} \phi_H(Z) dG(Z)
\] (7)

I more explicitly define the thresholds of \( Z_1 \) and \( Z_2 \) (that separate \( Y \) and \( L \), \( L \) and \( H \) production respectively) as

\[
S(Z_1) \equiv \frac{\phi_1(Z_1)}{\phi_L(Z_1)} = C_L \quad \text{and} \quad A(Z_2) \equiv \frac{\phi_L(Z_2)}{\phi_H(Z_2)} = \frac{C_H}{C_L}
\] (8)

Recall, furthermore, that \( Y = (1 - \beta)E = (1 - \beta)M\bar{W} = M \int_{0}^{Z_1} \phi_1(Z) dG(Z) \) from the market clearing condition in \( Y \). Therefore, the second equilibrium condition is

\[
\frac{\beta}{1 - \beta} S(Z_1) \int_{0}^{Z_1} \phi_1(Z) dG(Z) = \int_{Z_1}^{Z_2} \phi_L(Z) dG(Z) + A(Z_2) \int_{Z_2}^{\infty} \phi_H(Z) dG(Z)
\] (9)

Equations (6) and (9) define the closed economy equilibrium. Note that neither of these equilibrium conditions are dependent on \( M \), so the amount of workers in the economy does not influence the separation of production into the three types. In addition, the distribution of skill given by \( g(Z) \) affects the distribution of productivities \( Z \), and will therefore impact \( Z_1 \) given \( Z_2 \) (as pinned down by (6)), but also the mapping of worker skill onto the wage function \( W(Z) \).

Totally differentiating equation (9) shows that \( dZ_1 dZ_2 < 0 \). This implies that the individual thresholds move in opposite directions. Changes that increase \( Z_1 \) will decrease \( Z_2 \), and vice versa. In addition, changes in the level of financial constraints will affect the thresholds of \( Z_1 \) and \( Z_2 \) through equation (6), which pins down \( Z_2 \), which pins down \( Z_1 \) in equation (9).
C. Open Economy Equilibrium

Recall that firms must pay fixed costs for production in good \( X \), where \( j \in \{L,H\} \), \( F_L \) for low-technology \( X \) and \( F_H \) for high-technology \( X \). Now, firms can now enter the export market, but the decision to export also carries an additional fixed cost \( F_x \). Firms additionally face transport costs \( \tau \) and \( \gamma \) in their decision, where \( \tau \) represents industry-level transport costs and \( \gamma \) represents firm-level transport costs. With the introduction of \( \gamma \), my work further departs from the Yeaple (2005) model. In the majority of the literature, transport costs are exogenous and occur at the industry level, especially in empirical analyses. The addition of \( \gamma \) accounts for firm heterogeneity in trade costs: while all firms will face identical industry-level trade costs, given a host of factors (including but not limited to infrastructure, government barriers, or technological inefficiencies at the firm level), a firm’s true transport costs may not be accurately captured by \( \tau \) alone, potentially leading to misspecification and mis-measurement. Therefore, I assume that \( \tau > 1 \) and \( \gamma \geq 0 \).

Ergo, revenue for exporters can be written as \( R_j [1 + (\tau + \gamma)^{1-\sigma}] \) when serving both the local market and foreign market. This implies that additional revenue from exporting, \( R_x \), can be written as \( R_x = R_d / [(\tau + \gamma)^{1-\sigma}] \). Therefore, firms’ costs will be \( C_j F_j \) for serving the local market, and \( C_j (F_x + F_j) \) when serving the local market and the foreign market. I impose the assumption that

\[
F_H > F_x (\tau + \gamma)^{\sigma-1} > F_L
\]  \hspace{1cm} (10)
This separation condition ensures that there will not only be producers of \( H \) and \( L \), but also that some firms will export and some will not\(^2\). With this separation condition, all \( H \) producers will choose to export, while all \( L \) producers will not export. Equations (2), (3), and (10) imply that exporters have a low unit cost and a high fixed cost, pay a higher wage, and have a higher value of output per worker. This condition implies that the ratio of revenue between \( H \) and \( L \) technologies can now be written as:

\[
\frac{R_H (1 + (\tau_k + \gamma_i)^{1-\sigma})}{R_L} = \left( \frac{C_H}{C_L} \right)^{1-\sigma} (1 + (\tau_k + \gamma_i)^{1-\sigma}) = \frac{C_H (\delta_H F_H + F_X)}{\delta_L C_L}
\]

(11)

Of particular interest are the breakpoints \( Z_1 \) and \( Z_2 \), where production shifts from \( Y \) to \( L \), and from \( L \) to \( H \). Like before, I define \( A(Z_2) \) and \( S(Z_1) \) as the functions that explicitly model the thresholds of \( Z_1 \) and \( Z_2 \). These are

\[
\frac{C_H}{C_L} = \frac{\phi_L(Z_2)}{\phi_H(Z_2)} \equiv A(Z_2) = \left( \frac{\delta_H F_H + F_X}{\delta_L F_L (1 + (\tau_k + \gamma_i)^{1-\sigma})} \right)^{1/\sigma} \quad \text{and} \quad S(Z_1) = \frac{\phi_L(Z_1)}{\phi_L(Z_1)} = C_L
\]

(12)

Equation (9) and \( A(Z_2) \) from equation (12) define the equilibrium for the open economy. The same principles from the closed economy equilibrium apply here in the open economy equilibrium. The equilibrium is likewise independent of the mass of workers \( M \). Additionally, given \( Z_2, Z_1 \) is impacted by potential changes in the distribution of worker skill \( G(Z) \). The impact of financial constraints in the open economy equilibrium is also identical to the case presented in the closed economy equilibrium.

\(^2\) Note that if \( F_X (\tau_k + \gamma_i)^{\sigma-1} > F_H \), then no firms export, while if \( F_H > F_L > F_X (\tau_k + \gamma_i)^{\sigma-1} \), all firms export. These cases do not yield interesting economic problems, and therefore are not considered in my analysis.
By acknowledging that production by $H$ firms is $M \int_{Z_l}^{\infty} \phi_H (Z) dG(Z)$, and by the zero-profit condition, it is possible to derive the number of firms producing the $H$ good. This can be written as:

$$N_H = \frac{M}{\sigma(\delta_F X + F_H)} \int_{Z_l}^{\infty} \phi_H (Z) dG(Z) \quad (16a)$$

Similarly, the firms producing $X$ with $L$ technology can be expressed as

$$N_L = \frac{M}{\sigma \delta_F L} \int_{Z_l}^{\infty} \phi_L (Z) dG(Z). \quad (16b)$$

Therefore, the number of firms producing in $X$ is $N_X = N_H + N_L$.

Therefore, given Equations (9) and $A(Z_2)$ in (12), it is possible to derive the effects of decreases in trade costs on the number of firms producing $H$ and $L$ (thus also deriving the change in the number of firms exporting as implied by the condition in (4)). These can be written as:

$$dZ_t d\gamma_t < 0 \quad dZ_t d\gamma_i < 0$$

$$dZ_t d\gamma_i > 0 \quad dZ_i d\gamma_i > 0 \quad (17)$$

The comparative statics from (17) combined with (16) yield the main re-allocative effect of falling trade costs: falling trade costs will increase $N_H$. This sorting into higher production implies increased productivity and revenue per worker of firms in $X$. These effects are driven by the ability of firms to adopt higher and more productive technologies with falling trade costs. Firms that are able to adopt $H$ technology enjoy $R_H > R_L$, thus implying growth in revenue per worker. Producing with $H$ technology additionally implies $\phi_H > \phi_L$, such that firms become more productive. These effects are summarized below:

**PROPOSITION 1:** With falling industry-level or firm-level trade costs, more firms enter the export market. This selection into the export market yields productivity growth and growth in revenue per worker.
Additionally, the model shows the effect of financial constraints. Given that $\delta_j$ decreases, the overall fixed costs that firms must overcome to enter the export market (and, moreover, enter the market overall) decrease, thus making it easier for firms to enter the market and so $N_H$ decreases (and vice versa). Similar to the effect of falling trade costs, this increased ability to enter the market due to less financial constraints yields a sorting effect that leads to productivity growth and growth in revenue per worker ($\phi_H > \phi_L$ and $R_H > R_L$, respectively). The effect of financial constraints can be summarized thusly:

**PROPOSITION 2:** With less financial constraints (such as better credit access or more complete credit markets), firms are more likely to enter the export market. This selection into the export market yields higher revenues and productivity for firms. Conversely, tighter financial constraints means that firms are less likely to enter the export market, which implies negative productivity growth and negative growth in revenue per worker.

The two propositions form the foundation of the empirical analysis in the following sections. Decreases in industry-level trade costs ($\tau_k$) and firm-level trade costs ($\gamma_i$) should increase the amount of firms that export, yield productivity growth and growth in revenue per worker. Improving credit constraints or credit markets (through falling $\delta_j$) should make it easier for firms to enter the market as exporters (with quality $H$), lead to productivity growth, and lead to growth in revenue per worker$^3$.

**III. Data**

Firm-level data for Argentinian manufacturers comes from Enterprise Surveys, a data set compiled by the World Bank$^4$. The data from the Enterprise Surveys samples the entirety of an economy’s private sector, with data covering aspects of business operations and the business

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$^3$ These results can also be construed as movements in average productivity and average revenue per worker in this framework. The theoretics motivating this can be found in Appendix A.

$^4$ Enterprise Surveys can be found at www.enterprisesurveys.org.
environment such as infrastructure, in addition to the typical measures of firm performance (aggregated at the equivalent of the 2-digit ISIC level). The analysis I conduct utilizes the typical measures of firm performance, in addition to a set of business environment indicators that form the basis of my barriers to trade measure. The data set is nominally available in panel form (consisting of two cross-sections containing years 2006 and 2010). Given the lack of a more robust sample, I reduce the panel into a cross-section for the year 2006 to obtain measures in time $t$ and $t+1$.

The firm-level data itself serves as the basis for the construction of the key variables: the quantity exported, total factor productivity, and estimates of the firm’s production. Total factor productivity in particular is more simply constructed as a measure of the total value of outputs over the total value of labor inputs for a given firm. This deviates from Bernard, Jensen and Schott (2006) and some following work (i.e. Blyde & Iberti 2012), who use more complicated superlative productivity indices in the vein of Caves, Christensen, and Diwert (1982) and Good et al. (1997). Given the data constraints presented by utilizing the Enterprise Survey, I use a simplified TFP measure instead. The measure of TFP is essentially a measure for labor productivity, constructed in this way to more closely align with the theoretical model, wherein labor is the only input:

$$TFP = \frac{value(outputs)}{value(inputs)} = \frac{value(outputs)}{value(labor)}$$

Freight cost data is provided by Argentina’s National Institute of Statistics and Censuses (INDEC). Freight costs pose significant costs of trade for firms, and cannot be dismissed from analysis as was common in the prior literature. This is true especially for developing countries,

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5 Aggregated at the 2-digit ISIC level, the firm-level data provided by Enterprise Surveys the limiting factor in my analysis. The resulting measures I construct are therefore aggregated at the 2-digit ISIC level.
where burgeoning economies may face industry-level costs of entry into the export market. I closely follow the literature and construct *ad valorem* freight rates as the value of freights and insurance over the value of imports\(^6\). Additionally, *ad valorem* tariff rates are obtained from the TRAINS database, a part of the World Integrated Trade Solution developed by the World Bank. Both *ad valorem* freight rates and tariff rates are aggregated at the 2-digit ISIC level.

The measure of firm-specific costs of trade that I construct is contained in the Enterprise Survey data. In the trade and regional literature, costs of trade have been represented as “iceberg” costs: when trading a good, a certain quantity is lost over the course of delivery. I follow that vein of the literature in specifying my firm-level costs of trade variable. As part of the Enterprise Survey, firms were asked to estimate the percentage of goods in transit lost due to various factors such as breakage, spoilage and theft.

These losses, at the firm level, represent costs of trade at a level that is not captured via the industry-level freight rates and tariff rates. While these firm-level costs of trade may not exist or be relevant for a developed country, it is plausible that these costs of trade are relevant and problematic in developing countries. This variable is the empirical representation of \(\gamma\), found in the theoretical model, allowing for the testing of its significance.

Therefore, I include this measure in my empirical specifications, to test whether firm-level costs of trade affect export decision-making choices by firms, in conjunction with industry-level trade costs. However, it is possible that the raw costs-of-trade measure does not effectively capture the firm-level heterogeneity. I augment the firm-level costs-of-trade variable, instrumenting it with a series of multinominal choice variables measuring “difficulty of trade” that are also present in the data set. This instrumented costs-of-trade is specifically used in the testing

\(^6\) This construction of the *ad valorem* freight rate follows Blyde and Iberti (2012) and Bernard, Jensen, and Schott (2006).
whether falling trade costs induce firms into exporting, given that “iceberg” costs may not completely capture the entry decision for firms\(^7\).

I capture the effect of financial constraints through the firm’s response to the following question in the Enterprise Surveys: “Is access to finance, which includes availability and cost, interest rates, fees and collateral requirements, No Obstacle, a Minor Obstacle, a Moderate Obstacle, a Major Obstacle, or a Very Severe Obstacle to the current operations of this establishment?” (2010). The response to this question serves as a rough estimate of the extent of financial constraints for use in my empirical analysis. However, given how imprecise this measure is and potential endogeneity issues (such as simultaneity when considering effects of trade costs on productivity and revenue), I choose to instrument this measure of financial constraints via a set of instruments describing where the firm borrows from (such as banks, lenders, for example).

Table 1 shows the breakdown of trade costs by industry. Freight rates and tariff rates both decline overall in between 2002 and 2006. Freight rates, in general, do not decline by nearly as much as tariff rates, where tariff rates reduce by at least 50% for the industries in the sample. The largest tariff rate reduction occurs in the food industry, where tariffs are reduced by a staggering 65.5%, while machinery and textile industries also receive large reductions in tariffs of around 60%. Decreases in freight rates typically are by about one percentage point or less in comparison such as in textiles, where the rate falls from 5.08% down to 4.52%, a small reduction in freight costs in comparison to the large tariff rate reductions. Additionally, firm-level trade

\(^7\) More specifically, the decision-making rule for the firm to enter the export market may not be the same as the decision-making rule for quantity exported (i.e. the intensive margin). The multinomial choice variables used as instruments ask whether “transport” or “customs and trade regulations” pose problems for the firm.
<table>
<thead>
<tr>
<th>Industry</th>
<th>2002 Freight Rate</th>
<th>2006 Freight Rate</th>
<th>2002 Tariff Rate</th>
<th>2006 Tariff Rate</th>
<th>2006 Firm-Level Costs</th>
</tr>
</thead>
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<tr>
<td>Other</td>
<td>4.11</td>
<td>3.22</td>
<td>13.98</td>
<td>7.72</td>
<td>0.417</td>
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<td>6.16</td>
<td>15.48</td>
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<td>18.41</td>
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<td>21.48</td>
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<tr>
<td>Equipment</td>
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</tr>
</tbody>
</table>

Note: Both freight and tariff rates are calculated *ad valorem*. Firm-level costs are the estimated percentage of goods lost in transport.

costs are small effects, wherein the maximum average firm-level trade cost is found in the food industry, with a 0.737% estimated firm-level trade cost. Argentina was a developing country with some developed export markets in this time frame (and still is developing today): it is plausible that the small firm-level trade costs are a reflection of more developed export markets. However, given the combination of freight and tariff costs, it is plausible that even these small firm-level trade costs may influence firm export decision-making and other measures of firm performance. Therefore, it is important to test whether these firm-level trade costs matter, since a small *absolute* size of firm-level trade costs does not necessarily imply that the firm-trade costs do not matter to firms on the margin.

**IV. Empirical Specification, Results**

The empirical analysis herein loosely follows the structure found in Bernard, Jensen, and Schott (2006), for example. I test the three results derived from the theoretical model separately utilizing simple regressions to examine whether the comparative statics hold. First, I test whether falling trade costs increase the chances of a firm entering the export market. Next, I test whether falling trade costs yield productivity growth. Last, I test whether falling trade costs lead to growth in revenue per worker. Testing these specifications also lets me test the effect of
improving financial constraints in each scenario: improving financial constraints should improve the chances of a firm entering the export market, lead to productivity growth and growth in revenue per worker.

The results are all condensed into Table 2 for viewing.

A. Entry into the Export Market

To test whether falling trade costs cause more firms to enter the export market (i.e. increasing \( N_{H} \)), I follow the approach in Roberts and Tybout (1997) and, similarly, in Bernard et al. (2003). These approaches rely on the observation that firms who export must overcome fixed costs to enter the export market. This observation is expressed in the theoretical model as equation (4), \( F_{i} > F_{i}(\tau_{k} + \gamma_{i})^{\sigma-1} > F_{L} \). Therefore, this export condition is formulated into a probit equation that tests whether trade costs affect firm export decisions:

\[
\Pr(\text{Export}_{i,t+1} = 1 | \text{Export}_{i,t+1} = 0) = \alpha \Delta \tau_{k} + \beta X + \eta (\Delta \tau_{k} \cdot X) + \theta \gamma_{i} + \epsilon
\]  

\[(18)\]

\( \Pr(\text{Export}_{i,t+1} = 1 | \text{Export}_{i,t+1} = 0) \) is the probability that a firm chooses to begin exporting in the period \( t + 1 \) (2010) given that in time \( t \) (2006), they were not exporting. \( \Delta \tau_{k} \) represents the vector of industry-level trade costs in between 2002 and 2006, including freight rates and tariff rates, \( X \) is the vector of firm attributes, \( \Delta \tau_{k} \cdot X \) is the vector of industry-level trade costs interacted with the vector of firm attributes, and \( \gamma_{i} \) is the firm-level trade costs.

The results (found in column [1]) show that industry-level trade costs do not affect firm entry into the export market as suggested by the theoretical work in the paper. These results currently
Table 2 – Summarized Results, log(Employment)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Entry into the Export Market</th>
<th>Δlog(TFP)</th>
<th>Δ log Ωi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
</tr>
<tr>
<td>ΔFreight Rates (ΔFC)</td>
<td>4.753</td>
<td>-7.527***</td>
<td>-7.005***</td>
</tr>
<tr>
<td></td>
<td>(4.875)</td>
<td>(2.314)</td>
<td>(2.552)</td>
</tr>
<tr>
<td>ΔTariff Rates (ΔTC)</td>
<td>2.37**</td>
<td>-1.915***</td>
<td>-2.123***</td>
</tr>
<tr>
<td></td>
<td>(1.168)</td>
<td>(0.651)</td>
<td>(0.697)</td>
</tr>
<tr>
<td>ΔFC · TFP</td>
<td>-0.00628</td>
<td>0.00725</td>
<td>0.00274</td>
</tr>
<tr>
<td></td>
<td>(0.076)</td>
<td>(0.00969)</td>
<td>(0.00274)</td>
</tr>
<tr>
<td>ΔTC · TFP</td>
<td>-0.00131</td>
<td>0.00588**</td>
<td>0.00274</td>
</tr>
<tr>
<td></td>
<td>(0.00453)</td>
<td>(0.00274)</td>
<td>(0.00274)</td>
</tr>
<tr>
<td>Total Factor Productivity (TFP)</td>
<td>-0.011</td>
<td>0.0138**</td>
<td>0.00622</td>
</tr>
<tr>
<td></td>
<td>(0.0148)</td>
<td>(0.00622)</td>
<td>(0.00622)</td>
</tr>
<tr>
<td>log(Employment)</td>
<td>0.258</td>
<td>-0.812***</td>
<td>0.288**</td>
</tr>
<tr>
<td></td>
<td>(0.193)</td>
<td>(0.112)</td>
<td>(0.131)</td>
</tr>
<tr>
<td>log(Labor Cost)</td>
<td>-0.284*</td>
<td>0.708***</td>
<td>-0.447***</td>
</tr>
<tr>
<td></td>
<td>(0.157)</td>
<td>(0.0928)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>K/L Ratio</td>
<td>0.245**</td>
<td>-0.00264</td>
<td>-0.118</td>
</tr>
<tr>
<td></td>
<td>(0.125)</td>
<td>(0.00347)</td>
<td>(0.0779)</td>
</tr>
<tr>
<td>Firm-Level Trade Costs</td>
<td>-1.262**</td>
<td>-1.259***</td>
<td>-1.003**</td>
</tr>
<tr>
<td></td>
<td>(0.603)</td>
<td>(0.404)</td>
<td>(0.429)</td>
</tr>
<tr>
<td>Financial Constraints</td>
<td>-0.287</td>
<td>-0.678**</td>
<td>-0.833**</td>
</tr>
<tr>
<td></td>
<td>(0.589)</td>
<td>(0.316)</td>
<td>(0.346)</td>
</tr>
<tr>
<td>N = 242</td>
<td>N = 212</td>
<td>N = 222</td>
<td></td>
</tr>
<tr>
<td>W = 29.64</td>
<td>F = 33.90</td>
<td>F = 11.20</td>
<td></td>
</tr>
<tr>
<td>$R^2 = 0.116$</td>
<td>$R^2 = 0.4089$</td>
<td>$R^2 = 0.2916$</td>
<td></td>
</tr>
</tbody>
</table>

Note: Industry dummies are included in all specifications.

Note: Dependent variable represents either: the chance a firm enters the export market in between 2006 and 2010, percent change in productivity between 2006 and 2010, and the percent change in revenue per worker between 2006 and 2010 given yearly changes in trade costs from 2002 to 2006. The firm-level data is from the Enterprise Survey, while the industry level trade costs are from the National Institute of Statistics and Censuses (INDEC).

Note: Firm-level costs of trade is instrumented here by a series of multinomial choice variables describing difficulty of trade, where $F = 2.03$, $p = 0.1356$, and $R^2 = 0.0145$ in the first stage. Financial constraints are also instrumented by the sources of the firm’s borrowing, where $F = 2.17$, $p = 0.0466$, and $R^2 = 0.0364$.

Note: *, **, *** Significant at the 10%, 5%, and 1% level, respectively.
illustrate that falling industry-level trade costs (freight and tariff rates both) make it more
difficult for firms to enter the export market. The coefficient estimate on the effect of freight
rates is insignificant while the coefficient estimate on tariff rates is strongly significant. It is
currently unclear what drives these results, and further empirical testing, primarily with a larger
data set, would help shed light onto these results.

However, firm-level trade costs have a strongly significant effect on entry into the export
market. Falling firm-level trade costs increase the chance that a firm will enter the export market.
A decrease in firm-level trade costs of one standard deviation corresponds to a 9.68% increased
chance that a firm will begin exporting in 2010 given that they did not in 2006. The presence of
these firm-level trade costs implies that despite the low firm-level trade costs in absolute terms,
the marginal importance of these firm-level trade costs affects a firm’s export decision-making.
Therefore, the results indicate that potential firm heterogeneity in trade costs should not
necessarily be ignored when examining firm behavior. Additionally, it is inherently plausible that
adding in these firm-level trade costs has soaked up some of the effect provided previously by
industry-level trade costs.

Financial constraints do not play a significant role in the firm’s export entry decision,
according to the results. The coefficient has the expected sign, but the significance is lacking,
meaning that their effect on export entry is indiscernible. It is not altogether clear as to why this
is the case. Potentially, the industries contained in the sample (as seen in the summary statistics
in Table 1) may not be particularly susceptible to financial constraints, given that the sample
includes industries such as food and garments. Industries such as technology, steel
manufacturing are more likely to have hefty startup costs that would require loans (especially in
developing countries), so the absence of these manufacturing-heavy industries in the sample may
explain the lack of statistical significance in the financial constraints indicator. Adequately addressing this empirical result would require further work in the area.

B. Firm Productivity

To test whether falling trade costs and improving credit markets (or less financial constraints) leads to productivity growth, I utilize a simple regression:

$$\Delta \log(TFP) = \alpha \tau_k + \beta X + \theta \gamma_i + \epsilon$$

(19)

$\Delta \log(TFP)$ is the percent change in the level of productivity of a firm between time $t+1$ (2010) and time $t$ (2006). $\Delta \tau_k$ represents the vector of industry-level trade costs, including freight rates and tariff rates in between 2002 and 2006. $X$ is the vector of firm attributes and controls, and $\gamma_i$ is the firm-level trade costs.

Results can be found in column [2]. I find that industry-level trade costs have a strongly significant effect on a firm’s productivity. Falling industry-level trade costs (both freight costs and tariff costs) induce productivity growth in firms. Additionally, I find that firm-level trade costs have a similar effect on productivity, in that reductions in firm-level trade costs correspond with increases firms experiencing productivity growth between 2006 and 2010. Overall, it appears that while both are significant in affecting the productivity of the average firm, industry-level trade costs have a larger impact on productivity than firm-level trade costs. This implies that while firm-level trade costs may be smaller than industry-level trade costs, they do affect firm productivity and thus should not necessarily be ignored, especially in the developing-country context. The effect of trade costs on productivity growth (as estimated here) coincides with the theoretical model and the extant literature.
Financial constraints do significantly influence firm productivity. As financial constraints lessen and credit markets improve and become more complete, firms should expect to see productivity growth. This is in accordance with the theoretical model, which states that firms who face more stringent financial constraints are less likely to be productive in comparison to firms who face more complete credit markets. Intuitively, more complete financial markets should allow more firms to participate in the market and let more firms participate at higher and more advanced technologies, thus improving productivity.

C. Revenue per Worker of the Firm

To test whether falling trade costs and improving credit markets (or less financial constraints) leads to productivity growth, I utilize the following regression:

\[
\Delta \log \Omega_i = \alpha \Delta \tau_k + \beta X + \eta (\Delta \tau_k \cdot X) + \theta \gamma_i + \varepsilon
\]

(20)

\(\Delta \log \Omega_i\) is the percent change in level of revenue per worker of a firm between time \(t+1\) (2010) and time \(t\) (2006). \(\Delta \tau_k\) represents the vector of industry-level trade costs, including freight rates and tariff rates in between 2002 and 2006, \(X\) is the vector of firm attributes, \(\Delta \tau_k \cdot X\) is the vector of industry-level trade costs interacted with the vector of firm attributes, and \(\gamma_i\) is the firm-level trade costs. The results from testing this portion of the model are found in column [3].

These results show that industry-level trade costs are strongly significant and have the correct sign: falling trade costs (both freight and tariff costs) increase revenue per worker, in line with both the extant literature and the model derived in this paper. Firm-level trade costs are likewise strongly significant. As firm-level trade costs fall, firms improve their revenue per worker,
following closely to the theoretical model derived in this paper. The significance of the estimates of firm-level trade costs in this specification mean that they are likely important enough to not be ignored, especially in the developing-country context where these firm-level trade costs may be high, or where the firm-level trade costs have a high marginal effect.

Financial constraints likewise affect revenue per worker, and the estimate in this specification is significant at the 5% level. Firms who face more stringent financial constraints will have lower revenue per worker than those firms that face more complete credit markets, following the theoretical model set out in the paper. Thus, more complete markets will allow more firms the ability to participate in the market, and participate with higher technologies, which will correspond to higher revenue per worker.

V. Summary, Discussion

This paper sets out a model that extends Yeaple’s (2005) version of the heterogenous-firms model. The model restricts itself to a two-good world, with one numeraire good and a composite good. By imposing skill-based comparative advantage onto the model, firms select a technology, either to produce the numeraire good, the low-technology $X$, or the high-technology $X$. Firms face fixed costs, not only to produce the good, but can also pay a fixed cost to export. In addition, exporting incurs both industry-level trade costs and firm-level trade costs that firms must also pay to export. Firm-level trade costs account for potential heterogeneity in trade costs, and their inclusion is one contribution of this paper. This leads to firms separating into the production of $Y$, $X$ with low technology, and $X$ with high technology, where only the firms who produce $X$ with high technology export. The equilibrium conditions allow for the derivation of a few comparative statics, showing that falling trade costs induce more firms into exporting, increase productivity and revenue per worker.
The main contribution of this paper is the incorporation of financial constraints into the model (as similarly seen in Manova 2013). Financial constraints may play a crucial role in developing countries, given that incomplete and poorly functioning markets may prevent firms from not only beginning to export, but may prevent firms from entering the market altogether. Therefore, I fully integrate the presence of financial constraints into the Yeaple (2005) framework to show that financial constraints make it tougher for firms to enter the market, and that they limit productivity growth and growth in revenue per worker.

The paper tests out the three comparative statics relating to export entry, productivity growth, and revenue per worker in an empirical setting. Utilizing the Enterprise Surveys in addition to trade cost data from Argentina’s National Institute of Statistics and Censuses (INDEC) and the World Integrated Trade Solutions (WITS), I construct a firm-level cross-section for the year of 2006. Testing the three comparative statics provides evidence that generally supports the model derived in this paper. In comparison to the extant literature, I find agreeing evidence that falling trade costs lead to productivity growth and growth in revenue per worker, but I find contrary evidenced in the effect of industry-level trade costs on export entry. This may be due to the inclusion of firm-level trade costs, which may be soaking up some of the effect.

Firm-level trade costs are found to significantly affect firm performance and firm export decision-making. Across all specifications, the results show that falling firm-level trade costs will yield more entrants into the export market, productivity growth, and growth in revenue per worker. While the estimated effect is not as large in magnitude as changes in industry-level trade costs might, a one standard-deviation change in firm-level trade costs will increase the chances of a firm entering the export market by approximately 9.68%, a significantly large increase in
probability. Therefore, it is unlikely that these firm-level trade costs should be ignored in future analysis given that their evident impact firm performance and a firm’s ability to enter the export market. These firm-level trade costs are also more likely to be relevant in the developing-country context, where trade costs at the firm level are more likely to be prevalent.

Financial constraints were shown to be partially supported in the empirical work. Financial constraints were found to not affect entry into the export market. However, the lack of significance may be due to the industries used in this sample: industries such as food and garments may not be as vulnerable to incomplete credit markets as other industries may be, such as electronics or heavy manufacturing. Therefore, in this context, further testing should occur. Incomplete credit markets were shown to hinder productivity growth and revenue per worker, as was shown in the theoretical model.

Future work could occur on both the theoretical front and the empirical front. On the theoretical front, one first extension could be relaxing the “perfect borrowing” assumption I make. This assumption has intuitive traction and greatly simplifies the model, but it hinges on the zero-profit condition. A logical first extension would be relax the “perfect borrowing” assumption and to work with a broader borrowing function \( \Phi(Z) \) and test whether or not the results derived in this paper are changed with a more loosely defined borrowing function. On the empirical front, future work could involve testing out the comparative statics on a larger, more robust sample. The empirics generally support the theoretical model, but do not completely. Adding in more countries would improve the sample and provide an opportunity to see if some of the inconsistencies in the results are due to the sample used in this paper. Additionally, the instrument for firm-level trade costs is currently weaker than what would be preferred for
estimation. Utilizing a better instrument or an expanded data set would help strengthen the constructed measure of firm-level trade costs.
Appendix A – Movements in Average Productivity and Average Revenue Per Worker

Given that \( Y = (1 - \beta)E \), aggregate revenue per worker in \( Y \) is given as

\[
\Omega_y = \frac{1}{G(Z_1)} \int_0^{Z_1} \phi_y(Z) dG(Z).
\]

Since revenue in \( X \) is \( M[C_L \int_{Z_1}^{Z_2} \phi_y(Z) dG(Z) + C_H \int_{Z_2}^{\infty} \phi_y(Z) dG(Z)] \), also utilizing the fact that employment in \( X \) is given by \( M[1 - G(Z_1)] \) makes it possible to also derive the aggregate revenue per worker in industry \( X \), which is given as:

\[
\Omega_x = \left( \frac{\beta}{1 - \beta} \right) \frac{1}{1 - G(Z_1)} \int_0^{Z_1} \phi_y(Z) dG(Z).
\]

This implies that the revenue per worker per firm in \( X \) is simply

\[
\Omega_i = \frac{\Omega_x}{N_H + N_L} = \frac{\Omega_x}{N_x}
\]

Thus, falling trade costs increases average revenue per worker, \( \Omega_i \), since \( N_x \) decreases and \( \Omega_x \) increases as \( \tau \) and/or \( \gamma \) decrease. For average productivity, let \( \tilde{Z} \) be the most productive \( Z \) in the market, such that \( \tilde{Z} > Z_1 \). Therefore, the range of productivities in the \( X \) market can be represented as the interval \([Z_1, \tilde{Z}]\). Then, let the average productivity be \( \bar{Z} \).

Given \( dZ_i d\tau_k < 0 \) and \( dZ_i d\gamma_i < 0 \) from (11), then \( \Delta \tau_k < 0 \) and \( \Delta \gamma_i < 0 \) should imply that \( \Delta Z_1 > 0 \). Therefore, \( \Delta Z_1 > 0 \) implies that \( \Delta \bar{Z} > 0 \). The productivity of the average firm should therefore increase with falling trade costs.

The empirical work presented in the paper supports the results of the theoretical model when constructed in this manner. Movements in average productivity and average revenue per worker are also tested in the specifications presented in section IV. The results presented in the section lend credence to the theoretics laid out in this Appendix.
References


