

The Opportunity Cost of Exporting

Alexander McQuoid*

Loris Rubini[†]

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Abstract

Recent evidence suggests that firms face tradeoffs between serving domestic and foreign markets. We advance this literature by first differentiating between two types of exporters, transitory and perennial exporters, and then documenting differential behaviors for these firms. Using data on Chilean firms, we find a negative correlation (-0.30) between domestic and foreign sales for transitory exporters, but a mild positive correlation (+0.14) for perennial exporters, with an overall correlation of -0.19. To address these facts, we build a model that combines a linear demand system a la [Melitz and Ottaviano \(2008\)](#) with decreasing returns to scale in production and shocks to demand and productivity. The key departure is that costs can no longer be separated and treated in isolation across markets. While a positive productivity shock increases both foreign and domestic sales, a positive foreign demand shock increases exports but decreases domestic sales. We then calibrate the model and find that the model matches the data well, generating correlations of the right sign for each type of exporter and accounts for nearly 80% of the overall correlation. To evaluate the economic significance, we consider the counterfactual experiment of reducing trade costs. Contrary to existing studies, decreasing trade costs has on average positive effects on firms' domestic sales. Furthermore, while markups are higher for exporters than non-exporters, markups within a firm tend to decline when starting to export. Both results would be absent in a model where markets are treated independently.

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*Department of Economics, Florida International University. Email: alexander.mcquoid@fiu.edu

[†]Department of Economics, Universidad Catolica de Chile and Universidad Carlos III. Email: lrubini@uc.cl

1 Introduction

Standard trade models focused on the behavior of the firm tend to assume constant marginal cost in production. While the validity of this assumption has always been dubious, it has been a useful assumption nonetheless because it significantly improves the tractability of the models. Assuming a constant marginal cost structure effectively allows for foreign and domestic markets to be treated independently. Such an approach, while common, is somewhat surprising for the trade field since it is precisely dimensions of cross-national interconnectedness that are at the heart of the discipline. Dropping this assumption of convenience has far-reaching consequences as firms must face the full opportunity cost of exporting. When marginal costs aren't constant, markets are interdependent: exporting an additional unit alters the optimal amount of domestic sales.

In the present paper, we reconsider the importance of market linkages via production costs by first showing that patterns of substitution between domestic and export sales are prevalent in the data, and then incorporating these linkages into a flexible model of firm behavior. We calibrate and then simulate the model to evaluate the effectiveness of the approach. Lastly, we conduct counterfactual trade liberalization experiments, and highlight differences with models that lack production cost linkages.

Turning first to the data, we find a negative correlation between domestic and foreign sales for exporters, equal to -0.19 . This observed pattern of substitution motivates our decreasing returns to scale assumption in production, which makes explicit the tradeoffs faced by a firm choosing to sell domestically and abroad. The aggregate negative correlation, however, masks differential behaviors between two groups of exporters. Transitory exporters, who frequently enter and exit the export market, exhibit a negative correlation equal to -0.30 . Perennial exporters, who never exit the export market, exhibit a mild positive correlation equal to $+0.14$. Taken together, these facts present a puzzle in light of current international trade models that implicitly assume market independence.

To account for these observations, we build a model with heterogeneous elasticities of demand a la [Melitz and Ottaviano \(2008\)](#) that incorporates decreasing returns to scale in production. In addition, we introduce three shocks: to productivity, to domestic demand, and to foreign demand. These shocks, in conjunction with decreasing returns, imply that the decision to export is now directly related to the decision to sell domestically. As a result, shocks originating in the foreign (domestic) market now affect decisions in the domestic (foreign) market. Under a constant marginal cost assumption, market-specific shocks only affect local behavior and markets can be analyzed in isolation. Firm-specific shocks (e.g. productivity) will have similar qualitative effects in both foreign and domestic markets, although the actual magnitudes will depend upon relative demand elasticities in each market.

Consider first the effects of a positive shock to domestic demand. An increase in the preference for a domestic variety shifts up the demand curve, and leads to an increase in domestic sales. With decreasing returns to scale, an increase in domestic quantity leads to an increase in the marginal cost of producing an additional unit, which causes the firm to re-optimize in the foreign market where demand was unchanged. This leads to a decline in foreign sales, and consequently to an observed negative correlation between foreign and domestic sales. In a model with constant marginal cost, a domestic demand shock leads to an increase in domestic sales, but has no effect on the foreign market, and would fail to generate a correlation between domestic and foreign sales. On the other hand, consider a firm-specific positive shock to productivity. The reduction in costs leads to an increase in both domestic and foreign sales, generating a positive correlation between foreign and domestic sales. In principle, with decreasing returns to scale and shocks to both demand and productivity, one could observe either a positive or a negative correlation in the data depending on the quantitative importance of each type of shock.

We calibrate the model to match certain aspects of the data for Chilean manufacturing firms. The calibration strategy works as follows. First, we leverage the theoretical framework to identify and extract each of the three shocks from the data. We directly observe information on domestic market sales and export market sales in the data, and in addition, we estimate firm markups using available input information following the suggested methodology of [De Loecker and Warzynski \(2012\)](#). The model provides a nonlinear mapping between these observables and the unobservable shocks to productivity and demand (domestic and foreign). After recovering realizations of shocks given the theoretical structure, we estimate the distribution of domestic demand and productivity shocks via maximum likelihood. For the foreign demand shock process, the situation is more complicated since we observe a biased sample of foreign demand realizations since we only observe some firms in the export market, and these firms had foreign demand shocks that were sufficiently high relative to their domestic demand and productivity shocks. Instead, we calibrate the foreign demand process by matching total export volume and the share of firms that export in the data. Lastly, to match the time-series component of the model to the data, we calibrate the model to match firm sales autocorrelations for perennial exporters and non-exporters.

The simulated model performs quite well qualitatively and quantitatively. Overall, the model can account for 80 percent of the aggregate correlation, and accurately predicts the correct (opposing) signs for transitory and perennial exporters. The traditional model with constant marginal cost would fail to match both the overall correlation and the disaggregated group differences.

The negative correlation for transitory exporters implies that the effect of the shocks to demand is stronger than the effect of the shocks to productivity. Perennial exporters tend to be larger than transitory exporters who are in turn larger than non-exporters, both in the data and the simulated model. Based on the decreasing returns to scale in production, for a given productivity level, as

a firm increases production, marginal costs rise but at a decreasing rate so that very large firms operate on a relatively flat portion of the cost curve compared to smaller firms. This implies that an increase in quantity produced has a relatively mild effect on marginal costs for large firms. Consequently, an increase in foreign demand has a smaller impact on domestic sales for large firms compared to small firms. However, the effect of a shock to productivity does not depend on firm size. This suggests that the assumption of increasing marginal costs is more important when studying transitory (small) exporters.

Based on the success of the simulated model to match key characteristics in the data, we move next to conducting policy relevant counterfactual experiments. Our primary focus is on the impact of declining trade costs on the domestic market through purely domestic channels as native firms adjust their composition of sales across both foreign and domestic markets, a mechanism wholly absent from traditional trade theory based on constant marginal cost technology.

It is important to remember that by dropping the restrictive assumption of constant marginal cost, a whole variety of interactions between domestic and foreign market behavior is possible, leading to differential firm responses. On average, the decline in trade costs leads to an increase in domestic sales for native firms. In the counterfactual trade liberalization thought experiment, in response to a decline in trade costs from 50% to 10%, the mean increase in domestic sales is nearly 7%, while the median firm experiences no change in domestic sales. That is, 50% of exporting firms see a decline in domestic sales in response to a decline in trade costs, while the other half of exporters see domestic sales increase. The observed skewness in the distribution of sales responses comes from the fact that declines in sales tend to be small while some firms benefit greatly from the decline in costs.

The heterogeneous response comes from the interaction of the decline in trade costs with both the reduction in marginal costs and the relative elasticity of demand in each market. Firms faced with a reduction in marginal costs as trade costs fall tend to respond by increasing output. Where this output is sold depends on the relative elasticity of demand faced by each firm in the foreign and domestic market. When domestic demand is more elastic than foreign demand, the reduction in costs leads to a larger increase in domestic sales. This result cannot be replicated in a model of constant elasticity of demand even when paired with decreasing returns to scale. Since there is strong evidence for both decreasing returns to scale in production and non-constant elasticity of demand empirically, these results are likely to be quite general and provide a new channel through which international integration impacts domestic markets.

We next consider the relationship between markups and trade costs. When focusing on firms that don't export under the high trade cost regime, but do export under the lower trade cost regime, we find that markups fall by 5% on average. This is in contrast to exporters who export under either trade cost regime who see an average increase in markups of 16%. In both the actual data

and the simulated data, markups tend to be higher for exporters than non-exporters, in line with the more recent literature of firm-level markups (see [De Loecker and Warzynski \(2012\)](#)). However, we find that when the reduction in trade costs drive a firm to start exporting, its markup tends to decline. This result suggests that exporters share certain characteristics, particularly high foreign demand and high productivity, which increase both markups and the likelihood of exporting.

The challenge of dropping the convenient assumption of constant marginal cost is to provide an alternative framework that captures essential characteristics of the data while providing a useful framework to investigate the complex interactions between interdependent markets. Even without modeling a complex dynamic adjustment process, our model is able to capture the essential features in the data extremely well. Our results show that a simple, tractable model with only minor departures from the mainstream literature can account for these facts and improve our understanding of the mechanics of adjustment in response to increased international integration.

We are not the first to notice the need for decreasing marginal returns. [Blum et al. \(2013\)](#) account for the negative correlation between domestic and export sales growth by developing a framework with physical capacity constraints, which is isomorphic to decreasing returns to scale. A key distinction between that approach and ours is that we can also account for the positive correlation among perennial exporters. [Ahn and McQuoid \(2013\)](#) document similar substitution patterns in both Indonesia and Chile, and find that both financial and physical constraints play an important role in accounting for these observations.

[Soderbery \(2011\)](#) uncovers a similar pattern using firm-level data from Thailand and uses a self-reported measure of firm capacity utilization to study the importance of physical capacity constraints in rationalizing the observed behavior. [Soderbery \(2011\)](#), using a similar modeling approach of linear demand combined with random and idiosyncratic capacity constraints, derives conditions under which domestic welfare may decline with the introduction of trade. While his focus is on the qualitative implications of the model, we are interested in using the data to estimate key parameters of the model, and our results suggest that substitution patterns are more systematic than would be expected based on random capacity constraint draws.

There is also evidence of non-constant returns to scale from richer economies. [Vannoorenberghe \(2012\)](#) explores output volatility for French firms to conclude that the assumption of constant marginal cost may be unwarranted, while [Nguyen and Schaur \(2011\)](#) use Danish firm data to consider the impact of increasing marginal cost on firm output volatility. [Berman et al. \(2011\)](#) conjecture that capacity constraints might make foreign and domestic market sales substitutes whereas unconstrained firms might see foreign and domestic sales as complements.

The assumption of decreasing returns to scale has been used in theoretical approaches that have considered the dynamics of new exporters (see [Ruhl and Willis \(2008\)](#), [Kohn et al. \(2012\)](#), and [Rho and Rodrigue \(2012\)](#) for example) or in patterns of foreign acquisitions (see [Spearot \(2012\)](#)).

Other studies have departed from the assumption of constant returns to scale by exploring the implications of increasing returns to scale via innovation. [Atkeson and Burstein \(2010\)](#) introduce a costly productivity choice into the [Melitz \(2003\)](#) framework, which effectively introduces technologies with increasing returns to scale. [Rubini \(2011\)](#) shows that this assumption is of particular importance under permanent changes in trade costs, such as trade liberalization agreements.

Our model is related with papers that generate entry and exit in the export market. [Arkolakis et al. \(2011\)](#) generate this by introducing switching frictions on the customers' side to analyze short-run trade dynamics.

The rest of the paper is organized as follows. In the next section, motivating empirical evidence is presented. Section 3 describes the model while Section 4 discusses estimation techniques. Counterfactual experiments and results are discussed in Section 5. Section 6 concludes.

2 Data

To motivate and calibrate the theoretical model, we focus on a panel of Chilean manufacturing firms from 1995 through 2006. This dataset includes all manufacturing firms with 10 or more employees. Standard measures of firm activity are recorded, including information on inputs, outputs, ownership, assets, exporting, and a variety of other measures that provide a complete portrait of the firm.¹ The data has been widely used in empirical studies of firm behavior, most notably in [Liu \(1993\)](#) and [Pavcnik \(2002\)](#). A thorough description of the data can be found in [Blum et al. \(2013\)](#).²

Focusing on the sample from 1995-2006, there are 61,548 total observations and 10,163 unique firms. Of these observations, 19,433 belong to firms classified as exporters, meaning that these firms export at some point in the sample. 32% of the sample observations belong to a firm that will export at least once during the sample, or roughly 26% of all firms (2,701 unique firms).

There is a significant amount of switching in to and out of the export market during the sample. In a given year, 2.5% of firms are starting exporting (meaning they did not export in the previous year, but are exporting in the current year) while another 2.5% of firms have ceased exporting. Furthermore, in a given year, 17% of firms are continuing exporting, meaning that they exported in both the previous year and the current year, while 68% of firms are continuing non-exporters (meaning these firms did not export in the last year or in the current year).³

¹As with most available firm-level datasets, the object of focus is actually the plant rather than the firm. For the rest of the paper, we will use firm and plant interchangeably.

²All measures of sales, materials, and capital used in the analysis were deflated using an industry-level price index found in [Almeida and Fernandes \(2013\)](#).

³The final 10% are firms that are new to the sample, or are returning to the sample having been absent in the previous year.

Based on those numbers, the amount of churning at the extensive margin is obviously quite significant. 85% of firms are staying in the market (or markets) that they operated in the previous period, but 15% of firms are operating in a new market (or markets). To further quantify the amount of switching in the market, we classify every observation of every firm in every year. Of the approximately 10,000 unique firms, 85% experience no switching over the span of the sample. Of these firms, 14% are continuous exporters and 86% are continuous non-exporters. Of the rest of the firms, 7% switch in to or out of the export market exactly once, and the other 7% experience at least two switches in to or out of the export market.⁴ Since exporters tend to be in the sample for longer than non-exporters, in terms of overall observations, 12% of all observations belong to firms that switch more than once, while 20% of all observations belong to a firm experiencing at least one switch in export market participation. Over 5% of all observations belong to firms experiencing 3 or more switches.

At this point, it is important to mention that exporting is itself a rare phenomena. If 12% of all observations belong to firms that switch more than once, among the class of all exporters, this accounts for 38% of all observations associated with exporters, while 16.5% of all exporter observations belong to firms that experience 3 or more changes in their exporting behavior.

Based on this observed switching behavior, we classify exporting firms as transitory or perennial.⁵ Perennial exporters are observed exporting on a continual basis for a significant number of years, and are never observed to leave the export market over the sample period. We consider three consecutive years in the export market to be sufficient for classification as perennial, but have experimented with alternative standards with no qualitative difference in results. Transitory exporters are defined as exporters that complete at least one cycle of switching in to and out of the export market. Perennial exporters make up 14% of all observations and all firms.⁶ Transitory exporters account for 11% of all firms, but 16% of all observations, since transitory exporters tend to have longer operating spells than non-exporters.⁷

⁴Since the sample is censored in that firms with less than 10 employees are not observed, and no firms prior to 1995 are observed, it is possible to first appear in the sample as an exporter. We do not record this as a switch into the export market since we don't know for certain the firm didn't export in the previous year. As constructed, some firms with exactly one switch are firms exiting the export market, although these firms have actually experienced at least two switches since they had to start in the export market at some point. The amount of switching is therefore based only on observed behavior, and as such, understates the actual amount of market switching.

⁵A third class of exporters are considered unclassified if they don't have characteristics of transitory exporters, but haven't been in the sample long enough to observe at least three consecutive years in the export market. These account for about 1% of all firms.

⁶The discrepancy between share of firms and share of observations comes from the fact that while many perennial exporters are in the sample for longer than a typical firm, there is a significant number of firms that enter late into the sample and export continuously but are observed in the sample for a shorter period of time than the typical non-exporter.

⁷These results are consistent with churning identified in [Blum et al. \(2013\)](#) who use more detailed transaction level data.

The primary empirical goal is to identify and quantify patterns of substitution between domestic and foreign sales at the firm level. To do this, we calculate correlations between export and domestic sales for each firm. Furthermore, we investigate whether substitution patterns differ significantly across types of firms.

There are systematic differences across types of firms, where categories are identified based on export market switching behavior. In general, perennial exporters are larger than transitory exporters, and transitory exporters are larger than non-exporters. That is, the patterns of differences typically found in firm level studies between exporters and non-exporters are also found among types of exporters. There are statistically significant perennial premia compared to transitory exporters. Summary statistics are reported in Table 1.

Exporter Type	Total Sales	Domestic Sales	Export Sales	Employees	Value-added	Investment	Capital	Productivity
Perennial Exporter	13803555 (436404)***	7017161 (333862)***	3956400 (531999)***	169.4 (1.69)***	7435356 (305217)***	606533 (47592)***	8727138 (408332)***	0.665 (0.015)***
Transitory Exporter	7834398 (420888)+++	5004404 (321991)+++		90.1 (1.63)+++	5042351 (294365)+++	341554 (46106)+++	4650903 (393813)+++	0.562 (0.014)+++
Non-Exporter	957116.7 (182573)	957117 (139673)		34.86 (0.71)	585302 (127690)	38096 (19944)	426037 (170828)	5.629171 (0.006)
N	61,548	61,548	18,686	61,548	61,548	56,479	61,548	57,773

Notes: Coefficients from regression of column variable on exporter type indicator function. Unclassified exporters are included as additional category in regression, but not reported in table. Transitory and Perennial Exporter are indicator functions for classifications of firms as defined in the paper. Standard errors are reported in parentheses. (+++) indicates coefficient on transitory is different from non-exporter at 0.1 percent significance. (***) indicates coefficient on perennial is different from transitory exporter at 0.1 percent significance. Regression on export sales only includes perennial and transitory exporters in the sample.

Table 1: Summary Statistics (by Exporter Type)

When we consider the correlation between domestic and foreign sales across all firms, we find a raw correlation of 0.16 overall, which is reasonably similar across different types of exporters (0.21 for perennial exporters, 0.15 for transitory exporters (see column (1) of Table 2). By looking across firms, the relationship identified in the data is not a within-firm experience, but rather captures the fact that larger firms tend to sell more domestically and tend to sell more abroad, which generates the observed positive relationship.

If we focus instead on within-firm behavior, we find a very different story. The aggregate within-firm correlation is -0.18, which is of similar magnitude but the opposite sign when compared to the correlation across all firms. The within-firm correlation is indicative of the fundamental tradeoff firms face when choosing between supplying the domestic market and supplying

	(1)	(2)	(3)	N
Exporters	0.16	-0.18	-0.19	19,443
Perennial Exporters	0.20	0.15	0.14	8,930
Transitory Exporters	0.15	-0.30	-0.30	9,756
Firm Fixed Effects	No	Yes	Yes	
Sector Fixed Effects	No	No	Yes	
Year Dummies	No	No	Yes	

Table 2: (Partial) Correlation of domestic and foreign sales

the foreign market. This result is consistent with previous literature that has identified patterns of substitution between domestic and foreign sales.

This aggregate correlation, however, masks important differences across different types of exporters. As can be seen in column (2) of Table 2, for perennial exporters the correlation between domestic sales and exports is a mildly positive 0.15. Transitory exporters, on the other hand, have a very different experience with a negative correlation of -0.3. Given how stark the difference in behavior is for these two types of exporters, it will be important for the model to be able to capture and explain these observed differences.

The correlation observed in the data might be driven by latent variables and not reflect a direct relationship between domestic and export sales. As will become explicit in our theoretical exposition, one needs to be careful to distinguish between productivity shocks and demand shocks when observing sales across borders for an individual firm since a productivity shock will tend to create a positive correlation between domestic and export sales while individual market demand shocks will generate patterns of substitution. To better get at the direct relationship between domestic and foreign sales, consider the partial correlation after controlling for firm fixed effects as well as year and industry effects found in column (3) of Table 2. After partialling out these effects, the overall correlation is -0.19. The partial correlation for perennial exporters is 0.14 and -0.30 for transitory exports, confirming that the observed substitution patterns at the aggregate level are capturing two distinct modes of behavior.

After calibrating and simulating the model, evaluating the value of the model will be partially based on the ability of the model to account for the overall correlation as well as the differential behaviors of perennial and transitory exporters. The correlations estimated in column (3) of Table 2 will provide the standard with which to evaluate the model.

Lastly, to motivate our demand side assumptions, we estimate and analyze firm level markups,

following the method suggested by [De Loecker and Warzynski \(2012\)](#). The major innovations of the estimation approach are the ability to account for simultaneity in input decisions and the use of a flexible production structure. The estimation procedure is consistent with our production and demand modeling assumptions.

Year	Mean	Median	p5	p25	p75	p95	N
1996	2.298	1.936	0.724	1.338	2.827	5.065	4,369
1997	2.279	1.901	0.699	1.304	2.804	4.958	4,212
1998	2.420	1.813	0.691	1.243	2.716	5.137	4,237
1999	2.180	1.754	0.633	1.184	2.648	4.948	4,039
2000	3.007	1.781	0.635	1.195	2.770	6.197	3,877
2001	2.134	1.665	0.669	1.155	2.511	4.884	3,429
2002	2.223	1.739	0.647	1.153	2.625	5.205	3,847
2003	2.435	1.700	0.541	1.115	2.602	5.189	4,026
2004	2.254	1.786	0.671	1.199	2.676	5.169	3,968
2005	2.240	1.770	0.651	1.184	2.660	5.236	3,953
2006	2.432	1.786	0.658	1.179	2.729	5.694	4,009
Aggregate	2.356	1.787	0.655	1.207	2.697	5.219	43,966

Table 3: Distribution of Markups across years

There is overwhelming evidence in the data of significant heterogeneity of markups at the level of the firm, and these markups change significantly over time as well. Across all observations, the mean markup is larger than the median markup, and this observation holds in each individual year and within each sector. The average markup for the entire sample is 2.36 while the median markup is 1.78. The skewness in the data is driven by two forces. On the lower bound, firms with markups much below 1 are likely to exit the market since they are not sufficiently covering costs. For the top 5% of firms, markups exceed 5, suggesting a few firms are able to price well above costs.

When looking at the relationship between export status and markups, we find a similar result to [De Loecker and Warzynski \(2012\)](#) in that exporters tend to have larger markups than non-exporters, and this is robust to the inclusion of observable characteristics such as inputs, productivity, industry and year controls. Exports charge 26% higher markups than non-exporters when looking across firms, which drops to 3% when looking at within firm adjustments.

ln(markup)	1	2	3	4
Export Status	0.259 (34.72)***	0.033 (3.46)***		
Starter			0.051 (2.48)*	
Stopper			0.023 (1.09)	-0.012 (0.88)
Continuer			0.150 (10.62)***	
Perennial			0.325 (20.72)***	
Transitory			0.225 (20.53)***	
perennial X starter				0.068 (1.73)+
transitory X starter				0.014 (0.94)
perennial X continuer				0.041 (1.41)
transitory X continuer				0.035 (2.66)**
Sector FE	yes	yes	yes	yes
Year Dummies	yes	yes	yes	yes
Firm FE	no	yes	no	yes
Observations	43,975	43,975	43,975	43,975

Notes: The dependent variable is firm-level markup. Export Status is a 1 when a firm is exporting in that period, and 0 otherwise. The Starter indicator is a 1 when a firm has positive exports in a given year and no export sales in the previous year, and 0 otherwise. The Stopper indicator is a 1 when a firm has no export sales in a given year but had positive exports in the previous year, and 0 otherwise. The Continuer indicator variable is a 1 when a firm has positive exports this period and had positive exports in the previous period, and 0 otherwise. Transitory and Perennial are indicator functions for classifications of firms as defined in the paper. A constant term and firm productivity are included in each regression and omitted in the table. T-statistics are provided in parentheses based on robust standard errors. Significance: + 10 percent; * 5 percent; ** 1 percent, *** 0.1 percent.

Table 4: Markups and Exporting Behavior

Furthermore, when interacting exporting behavior with exporter category, interesting differences appear. For perennial exporters, markups increase by 7% when they start exporting, but there is no additional affect for perennial exporters as they continue in the export market. For transitory exporters, on the other hand, there is no statistical effect on markups when the firm starts exporting, although for transitory exporters continuing in the export market, there is a 3.5% increase in markups.

While this evidence is suggestive, particularly given the differential impacts found for different

types of exporters, since exporting behavior is not randomly assigned, there should be caution in interpreting these results causally. We will return to these issues when we conduct counterfactual experiments on the simulated data. We now turn to building the theoretical model with these facts and relationships in mind.

3 Model

Guided by the evidence presented in the previous section, we drop the traditional assumptions of sunk and fixed costs to entry in the export market and constant marginal costs of production. The existence of two groups of exporters in the data, one that is perennially in the export market and one that regularly cycles in and out of the export market along with no observed discrete jump in total sales when a firm enters (or exits) suggests the assumption of sunk and fixed costs of exporting may be inappropriate. Furthermore, the patterns of substitution between domestic and foreign sales observed is inconsistent with a constant marginal cost assumption.

We address these empirical regularities by extending the Melitz-Ottaviano linear demand system with non-constant elasticity of firm demand to include increasing marginal cost to production and three distinct firm shocks (shock to productivity, domestic demand, and export demand). The linear demand system generates a choke price above which demand is zero, and drops the assumption of fixed costs to rationalize the fact that few firms export. Increasing marginal cost gives rise to the observed patterns of substitution between domestic and foreign sales.

Time runs $t = 0, 1, \dots$. There are two symmetric countries, populated by a continuum of consumers of mass 1. Country H is the Home country and country F is the foreign country.

Consumers. Consumers have within period preferences given by

$$U = q_0 + \int_{\Omega_H} \exp(x(\omega))q(\omega)d\omega + \int_{\Omega_F} \exp(y(\omega))q(\omega)d(\omega) - 1/4\gamma \left(\int_{\Omega_H} q(\omega)^2 d\omega + \int_{\Omega_F} q(\omega)^2 d\omega \right) - 1/2\eta \left(\int_{\Omega_H} q(\omega)d\omega + \int_{\Omega_F} q(\omega)d\omega \right)^2 \quad (1)$$

where Ω_i is the set of goods produced in i , $i = H, F$, $q(\omega)$ is the quantity consumed of good ω , $x(\omega)$ is the domestic demand shock for good ω , and $y(\omega)$ is the foreign demand shock for good ω . q_0 is a non traded, numeraire good produced by a stand in representative firm with linear technology. $\gamma > 0$ and $\eta > 0$ are preference parameters that govern the elasticity of demand and the elasticity of substitution between varieties, respectively.

The shocks $x(\omega), y(\omega)$ follow AR(1) processes, given by

$$x_{t+1}(\omega) = (1 - \rho_x)\bar{x} + \rho_x x_t(\omega) + \varepsilon_{xt}(\omega)$$

$$y_{t+1}(\omega) = (1 - \rho_y)\bar{y} + \rho_y y_t(\omega) + \varepsilon_{yt}(\omega)$$

where $\varepsilon_{xt}(\omega) \sim N(0, \sigma_x^2), \varepsilon_{yt}(\omega) \sim N(0, \sigma_y^2), 0 < \rho_x < 1, 0 < \rho_y < 1$.

Each consumer has one unit of labor each period which she supplies inelastically. The budget constraint is as follows, given prices $p(\omega), p_0$, and a wage w ,

$$\int_{\Omega_H} p(\omega)q(\omega)d\omega + \int_{\Omega_F} p(\omega)q(\omega)d\omega + p_0q_0 = w + \pi \quad (2)$$

where π is the sum of profits.

Maximizing the utility function with respect to the budget constraint delivers a demand function that firms take as given when maximizing profits. The inverse demand functions are:

$$p_H(\omega, q_H) = \exp(x(\omega)) - \eta Q - \frac{\gamma}{2}q_H \quad (3)$$

$$p_F(\omega, q_F) = \exp(y(\omega)) - \eta Q - \frac{\gamma}{2}q_F \quad (4)$$

$p_i, i = H, F$ is the price of the good depending on the market where it is sold, and $Q = \int_{\Omega_H} q(\omega)d\omega + \int_{\Omega_F} q(\omega)d\omega$. Notice that the demand for a particular good may be negative, which implies the existence of a choke price above which no quantity will be sold in equilibrium.

Firms. There is one representative firm in the non tradable sector with technology $q_0(n) = n$. This sector is perfectly competitive, which implies that in equilibrium, $p_0 = w = 1$.

In the tradable sector, there is one firm per good, acting as monopolists. The production function is $q(n; \omega) = \exp(-z(\omega))n^{1/\alpha}$. In addition, if q_F units are exported, there is a transport cost equal to $(\tau - 1)q_F$. This yields the following cost function to produce q_H units for the domestic market and q_F units to export:

$$c(q_H + q_F; \omega) = \exp(z(\omega))(q_H + \tau q_F)^\alpha$$

$\alpha > 1$ is the returns to scale parameter, and $\exp(z(\omega))$ is the inverse of productivity, which follows the following AR(1) process:

$$z_{t+1}(\omega) = (1 - \rho_z)\bar{z} + \rho_z z_t(\omega) + \varepsilon_{zt}(\omega)$$

where $\varepsilon_{zt}(\omega) \sim N(0, \sigma_z^2), 0 < \rho_z < 1$. Each period, firms observe their productivity and the demand

shocks and choose prices and quantities to maximize profits. That is, firm ω solves

$$\max_{p_H, q_H, p_F, q_F} p_H q_H + p_F q_F - \exp(z(\omega))(q_H + \tau q_F)^\alpha \quad (5)$$

s.t. equations (3) and (4).

Market Clearing. In equilibrium, all firms producing tradable goods with positive demands ($x > \eta Q$ or $y > \eta Q$) will demand labor units. The representative firm producing non tradable goods also demands labor. The quasilinear nature of preferences implies that all labor in excess of that demanded by the tradable sector is absorbed by the non tradable sector. Thus, $\int_{\Omega_H} n(\omega) d\omega + n_0 = 1$, where $n(\omega)$ solves problem (5) and n_0 is the labor demand of the non tradable sector.

3.1 Equilibrium

While the setup is dynamic, the decisions of the firm are static, since there is no endogenous state variable. Also, we have not introduced any elements to transfer resources intertemporally, such as bonds. Notice that introducing bonds would not matter because of the assumption of symmetric consumers and symmetric countries. Thus, we can define a static equilibrium as a list of quantities $q(\omega)$ and q_0 , labor inputs $n(\omega)$ and n_0 and prices $p(\omega)$ such that consumers maximize (1) subject to equation (2), firms solve (5), and markets clear.

In what follows, it is convenient to drop the name of the good ω and refer to firms according to their type. Each firm is a triplet (x, y, z) . In equilibrium, the solution to problem (5) allows for several corners. In particular, when $\exp(x) < \eta Q$, the good will not be sold domestically, and when $\exp(y) < \eta Q$, it will not be exported. Still, when neither of these conditions are met, it will be sometimes optimal to sell in only one market. The next proposition shows all the possible cases.

Proposition 1. *A firm x, y, z will only sell domestically when $\exp(x) > \eta Q$ and $x > \bar{x}(y, z)$. Similarly, it will only export when $\exp(y) > \eta Q$ and $y > \bar{y}(x, z)$. It will sell in both markets when $\exp(x) > \eta Q$, $\exp(y) > \eta Q$, $x \geq \bar{y}(x, z)$ and $y \geq \bar{x}(x, z)$, where*

$$\bar{x}(y, z) = \log \left(\gamma \left(\frac{\exp(y) - \eta Q}{\tau \alpha \exp(z)} \right)^{\frac{1}{\alpha-1}} + \frac{\exp(y) - \eta Q}{\tau} + \eta Q \right) \quad (6)$$

$$\bar{y}(x, z) = \log \left(\frac{\gamma}{\tau} \left(\frac{\exp(x) - \eta Q}{\alpha \exp(z)} \right)^{\frac{1}{\alpha-1}} + \tau (\exp(x) - \eta Q) + \eta Q \right) \quad (7)$$

Proof. The proof is straightforward, and detailed in the Appendix. Intuitively, when x is too large relative to y , the firm will choose not to export, since exporting increases its marginal cost given decreasing returns to scale, may be optimal to keep these costs low. The opposite happens if y is

large relative to x , in which case the firm will choose not to sell domestically and export all its output. \square

Corollary 1. *Let x_0, y_0, z_0 be such that the firm chooses to sell domestically but not export, that is, $\exp(x_0) > \eta Q, x_0 > \bar{x}(y_0, z_0)$. Then $y_0 < \bar{y}(x_0, z_0)$. Similarly, if the firm chooses to export only, that is $\exp(y_0) > \eta Q, y_0 > \bar{y}(x_0, z_0)$. Then $x_0 < \bar{x}(y_0, z_0)$.*

Proof. The proof shows the first part of the corollary. The second part is straightforward given the first part. Proceed by contradiction, that is, assume that (x_0, y_0, z_0) are such that $x_0 > \bar{x}(y_0, z_0)$ and $y_0 > \bar{y}(x_0, z_0)$. The proof shows this leads to a contradiction.

Let $\tilde{x} = \exp(x_0) - \eta Q$ and $\tilde{y} = \exp(y_0) - \eta Q$.

$$x_0 > \bar{x}(y_0, z_0) \Rightarrow \tilde{x} > \gamma \left(\frac{\tilde{y}}{\tau \alpha \exp(z_0)} \right)^{\frac{1}{\alpha-1}} + \frac{\tilde{y}}{\tau} \quad (8)$$

$$y_0 > \bar{y}(x_0, z_0) \Rightarrow \tilde{y} > \frac{\gamma}{\tau} \left(\frac{\tilde{x}}{\alpha \exp(z_0)} \right)^{\frac{1}{\alpha-1}} + \tilde{x} \tau \quad (9)$$

Using equation (9) in equation (8),

$$\begin{aligned} \tilde{x} &> \gamma^{\frac{\alpha}{\alpha-1}} \tilde{x}^{\frac{1}{\alpha-1}} (\tau \alpha \exp(z_0))^{\frac{-2}{\alpha-1}} + \tau \tilde{x} \Leftrightarrow \\ (1 - \tau) &> \gamma^{\frac{\alpha}{\alpha-1}} \tilde{x}^{\frac{2-\alpha}{\alpha-1}} (\tau \alpha \exp(z_0))^{\frac{-2}{\alpha-1}} \end{aligned}$$

The last line is a contradiction, since the term on the left hand side is negative and the term on the right hand side non negative. \square

Proposition 1 fully describes the behavior of the firm in equilibrium. Each firm observes its demand functions, that are determined by their demand shocks x and y via equations (3) and (4), and determine whether to sell to both markets, to one, or to none. A firm will not operate in any market when both shocks x and y are too low (so that demand is non positive). It will sell only domestically when x is very large relative to y , it will sell in both markets when x and y are relatively close, and it will only export when y is large relative to x . The extent to which one shock is large relative to the other is given by the productivity shock z through equations (6) and (7).

4 Parameter Values

We set $\gamma = 2$ and $\eta = 1$ We have done sensitivity with respect to these parameters, and find that the results are not sensitive to this choice. We also set exogenously $\tau = 1.5$, such that to

export one unit, the exporter must produce 1.5. Sensitivity experiments show that results do not depend critically on this parameter, which at first seems important given that this is a key trade parameter. The reason is that increases in τ are associated with similar increases in \bar{y} or in $\bar{\sigma}_y$, which counteract the initial effect of τ . In other words, we were unable to successfully identify the effect of τ from the effect of \bar{y} or $\bar{\sigma}_y$.

For the parameters governing the distribution of firms we use firm level data on domestic revenues, exports and mark-ups to back out the unobserved triplet (x, y, z) consistent with the observed data.⁸ This procedure assumes that we know the value of Q . Fortunately, the free parameter M determines Q . So we set $Q = 1$ and back out the M that is consistent with this equilibrium value. We do this for all firms in year 1996.⁹

The model implies that, as $t \rightarrow \infty$, the economy converges to an invariant distribution of firms operating. Given the autorregressive nature of the stochastic processes, the unconditional distributions of the shocks are

$$x \sim N\left(\hat{x}, \frac{\sigma_x^2}{1-\rho_x^2}\right), y \sim N\left(\hat{y}, \frac{\sigma_y^2}{1-\rho_y^2}\right), z \sim N\left(\hat{z}, \frac{\sigma_z^2}{1-\rho_z^2}\right)$$

This distribution, paired with the optimizing strategies $\bar{x}(y, z)$ and the invariant distributions, imply an invariant distribution for quantities and sales.

We observe an unbiased sample of productivities z , so we can structurally estimate the parameters \hat{z} and $\bar{\sigma}_z = \frac{\sigma_z^2}{1-\rho_z^2}$ via maximum likelihood. We pick $\alpha = 1.5$, which implies that the labor share in the production function is $2/3$. This is somewhat larger than the returns estimated by [Coşar et al. \(2010\)](#), which is 1.66. However, [Hopenhayn and Rogerson \(1993\)](#) and others use a lower number, closer to 1.2. Thus, we set $\alpha = 1.5$.

For the demand parameters, we only observe a biased sample. For example, if the firm only sells domestically, we observe x but not y . Moreover, we know $x > \eta Q$ and $x > \bar{x}(y, z)$, so y must satisfy this condition. A similar argument holds for firms that choose to export but not sell domestically (we do not observe x in this case). However, there are very few cases in which the firm only exports (3 firms out of 1,417 export only among the firms operating every period). Thus, we eliminate these observations and assume that we observe all x such that $x > \eta Q$. Moreover, our backed out values for x suggest that the condition $x > \eta Q$ is rarely binding. Accordingly, we ignore it and estimate the parameters \hat{x} and $\hat{\sigma}_x = \frac{\sigma_x^2}{1-\rho_x^2}$ using maximum likelihood as well.

We observe y only when the firm exports. Thus, there are many draws of y that we do not observe, and since these are relatively low values of y , we cannot assume that our sample is repre-

⁸See Appendix for further details.

⁹Some data were inconsistent with our model equilibrium, such as negative markups. We eliminated these data. We explain this in detail in the Appendix.

sentative, which prevents us from estimating the relevant parameters via MLE. Alternatively, the distribution for y is key to determine exports, so we calibrate \bar{y} and $\bar{\sigma}_y$ such that the ratio of exports to total sales and the share of exporters is as in the data (30% and 32% respectively).¹⁰

The last step involves computing the autocorrelations. Ideally, we would compute them performing regressions on each variable on its lags. The problem is that the observed data for x and y is biased, and as such the errors would not be zero mean, so we choose an alternative approach. We set these parameters so that the autocorrelations of revenues with its lag is as close as possible to the data. We focus on the autocorrelation of domestic sales by non exporters, and domestic sales and exports for perennial exporters. These autocorrelations in the data are 0.43, 0.39 and 0.42, respectively. Table 5 shows all the parameter values.

Table 5: Calibrated Parameters

Parameter	Value	Target
α	1.5	Coşar et al. (2010) and Hopenhayn and Rogerson (1993)
η	1	Normalization
γ	2	Normalization
τ	1.5	Normalization
M	8×10^{-4}	Sets $Q = 1$
\bar{x}	7.46	Maximum Likelihood
\bar{z}	3.03	Maximum Likelihood
$\bar{\sigma}_x$	0.81	Maximum Likelihood
$\bar{\sigma}_z$	1.08	Maximum Likelihood
\bar{y}	6.30	$\frac{\text{Exports}}{\text{Sales}} = 30\%$ and 32% of firms export
$\bar{\sigma}_y$	1.21	
ρ_x	0.86	Sales autocorrelations
ρ_y	0.92	Sales autocorrelations
ρ_z	0.98	Sales autocorrelations
σ_x	0.41	ρ_x and $\bar{\sigma}_x$
σ_y	0.42	ρ_y and $\bar{\sigma}_y$
σ_z	0.21	ρ_z and $\bar{\sigma}_z$

Notice the differences in the distributions of the x and y shocks (\bar{x} , \bar{y} , $\bar{\sigma}_x$, $\bar{\sigma}_y$). While on average the x 's are larger, the y 's have a larger standard deviation. This is important, because low numbers for y do not matter (the firm will be a non exporter), so a large standard deviation can generate

¹⁰We also performed an alternative exercise to calibrate \bar{y} and $\bar{\sigma}_y$. While the estimates were similar, the model produced counterfactually large trade volumes. The alternative process is as follows. Whenever we do not observe y , we know that $y < y^*(x, z)$, where we define $y^*(x, z)$ as the value of y such that $x = \bar{x}(y^*(x, z), z)$ holds. For a given value y_i , we compute the probability of $y < y_i$ as the sum of the number of observations where $y < y_i$ plus the number of observations where $y^*(x, z) < y_i$. We repeat this for many different y_i 's. Finally, we set the parameters \bar{y} and $\bar{\sigma}_y$ to minimize the squared difference between the probabilities computed and the cumulative distribution function for y under the normal assumption evaluated at all the y_i 's.

large trade volumes in spite of small means. In this case, both the trade volume of 30 percent and the fact that 32 percent of firms export within a given year imply $\bar{x} > \bar{y}$ and $\bar{\sigma}_x < \bar{\sigma}_y$.

5 Findings

5.1 Exports and Domestic Sales

The main question in the paper is whether the model can account for the correlations between domestic and foreign sales in the data. This correlation is -0.19 across the board. Dividing the sample between type of exporters, the correlation for transitory exporters is -0.30, and the correlation for perennial exporters is 0.14.

In the model, the overall correlation is -0.15. It is -0.19 for transitory exporters, and 0.02 for permanent exporters. Thus, the model can account fairly reasonably for the change in sign between perennial and transitory exporters. Quantitatively, it accounts for almost 80 percent of the overall correlation. However, this is not evenly split among the subgroups: while it accounts for two thirds of the negative correlation among transitory exporters, it only accounts for 14 percent in the case of perennial exporters.

Next we try to understand why the correlation for transitory exporters is so much lower than for perennial exporters. We conjecture that this is due to the shape of the cost curve. Marginal costs are $\exp(z)\alpha Q^{\alpha-1}$, where Q is units produced. Since $1 < \alpha < 2$, this function is increasing and concave, so that marginal costs increase at a decreasing rate. Thus, marginal costs are relatively flatter (closer to constant returns) for larger firms. If this is the reason for the lower correlation among transitory exporters, then we should expect transitory exporters to be relatively smaller than perennial exporters. We verify this by performing the following regression on all firms, including non-exporters:

$$\log(Q_{it}) = \beta_0 + \beta_1 I_{Pi} + \beta_2 I_{Ti} + \epsilon_{it}$$

where

$$I_{Pi} = \begin{cases} 1 & \text{if firm } i \text{ is a perennial exporter} \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad I_{Ti} = \begin{cases} 1 & \text{if firm } i \text{ is a transitory exporter} \\ 0 & \text{otherwise} \end{cases}$$

Our estimates confirm that perennial exporters are on average larger than transitory exporters, which are on average larger than non exporters. The estimates are $\beta_1 = 1.42$ and $\beta_2 = 0.62$. This implies that, on average, perennial exporters produce 140 percent more than non exporters, and transitory exporters produce 62 percent more than non exporters, confirming our conjecture that

perennial exporters are on average larger than non exporters. These estimates are significant at the 1 percent level. If we replace physical quantities with sales, we still get the same effect, and the estimates suggest that perennial exporters sell 92 percent more than non exporters, while transitory exporters sell 30 percent more.

We then explore the effect of exports on the domestic price charged by a firm. To do this, we regress the (log of) the difference in price charged by a firm on a dummy indicating whether a firm started or stopped exporting. We first simulate the behavior of 10,000 firms for 1,000 periods, of which we only keep the last 10. We keep only firms that exported in some but not all the last 10 periods (and sold domestically in all 10 periods). Then we compute the difference in the domestic price between any 2 consecutive periods (p_{t+1}/p_t), and regress this measure against two dummies indicating whether the firm started or stopped exporting in that period. We control for the difference in productivity shocks and both demand shocks. That is, we perform the following regression using simulated data:

$$\log\left(\frac{p_{id,t}}{p_{id,t-1}}\right) = \beta_0 + \beta_1 \text{Enter}_{i,t} + \beta_2 \text{Exit}_{i,t} + \beta_3(x_{i,t} - x_{i,t-1}) + \beta_4(y_{i,t} - y_{i,t-1}) + \beta_5(z_{i,t} - z_{i,t-1}) + \epsilon_{i,t}$$

We are interested in the coefficients β_1 and β_2 . We find that $\beta_1 = 0.008$ and $\beta_2 = -0.008$, significant at the 1% level. Thus, starting to export increases the domestic price by 0.8 percent, and exiting the export market reduces it by the same amount. Starting to export increases the quantity produced, increasing the marginal cost, and subsequently the price.

5.2 Counterfactuals

To learn more about the interaction between exports and domestic sales, we drop trade costs from our benchmark value of 1.5 to 1.1.

Sales

When focusing only on those firms that are perennial exporters under both tariffs, several features stand out. First, firms tend to export more with lower tariffs. On average, they increase exports by 27 percent. This average is mainly driven by very few, very extreme observations. In fact, the median increase is of 3.5 percent. Dropping out the bottom and top one percent, the mean increase drops to 20 percent. However, this is very unevenly split. The 99th percent increase is of a factor of 5. And some firms reduce their exports: about 30 percent of them, but they do so very moderately. The firm that experiences the largest reduction exports 3.4 percent less than with larger tariffs.

Exporters also tend to increase their domestic sales when trade costs fall. The mean increase is almost 7 percent, while the median increase is zero. About 50 percent of firms increase their domestic sales volume. Figures 1 and 2 show the distribution of increases in domestic and foreign sales.¹¹

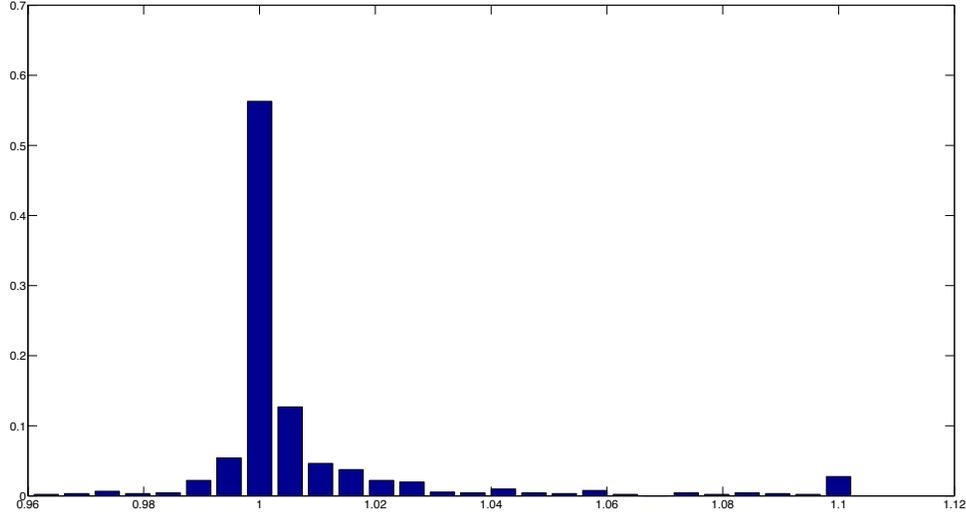


Figure 1: Increase in Domestic Sales by Perennial Exporters when Trade Barriers Drop

The facts that some firms sell more domestically after a reduction in tariffs is not present in standard international trade models. In our model, the reason for this is as follows. A reduction in trade costs implies a gain in efficiency and a reduction in costs. While this affects exports more than domestic sales, the decreasing returns to scale technology implies that cost reductions are also present for domestic output. When faced with a reduction in costs, firms tend to increase output. Which part of output increases the most depends on the elasticities of demand. In fact, we ask the model how the elasticities affect the change in revenues. To do this, we perform two regressions. The first regresses the increase in domestic sales (in logs) against the difference in the domestic and foreign elasticity of demand. The second regression does the same changing the dependent variable for the increase in exports. That is, we regress

$$\log\left(\frac{\text{Domestic sales low } \tau}{\text{Domestic sales high } \tau}\right) = \beta_{0d} + \beta_{1d}(|\eta_d| - |\eta_x|) + \epsilon_d$$

$$\log\left(\frac{\text{Exports low } \tau}{\text{Exports high } \tau}\right) = \beta_{0x} + \beta_{1x}(|\eta_d| - |\eta_x|) + \epsilon_x$$

¹¹For expositional purposes, this does not include the top and bottom 1 percent.

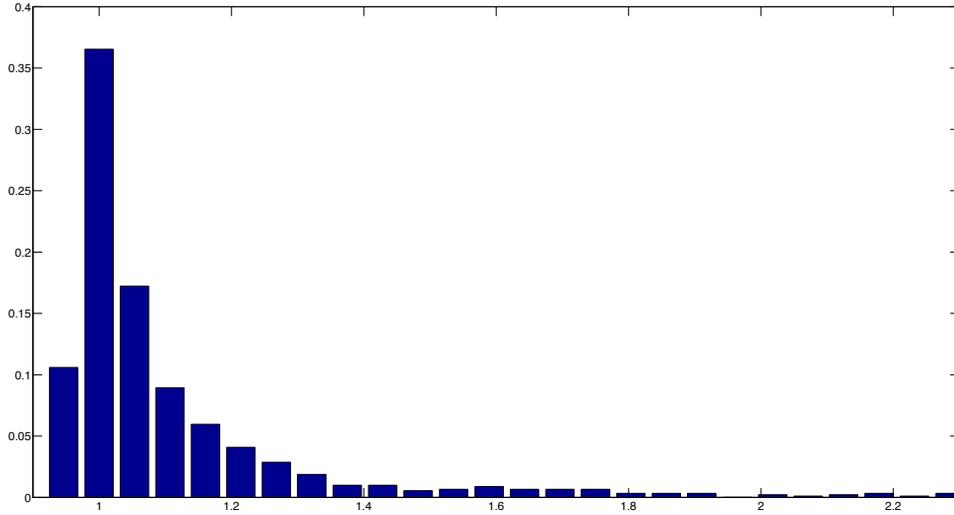


Figure 2: Increase in Exports by Perennial Exporters when Trade Barriers Drop

where η_d is domestic and η_x is foreign elasticity of demand, defined as

$$\eta_d = \frac{\partial q_d}{\partial p_d} \frac{p_d}{q_d} = -\frac{e^x - \eta Q - \gamma/2q_d}{\gamma/2q_d}$$

$$\eta_x = \frac{\partial q_x}{\partial p_x} \frac{p_x}{q_x} = -\frac{e^y - \eta Q - \gamma/2q_x}{\gamma/2q_x}$$

We evaluate the quantities q_d , q_x and Q at the average before and after the drop in τ . Table 6 shows our results. The estimates are very robust, and confirm that when the domestic demand is more elastic than the foreign demand, the reduction in costs (and prices), leads to larger increases in domestic sales. When the opposite happens, foreign demand increases more.

Parameter	Estimate	p-value	R^2
β_{1d}	0.0286	0.0000	0.6776
β_{1x}	-0.0350	0.0000	0.2241

Table 6: Elasticities and the change in domestic and foreign sales

Notice that the key elements for these results are decreasing returns to scale technologies, and heterogeneous elasticities of demand. Models based on Dixit-Stiglitz preferences cannot replicate this, even when paired with decreasing returns to scale technologies. In fact, in Melitz (2003), domestic sales can only be affected via a general equilibrium effect (wages increase after a reduction in trade costs), and unequivocally domestic sales drop in this case.

We next study the behavior of firms that for a given combination of shocks were not exporting under the high tariff, but exported later. In this case, domestic revenues fall in every case. The average reduction in domestic sales is 3.4 percent. The median, on the other hand, does not change its domestic sales. Figure 3 shows the change in domestic sales by firms that export only with the low tariff.

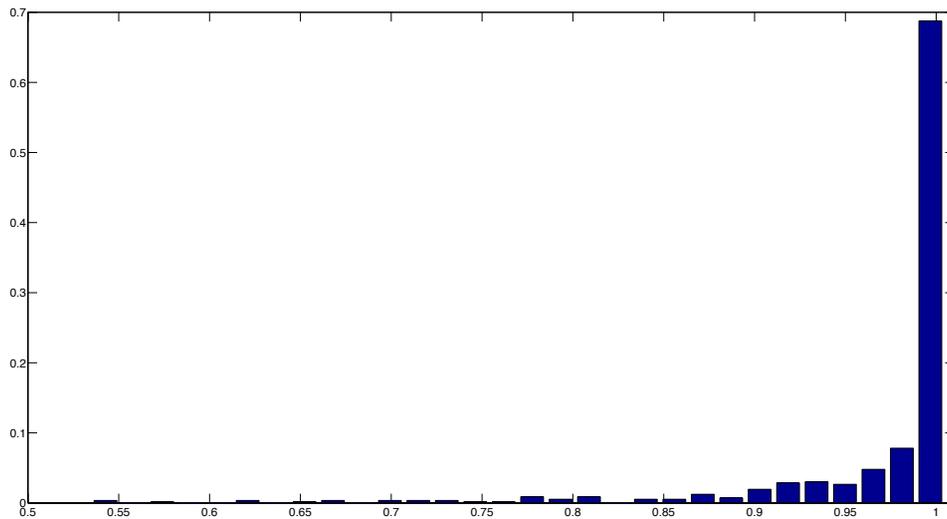


Figure 3: Change in Domestic Sales by Firms that only Export when Trade Barriers Drop

Prices

Next, we analyze the effect of the reduction in trade costs on domestic prices. Consider firms that are perennial exporters with high and low trade costs. How do their prices change with the reduction in trade costs?

As one would expect, export prices drop with lower trade costs. The average drop is 7.3 percent, and the median drop is 7.8 percent. No price increases, and the maximum drop is 12.5 percent. Figure 4 shows a histogram with the change in export prices.

The story is somewhat different considering domestic prices. On average, these change very slightly. However, the changes tend to be price drops. The average change is a reduction of 0.6 percent, and the median a drop of 0.35 percent. The maximum drop is 5.2 percent. A few prices increase, and the maximum increase is 6.1 percent. Figure 5 shows a histogram with the change in export prices.

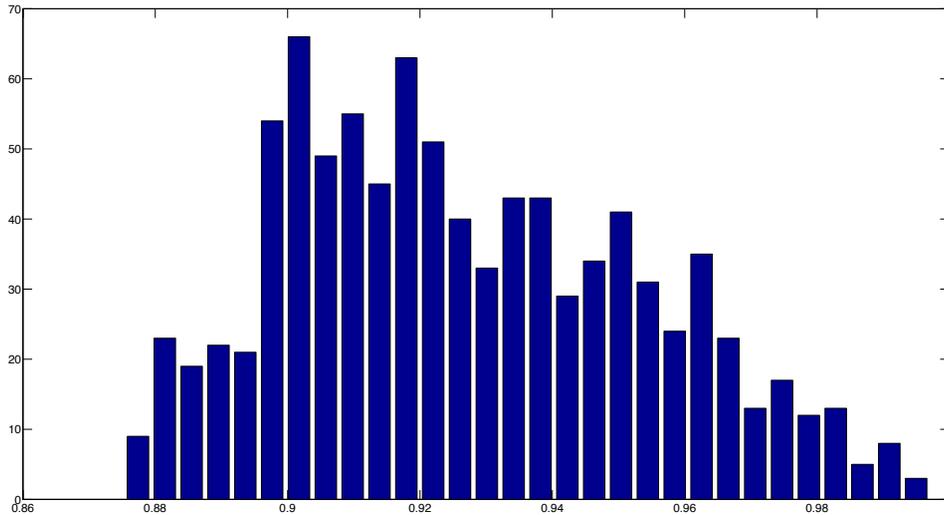


Figure 4: Increases in Export Prices when Trade Barriers Drop

The reason why domestic prices can increase or decrease is intuitive. A reduction in trade costs is a reduction in total cost. Given decreasing marginal returns, the marginal cost both for domestic and foreign quantities decreases, so domestic prices can go down. However, since trade costs affect exports more, exports increase more, increasing the marginal cost, and potentially increasing the domestic price. The magnitude of the change in domestic price will therefore depend on the elasticity of demands: when exports are more elastic relative to domestic goods, domestic prices are more likely to increase. We confirm this claim by running the following regression:

$$\log \left(\frac{\text{Domestic Price low } \tau}{\text{Domestic Price high } \tau} \right) = \beta_{0p} + \beta_{1p}(|\eta_d| - |\eta_x|) + \epsilon_p$$

The estimate on β_{1p} is -0.0011, which means that domestic prices are likely to fall more when domestic demand is more elastic than foreign demand. The coefficient is significant at the 1 percent level.

Compare this result with the behavior of domestic prices under constant trade costs. Before, we concluded that entering the export market is likely to *increase* domestic prices. Also, reducing trade barriers is likely to *reduce* domestic prices.

Thus, the behavior of transitory exporters under constant trade costs might lead to mistaken conclusions. A policy maker might believe that higher trade costs will reduce domestic prices since firms reduce these prices when they do not export. However, an increase in trade costs, by increasing marginal costs, is likely to increase domestic prices.

Our findings suggest that empirical research should focus on the effect of trade costs on domes-

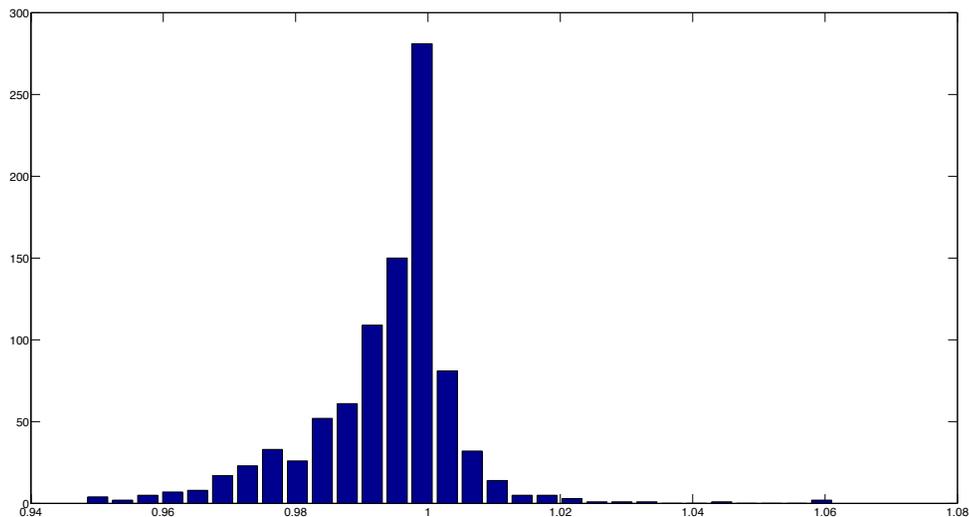


Figure 5: Increases in Export Prices when Trade Barriers Drop

tic sales in addition to their effect on foreign sales. Current models, based on constant returns to scale and constant elasticities of demand, never suggested the need to pay attention to the impact of trade costs on the domestic market.

5.2.1 Markups

Finally, we explore the effect of lower trade costs on markups. As before, we analyze two types of firms: perennial exporters under both levels of trade costs, and firms that do not export when trade costs are high, but export when trade costs fall.

Reductions in trade barriers have very different effects on perennial exporters and on firms that only export after the barriers drop. In the case of perennial exporters, markups increase. On average, the increase is of 16 percent, although the markup for some firms decreases. Figure 6 show the increase across different firms.

When we explore the relationship between the increase in markup and the elasticity of demand, we find that the larger the foreign elasticity of demand, the smaller the increase in markup. An increase in this elasticity of 1 percent is associated with a reduction in the markup increase of 3.5 percent. The domestic elasticity has a very small effect on this markup.

The behavior of the markups is very different among firms that only export under the low trade cost regimes. These firms lower their markup (although profits increase due to the larger sales volume). On average, the markups fall by 5 percent. No firm increases the markup. Figure 7

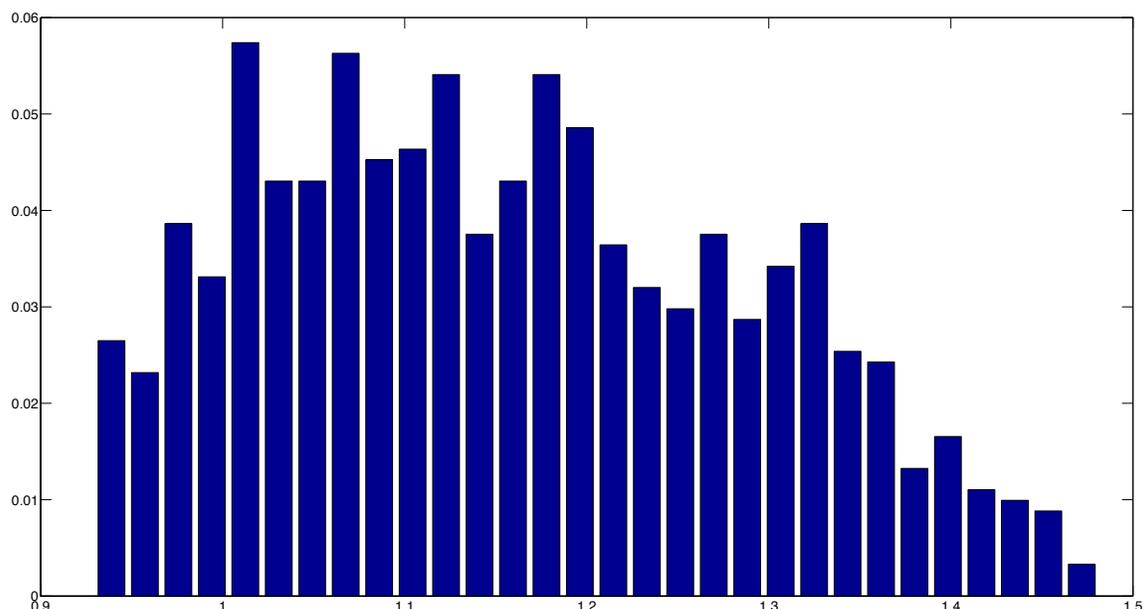


Figure 6: Increases in Mark-Ups by Perennial Exporters when Trade Barriers Drop

shows the distribution of the changes in markups for these firms.

This last observation suggests that entering the export market reduces the markup. On the other hand, both the markups in the data and the simulated markups in the model are larger for exporters than non exporters. In fact, the average markup in the data is 39 percent larger for exporters, and in the model this number is 69 percent. These differences are in line with the findings of [De Loecker and Warzynski \(2012\)](#), who shows that exporters charge higher markups. However, our counterfactuals suggest that this is not because of exporting. If anything, exporting reduces the mark-up. Our counterfactuals suggest that exporters share certain characteristics (higher foreign and domestic demand), that imply large markups and exporting. That is, the large mark-up is not a consequence of a low trade cost.

6 Conclusions

The negative correlation observed between domestic and foreign sales suggests that firms face tradeoffs between selling domestically and abroad. There is a real opportunity cost to exporting, which cannot be captured by models with constant marginal cost in production. Exporting an additional unit increases the cost of production, which in turn, forces the firm to re-optimize in the domestic market and reduce domestic sales. As such, markets cannot be treated independently.

This paper shows that by introducing increasing marginal cost technologies into an otherwise standard model of international trade effectively accounts for the observed firm behaviors. The

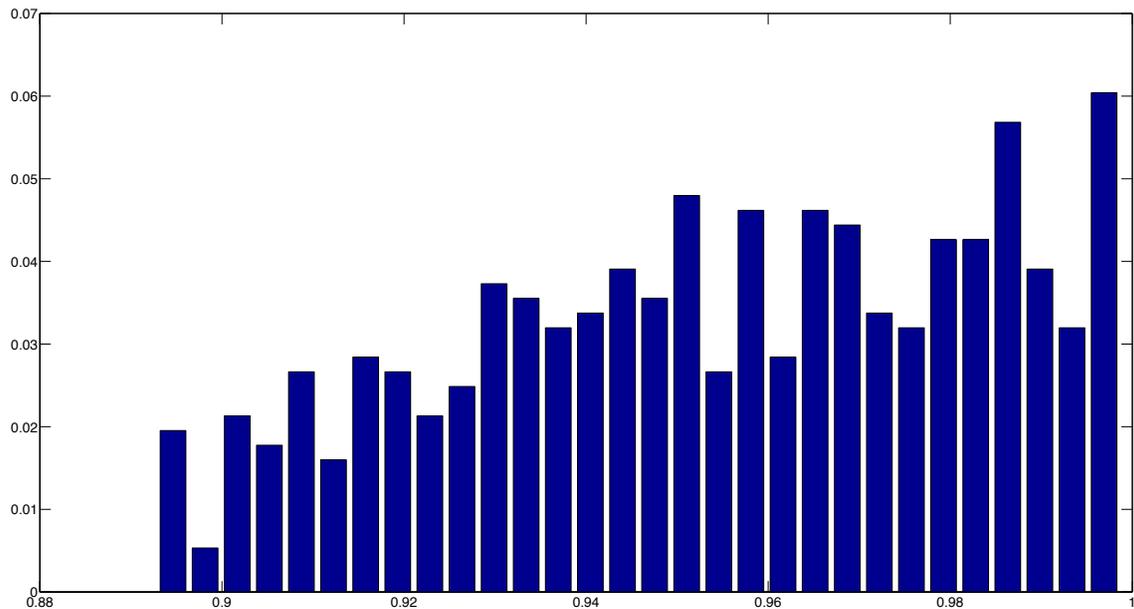


Figure 7: Increases in Mark-Ups by Firms that only Export when Trade Barriers Drop

model successfully generates a negative correlation between domestic and foreign sales for transitory exporters, and a positive correlation for perennial exporters. The reason for this asymmetry is related to the shape of the marginal cost curve and firm size. Marginal costs are increasing, but they increase at a decreasing rate, so larger firms tend to operate on relatively flatter segments of the marginal cost curve. In our numerical simulations, as well as in the data, perennial exporters are on average larger than transitory exporters, so the effect of decreasing returns to scale, which generates the negative correlation, is lower for these types of firms. This implies that the assumption of constant returns to scale matters more to account for the behavior of transitory (small) exporters.

This new framework generates novel responses to changes in trade costs that have not been previously discussed in the literature. In particular, it suggests that on average, a reduction in trade costs actually increase domestic sales via direct linkages. This contrasts with mainstream models such as [Melitz \(2003\)](#) and [Eaton and Kortum \(2002\)](#), where declines in trade cost lead to reductions in domestic sales, but only indirectly via general equilibrium effects.

The reaction of markups to changes in trade costs is also novel. We find that firms entering the export market because of a reduction in trade costs reduce their markups. [De Loecker and Warzynski \(2012\)](#) study the behavior of markups and exporting in the data, and find that on average, exporters have larger markups than non-exporters. While exporters have higher markups than non-exporters in our simulated model as well, our results imply that a causal interpretation of the relationship is unwarranted. Rather, exporters share certain characteristic, notably high foreign demand and high productivity, which account for both exporting behavior and high markups.

A particularly appealing aspect of the approach taken here is that a simple, tractable model can account for relevant correlations in the data. Alternative approaches based on physical and financial capacity constraints could be reconciled with transitory and perennial exporter behaviors, but would require a more complicated approach that incorporates dynamic investment in capacity with nonlinear costs and uncertainty. The results presented here show that such complications are not necessary for matching observed patterns. The flexibility and efficiency of the present model is a virtue in this regard.

Our results suggest that future research on international trade should consider frameworks with non-constant returns to scale. This implies that firm decisions on exports and domestic sales cannot be considered in isolation, and shocks to one market will have effects on both markets. In particular, the need for decreasing marginal returns is especially important to understand the high frequency response to shocks of relatively small exporters.

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Appendix

The following appendix details how we extracted the shock realizations from the data. Given the cross section of the shock realizations, we estimated the distributions of these shocks via maximum likelihood.

The process is as follows. Firms observe shocks x, y, z , unobservable to us, and makes production decisions, both for the export and domestic markets, which is available to us. In addition, information on sales plus other information on costs available in the database allows us to create markups for each firm, as in [De Loecker and Warzynski \(2012\)](#). The data on domestic sales, exports, and markups allows us to solve a non linear system of three equations and three unknowns that determine the shocks x, y and z .

Non Exporters

In the case of non exporters, we do not have relevant information on the export demand shock y . Thus, we can only extract the realization of the shocks x and z . We do this using data on markups (m) and sales (r). Let c be total (variable) cost.

$$m = \frac{r}{c} \Rightarrow c = \frac{r}{m}$$

Recall the first order condition and the price for these guys,

$$\begin{aligned} \exp(x) - \eta Q - \gamma q &= \beta \exp(z) q^{\beta-1} \\ p &= \exp(x) - \eta Q - \gamma/2q \end{aligned}$$

where $\exp(z)$ is the inverse of productivity. Thus,

$$pq - \frac{\gamma}{2}q^2 = \beta \exp(z) q^{\beta} = \beta c$$

This equation determines q for each firm. Given q , we can pin down the marginal cost $\beta \exp(z) q^{\beta-1}$ as follows.

$$\beta \frac{c}{q} = \beta \exp(z) q^{\beta-1}$$

Back to the first order condition,

$$\exp(x) - \eta Q = \beta \frac{c}{q} + \gamma q$$

We obtain x from this equation. The problem is that we don't know ηQ . However, we can always pick an arbitrary value for η and then calibrate the mass of firms in the economy such that $\eta Q = 1$ in equilibrium. This gives the shock realization x .

Given $x, \eta Q, q$, we can determine $\exp(z)$:

$$\exp(x) - \eta Q - \gamma q = \beta \exp(z) q^{\beta-1}$$

Thus, we have all the realizations of the random variables for non exporters.

Exporters

In this case we extract all shock realizations x, y, z as follows. Let r_d be the revenues of domestic sales and r_x exports. The first order conditions are

$$\begin{aligned} r_d - \frac{\gamma}{2} q_d^2 &= \beta \exp(z) (q_d + \tau q_x)^{\beta-1} q_d \\ r_x - \frac{\gamma}{2} q_x^2 &= \beta \exp(z) (q_d + \tau q_x)^{\beta-1} \tau q_x \end{aligned}$$

Adding these up

$$r_d + r_x - \frac{\gamma}{2} (q_d^2 + q_x^2) = \beta \exp(z) (q_d + \tau q_x)^\beta = \beta c$$

where $c = \frac{r_d + r_x}{m}$. So we have $(q_d^2 + q_x^2) = \tilde{q}$. Can find q_d and q_x by solving a system of two equations and two unknowns. The second equation combines the two equations above. The equations are

$$\begin{aligned} q_d^2 + q_x^2 &= r_d + r_x - \beta c \\ \frac{r_d}{q_d} - \frac{\gamma}{2} q_d &= \frac{r_x}{\tau q_x} - \frac{\gamma}{2\tau} q_x \end{aligned}$$

Given these variables, we obtain the marginal cost as

$$c' = \beta \exp(z) (q_d + \tau q_x)^{\beta-1} = \beta \frac{c}{q_d + \tau q_x}$$

Next obtain x, y from

$$\begin{aligned} \exp(x) - \eta Q - \frac{\gamma}{2} q_d &= c' \\ \exp(y) - \eta Q - \frac{\gamma}{2} q_x &= \tau c' \end{aligned}$$

Lastly, obtain $\exp(z)$ from

$$c' = \beta \exp(z)(q_d + \tau q_x)^{\beta-1}$$

Once we have all the data on $x, y, \exp(z)$, we can estimate the parameters in the distributions via Maximum Likelihood. Under the assumption that the processes for the variables are

$$\begin{aligned} x' &= \rho_x x + (1 - \rho_x)\mu_x + \epsilon_x, & \epsilon_x &\sim N(0, \sigma_x^2) \\ y' &= \rho_y y + (1 - \rho_y)\mu_y + \epsilon_y, & \epsilon_y &\sim N(0, \sigma_y^2) \\ \log(\exp(z)') &= \rho_d \log(\exp(z)) + (1 - \rho_d)\mu_d + \epsilon_d, & \epsilon_d &\sim N(0, \sigma_d^2) \end{aligned}$$

the distributions of the cross section in each variable are

$$\begin{aligned} x &\sim N\left(\mu_x, \frac{\sigma_x^2}{1 - \rho_x^2}\right) \\ y &\sim N\left(\mu_y, \frac{\sigma_y^2}{1 - \rho_y^2}\right) \\ z &\sim N\left(\mu_d, \frac{\sigma_d^2}{1 - \rho_d^2}\right) \end{aligned}$$

However, we need to deal with the selection bias. We observe only x such that $\exp(x) \geq \eta Q$ and $\exp(y) \geq \bar{y}(x, \exp(z))$ where $\bar{y}(x, \exp(z))$ solves

$$\begin{aligned} \gamma \left(\frac{\bar{y}(x, \exp(z)) - \eta Q}{\tau \exp(z)\beta} \right)^{\frac{1}{\beta-1}} + \eta Q (1 - \tau^{-1}) + \frac{\bar{y}(x, \exp(z))}{\tau} - \exp(x) &= 0, \\ \bar{y}(x, \exp(z)) &= \max \{ \eta Q, \bar{y}(x, \exp(z)) \} \end{aligned}$$

The densities for the variables x and z are

$$\begin{aligned} f_x(x) &= \frac{\text{normpdf}\left(x, \mu_x, \frac{\sigma_x^2}{1 - \rho_x^2}\right)}{1 - \text{normcdf}\left(\eta Q, \mu_x, \frac{\sigma_x^2}{1 - \rho_x^2}\right)} \\ f_d(\exp(z)) &= \text{normpdf}\left(\log(\exp(z)), \mu_d, \frac{\sigma_d^2}{1 - \rho_d^2}\right) \end{aligned}$$

However, it turns out that the restriction $\exp(x) \geq \eta Q$ hardly binds, so we ignore it. The problem is different in the case of the variable y . In this case, we have a problem of missing data, and it is not missing at random. One option would be to perform a censored Maximum Likelihood

Estimation. The problem is that, since most firms are non exporters in the sample, there are too many missing observations, and therefore the estimates are not likely going to be good. Thus, we do not estimate the distribution of y . Instead, we calibrate the relevant parameters μ_y and σ_y so that we match the ratio of total exports to total sales in the economy, and the proportion of firms that export.