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# Capacity Constrained Exporters: Micro Evidence and Macro Implications

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**Abstract**

This study challenges a central assumption of standard trade models: constant marginal cost technology. We present evidence consistent with the view that increasing marginal cost is present in the data, and further identify financial and physical capacity constraints as the main sources of increasing marginal cost. To understand and quantify the importance of increasing marginal cost faced by financially and physically constrained exporters, we develop a novel structural estimation framework that incorporates these micro frictions. Our structural estimates suggest that the presence of such capacity constrained firms can (1) reduce aggregate output responses to external demand shocks by 30% and (2) result in welfare loss by around 23%.

## 1 Introduction

Standard intermediate microeconomics courses teach that short-run marginal cost is increasing with output due to fixed factors in production. In practice, most theory models in international trade assume that firms face constant marginal cost. To the extent that the model is used to study relatively short-run consequences, these models may be ignoring important features. However, unless there exists strong evidence to suggest that the assumption is anything other than innocuous, there is little reason to give up the constant marginal cost assumption, not least because its simplifying nature greatly enhances modeling tractability.

This paper questions the validity of this simplifying assumption. First, we demonstrate robust evidence for the presence of increasing marginal cost and identify its main sources. We show

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that financial as well as physical capacity constraints give rise to increasing marginal cost. Next, we build a structural model populated by both constrained and unconstrained firms to quantify aggregate implications. We find that the presence of constrained firms can significantly reduce aggregate output responses to external demand shocks, and raise aggregate price level substantially.

Our study begins from the notion that firms with increasing marginal cost face a trade-off between domestic and export sales — when a firm increases export sales in response to a positive external demand shock, it will incur an increase in marginal cost, which in turn makes it optimal for the firm to reduce domestic sales. Firms with constant marginal cost, on the other hand, would have no incentive to reduce domestic sales in response to a positive export demand shock since increasing production to meet increased demand abroad has no effect on the level of marginal cost. Domestic sales of firms with constant marginal cost are therefore independent of their export sales.

Exploring first Indonesian plant-level data, our reduced form approach delivers robust findings that exporting firms in general face strong trade-offs between domestic and export sales. To identify the sources of such trade-offs, we investigate if the degree of export-domestic sales trade-offs varies systematically with characteristics of the firm. The underlying idea is that if the observed patterns are being driven by increasing marginal cost, we should expect to observe stronger patterns in the data for capacity constrained firms, as these firms face the steepest cost of increasing production.

We confirm the idea by showing that such systematic patterns exist in the data, measured either by export status or export sales. We use a capacity utilization variable as a proxy for physical capacity constraints, and follow the corporate finance literature in classifying financially distressed firms. The coefficient estimates suggest that (physically and financially) unconstrained firms exhibit no correlation between export and domestic sales growth, whereas being physically or financially constrained adds about a .2 percentage point reduction in domestic sales growth for each one-percentage point growth in export sales.

While the results in Indonesia are provocative, the ability to generalize is less clear. To that end, we employ a second plant-level dataset, this time from Chile. We find nearly identical qualitative patterns for Chilean firms as well. Differences in estimated magnitudes between the two countries are then explored, and we find the differences can be mostly explained by a large number of intensive exporters in Indonesia that switch in and out of the export market. Chile and Indonesia represent two very distinct market environments, suggesting that the documented behavior is more generally applicable in developing market contexts.

Having demonstrated the robustness of this trade-off pattern in the data, we turn next to quantifying aggregate implications. We develop a structural estimation process, and perform counterfactual exercises. Our contributions in the structural approach are two-fold. First, we build off the static portion of the seminal structural trade model of Aw et al. (2011). In particular, we consider capacity constrained firms explicitly, and thus relax the independent markets assumption for these firms. The novelty in the estimation process lies in exploiting the exporter's optimality condition that the marginal revenue in each market is equalized. As part of the process, we are able to recover firm-level demand curves, which in turn enable us to back out firm-level price and quantity sold in each market.

The subsequent counterfactual exercises constitute the second major contribution of the paper, providing quantitative implications of capacity constrained firms. Intuitively, increasing marginal cost would reduce firms output responses to external demand shocks via offsetting movements in domestic sales. In addition, capacity constraints lead firms to charge a higher price than would otherwise be optimal. Our structural estimates suggest that the presence of such capacity constrained firms can (1) reduce aggregate output responses to external demand shocks by around 30%, and (2) raise the aggregate price level by around 23%. These counterfactual results suggest that capacity constrained firms generate important policy implications.[1]

**Related Literature** The point of departure for this paper comes from the standard models of international trade that have followed from the seminal works of Krugman (1979), Krugman (1980), and Melitz (2003). The key feature of those models for the present purposes is the assumption of constant marginal cost, which allows domestic and foreign markets to be treated as independent markets in the analysis. This property was made explicit in the recent structural approaches to international trade, simplifying the estimation process substantially (Das et al. (2007); Aw et al. (2011)).

We demonstrate that the assumption of constant marginal cost, and hence final goods market independence, is not supported in the data, and that the assumption is not innocuous. We augment the static decision problem of Aw et al. (2011) to consider capacity constrained firms, thereby allowing inter-market dependence for these firms.

There is an emerging literature that explores the relationship between domestic and export sales as evidence for the presence of increasing marginal cost. Blum et al. (2011) find a negative correlation between domestic and export sales growth from Chilean firm-level data, which they attribute to physical capacity constraints. Soderbery (2011) finds a similar pattern when looking at firm-level data from Thailand, and uses a similar measure of capacity utilization as here to document the existence of physically constrained firms, but unlike our paper, does not consider financial dimensions, which are more likely to be beyond the control of individual firms.

Berman et al. (2011) also find a similar pattern from French firm-level data, but find that the pattern is reversed when they instrument for export sales growth using information on destination markets. They conjecture that capacity constraints might make foreign and domestic market sales substitutes, while unconstrained firms might see foreign and domestic sales as complements. Our results demonstrate that capacity constraints, both physical and financial, do indeed create trade-offs between foreign and domestic sales. Furthermore, once both capacity constraints and productivity growth are properly accounted for in the analysis, we show there is no clear relationship between domestic and foreign sales.

Related papers focus on firm-level output volatility, which we document and quantify structurally. Based on a similar observation from French firms covered in the Amadeus database, Vannoorenberghe (2012) further explores firm-level output volatility, and concludes that the constant marginal cost assumption may be inappropriate. Nguyen and Schaur (2011) also study the effects of increasing marginal cost on firm-level volatility using Danish firm-level data. Our paper differs from these papers in that we explore sources of increasing marginal cost, and develop a structural estimation model to quantify aggregate implications.

[1]There is an important distinction between capacity constraints that are a direct consequence of (optimal) firm investment decisions, and capacity constraints that are due to factors beyond the direct control of the firm. In the presence of demand uncertainty, firms optimally choose their ex ante capacity level, which ex post may be binding after the realization of demand shocks. There is little for policy to do in this regard since capacity level is chosen optimally given available information. However, financial constraints, which are beyond the control of the firm, would limit the ability of firms to choose the optimal level of physical capacity, leaving more scope for policy interventions. Our findings on the importance of financial constraints in addition to physical capacity constraints are especially noteworthy from this perspective.

Our reduced form approach resembles the strategy used in Fazzari et al. (1988). They start from the theoretical notion that, in the presence of imperfect financial markets, credit constrained firms' investment will be sensitive to their cash flow. Higher cash-flow sensitivity of investment for credit constrained firms in the data serves as supporting evidence for imperfect financial markets. In a similar vein, we draw out the implication of constant marginal cost for export and domestic sales, and find an interrelationship as evidence for increasing marginal cost.

Our finding can serve as direct micro-evidence that justifies the modeling strategy in several recent papers that consider decreasing returns to scale production or borrowing constraints to explain salient features of new exporter dynamics (Ruhl and Willis (2008); Kohn et al. (2012); Rho and Rodrigue (2012)) or patterns of foreign acquisitions (Spearot (2012)).[2]

This paper is also close to the literature that studies credit constraints and international trade. Previous studies focus on export fixed costs financing, and thus extensive margin effects of credit constraints (Chaney (2005); Manova (2011)). Indeed, there is abundant evidence that credit constrained firms are less likely to become exporters (Muûls (2008), among others). Our paper complements this literature by exploring the intensive margin, and showing that credit constraints affect incumbent exporters as well through the marginal cost channel. This is also consistent with the trade finance literature that studies intensive margin adjustments during the great trade collapse (e.g., Ahn (2011); Paravisini et al. (2011)).

One of aggregate implications of capacity constrained firms discussed in this paper offers an alternative explanation for the short-run trade elasticity puzzle. Ruhl (2008) considers an extensive margin adjustment in response to temporary and permanent shocks to explain low short-run trade elasticity and high long-run trade elasticity. Arkolakis et al. (2011) introduces switching frictions on the customers' side to generate staggered short-run trade dynamics. Our finding suggests that exports cannot fully respond to external demand shocks due to inherent capacity constraints at the firm-level.

The second aggregate implication of capacity constraints relates to the finance and misallocation literature (e.g., Buera and Shin (2010); Buera et al. (2011); Midrigan and Xu (2010); Buera and Moll (2012)). Compared to the literature that studies TFP losses from misallocation induced by financial frictions in a dynamic model, we investigate static welfare losses from financial constraints via higher aggregate price levels.

In sum, our paper is the first to identify multiple sources of increasing marginal cost, both physical and financial, and show that these sources are quite general in developing economies. These new insights on micro frictions are then incorporated into a structural estimation framework, which is then used to quantify aggregate implications.

The remainder of the paper proceeds as follows: Section 2 provides an illustrative theoretical discussion, and Section 3 describes the firm-level datasets used in this paper. Section 4 reports empirical findings from the reduced form approach for Indonesia before considering evidence from Chile. Section 5 develops a structural estimation process, and provides quantifying examples to gauge the macroeconomic implications. Section 6 concludes the paper.

[2]The structural estimation process in Rho and Rodrigue (2012), in particular, is closely related to our paper. Unlike their approach that imposes and estimates increasing marginal cost across all firms, we separate out constrained and unconstrained firms based on our reduced-form evidence.

# 2 Illustrative Theory

This section aims to provide a simple theoretical framework to contrast different predictions on the relationship between domestic and export sales movements, depending on the underlying characteristics of the marginal cost curve. A particular emphasis should be made on the fact that such predictions neither hinge on any specific model structure, nor require sophisticated theory models. For each type of marginal cost curve considered below, we begin by finding optimal sales quantity in each market, and then track the subsequent optimal sales decision in response to positive external demand shocks. It is important to note that since the area under each marginal revenue curve corresponds to sales revenues in each market, sales revenues are expected to move in the same way as quantities sold in each market in what follows.[3]

**Constant marginal cost** When a firm's marginal cost is constant, independent of the total amount of goods produced, the optimal output for each individual (segmented) market is independent of all other markets. In other words, when demand conditions in one market change, the firm would adjust sales in that particular market, leaving sales in all other markets unchanged.[4] This is illustrated in Figure 1.

Initially, the firm's optimal operating point in each market is determined by the usual optimality condition that marginal revenue in each market equals marginal cost (i.e., $MR_D = MR_F = MC^*$). For given domestic and export demand curves, this condition gives the optimal output for the domestic market, $Q_D^*$, and the optimal export volume, $Q_F^*$, with total output being given by $Q^* = Q_D^* + Q_F^*$. Now, suppose the firm experiences a positive foreign demand shock, which shifts up both the export demand curve and the marginal revenue curve in the export market. In response, the optimal export volume increases from $Q_F^*$ to $Q_F^{**}$ at which point the optimality condition in the export market is satisfied with the new marginal revenue curve (i.e., $MR'_F(Q_F^{**}) = MC^*$). Since the marginal cost and the domestic marginal revenue curves are unchanged, the optimal output for the domestic market is unchanged at $Q_d^*$. In sum, constant marginal cost technology predicts that, other things equal, exports respond to export demand shocks, but domestic sales are unaffected at the firm-level.

**Increasing marginal cost** When a firm's marginal cost increases with the total amount of goods produced, optimal outputs for each segmented market are no longer independent of each other. When demand conditions in one market change, the firm would adjust the sales in that market. This, in turn, alters the marginal cost, which would affect the optimal production decision in the other market. The situation with increasing marginal cost is illustrated in Figure 2.

At the initial equilibrium with $Q_D^*$, $Q_F^*$ and $Q^* = Q_D^* + Q_F^*$, the firm satisfies the optimality condition by equating marginal revenue from each market with marginal cost (i.e., $MR_D(Q_D^*) = MR_F(Q_F^*) = MC(Q^*)$). Now, suppose again that there occurs a positive export demand shock, which shifts up the marginal revenue curve in the export market. The firm responds to positive

[3]More precisely, this will be valid as long as the price elasticity of demand is greater than 1. This will be relevant for our empirical exercises below since our plant-level datasets contain information on sales revenue rather than quantity sold.

[4]This property is implicit in all trade models with constant marginal cost including Krugman (1979), Krugman (1980), and Melitz (2003), and explicitly assumed in structural applications such as Das et al. (2007) and Aw et al. (2011)).

export demand shocks by raising export sales because of higher marginal revenue relative to the current marginal cost level in the export market. However, as the firm produces more to meet the increased export sales, it incurs an increase in marginal cost due to the nature of increasing marginal cost. This means that, for unchanged domestic market conditions, the firm would incur losses by keeping domestic sales at $Q_D^*$, since marginal cost exceeds marginal revenue at this point in domestic market. The firm's optimal response is then to decrease domestic sales to recover the optimality condition in the domestic market. As a result, in the new equilibrium, the firm has higher export sales, lower domestic sales, and higher marginal cost than before (i.e., $Q_F^{**} > Q_F^*, Q_D^{**} < Q_D^*$, and $Q^{**} > Q^*$). Therefore, increasing marginal cost technology predicts that firm-level export and domestic sales would respond to export demand shocks in opposing ways.

**Infinite marginal cost (Capacity constraints)** In Figure 3, we propose a special case of increasing marginal cost technology, namely, infinite marginal cost. This can be understood as a combination of the two earlier cases in that a firm operates normally with constant marginal cost technology, but faces capacity constraints at a certain level of production beyond which production becomes infeasible. We present this special case here because our empirical section below suggests this most closely reflects patterns observed in the data.

Marginal cost is constant up to the output level $Q^*$, and it jumps to an infinite level beyond this point, implying that the firm's production capacity is such that the firm's maximum feasible output level is $Q^*$. Depending on market conditions, such a capacity constraint may or may not be binding. A firm without any capacity constraint would find it optimal to produce $Q'_D$ and $Q'_F$ in the domestic and the export markets, respectively, as shown in the constant marginal cost case earlier. However, if the sum of these output levels exceeds the maximum capacity (e.g., $Q'_D + Q'_F > Q^*$), the capacity constraint is binding, and the firm cannot attain the first-best outcome.

Instead, the firm needs to find sub-optimal points, $Q_D^*$ and $Q_F^*$, which satisfy (i) $MR_D(Q_D^*) = MR_F(Q_F^*) > MC^*$ and (ii) $Q^* = Q_D^* + Q_F^*$. We focus on this latter case with the binding capacity constraint since the non-binding case is equivalent to the earlier constant marginal cost case. Now, suppose that there occurs a positive export demand shock as before. As the firm decides to export more in response to positive demand shocks abroad, the capacity constraint forces the firm to face a trade-off between export and domestic sales, to keep total output at the maximum feasible level, $Q^*$. Furthermore, the new equilibrium needs to satisfy the sub-optimality condition at which marginal revenue from each market is equalized but exceeds the level of marginal cost (i.e., $MR_D(Q_D^{**}) = MR_F(Q_F^{**}) > MC^*$). Consequently, the new equilibrium features an increase in export sales and a decrease in domestic sales with total output unchanged (i.e., $Q_F^{**} > Q_F^*, Q_D^{**} < Q_D^*$, and $Q_D^{**} + Q_F^{**} = Q^*$). As was true with the more general case above, we conclude that the presence of capacity constraints, unlike constant marginal cost, leads to a negative correlation between export and domestic sales at the firm-level in response to market-specific demand shocks.

**Sources of export-domestic sales trade-offs** The most common rationale for increasing marginal cost is the presence of fixed factors in production. For example, when a firm cannot freely change the capital stock in the short run, the usual Cobb-Douglas production technology leads to an increasing marginal cost (e.g., as modeled in Blum et al. (2011)). Even when factors are flexible to adjust, still it is often increasingly costly as exemplified by overtime pay for labor.

More generally, we can think of various types of capacity constraints, which may be either physical or financial in nature. Any incumbent production line or plant itself has maximum capacity it can produce, and since it takes time to expand the production facility, it is natural to expect a firm to face a physical capacity constraint. In addition, financial institutions often set a line of credit to each borrower, beyond which a borrower has to pay a prohibitive premium. Existing collateral value or credit history may also act as a natural borrowing limit for each firm, which will in turn limit the maximum feasible production level.[5]

An alternative source of capacity constraints comes from managerial ability constraints, often referred to as a span of control problem *a la* Lucas (1978). Simply put, an entrepreneur's managerial skill exhibits decreasing returns to scale of the whole operation such that as the entrepreneur devotes her time and efforts in expanding export markets, the firm would start losing its domestic market share because she cannot spend as much time and effort on the domestic operation as before, and vice versa.

So far, we have proceeded as if the patterns of correlation between domestic and export sales growth are sufficient to verify the characteristics of marginal cost technology. The reality is more complicated because, unlike our simple comparative statics analysis, domestic demand shocks may arrive simultaneously with export demand shocks. To the extent that domestic demand shocks are negatively correlated with export demand shocks, negative trade-offs between export and domestic sales may arise even with constant marginal cost curve. In other words, if foreign and domestic demand shocks are negatively correlated, it would bias the data towards our interpretation incorrectly. Although literature on business cycle co-movement suggests this is unlikely, it is also not entirely implausible.[6] On the other hand, if they are positively correlated, it would bias the results against finding negative trade-offs. In the empirical section below, we will present systemic evidence that our findings are not simply driven by such negatively correlated demand shocks.

Although our theory holds most tightly when a firm produces and sells an identical product for two segmented markets (i.e., domestic and export markets), it is valid in more general cases as well. For example, multi-products firms even with a dedicated export market product line[7] will face such trade-offs by reallocating resources when they face capacity constraints. However, export-domestic sales trade-offs may occur in multi-products firms not necessarily due to increasing marginal cost but rather as a result of extensive margin adjustments (Bernard et al. (2010)).

Exchange rate movements would work against finding evidence for export-domestic sales trade-offs. In the case of producer currency pricing, effective marginal costs for exporting should be multiplied by the exchange rate. Then, currency depreciation will lower effective marginal costs for exporting, leading to increases in exporting. At the same time, it will make imported goods relatively expensive to domestic goods, shifting up the domestic demand curve and hence generating higher domestic sales. In the case of local currency pricing, export sales may change in domestic currency unit via valuation effect, but since domestic sales will not respond to exchange rate movements, this would tend to generate no relationship between domestic and export sales.

Lastly, it is important to note that firm productivity evolves over time. In fact, productivity growth, negative or positive, would affect export and domestic sales in the same direction. Even with increasing marginal cost, if a firm's productivity improves, the marginal cost curve would

[5]It is worth noting that increasing fixed costs of reaching new (foreign) customers as in Arkolakis (2010) will generate export-domestic sales trade-offs only when firms face financial constraints.

[6]Bilateral or multilateral trade liberalization may also generate such patterns, affecting domestic and export sales in opposing ways, which is why we take care to control for industry-year shocks in our empirical specifications below.

[7]A good example is the VW plant in Mexico (Verhoogen (2008)).

shift right in Figure 2, and the relevant marginal cost level goes down in Figure 2, possibly leading to increases in both domestic and export sales in response to positive export demand shocks. This force would work against finding evidence for export-domestic sales trade-offs.[8]

**Aggregate implication** The presence of increasing marginal cost is a firm-level micro phenomenon, and it will have direct impacts on the firm-level export-domestic sales relationship. Once aggregated, however, it also has an important macroeconomic implication. Since external demand shocks induce adverse movements in domestic sales for exporters with increasing marginal cost, aggregate output responses to external demand shocks will depend critically on the share of firms with increasing marginal cost, as well as the degree of these costs, in the economy. For example, total output in the economy populated primarily by constant marginal cost exporters becomes very sensitive to external demand shocks, whereas an economy with mostly increasing marginal cost exporters reduces output volatility in response to external demand shocks due to offsetting movements in domestic sales.

Furthermore, when increasing marginal cost takes the particular form of capacity constraints, as described in Figure 3, a direct consequence is that the price charged by such constrained firms is higher than the optimal price that would have been charged in the absence of any constraints. The wedge between actual and optimal prices can then be used to measure welfare losses caused by capacity constraints. Our structural section will quantify both of these implications.

# 3 Data

The primary data is drawn from a well-used plant-level dataset collected by the Indonesia Central Bureau of Statistics (BPS).[9] The survey includes all medium and large manufacturing plants with more than 20 employees starting from 1975. However, information on exporting was not included in the questionnaire until 1990. We choose to start our analysis in 1990 for this reason, leaving us with a seven-year panel.[10]

The Indonesian dataset is quite rich, with information on sector of main product, type of ownership, output, exports, assets, disaggregated inputs (including energy, raw materials, and labor), and a variety of other measures that give a complete portrait of firm boundaries, production and sales decisions.[11] For our structural estimation, we will focus on the largest exporting industry,

[8] When using measures of productivity in the analysis, caution is required. Failing to include productivity will result in a typical omitted variables problem, and in this context, bias upwards our estimates on export sales. However, there is some concern about the reliability of the productivity measure since it is constructed based on total revenues, which is used to construct our dependent variable (domestic sales). We take a conservative approach to this problem by omitting productivity growth in most specifications, knowing that this is likely to work against finding evidence of increasing marginal cost. In robustness checks, including productivity strengthens our findings as expected.

[9] Other studies that employed the same dataset include Blalock and Gertler (2004), Blalock and Gertler (2008), Rodrigue (2012), Mobarak and Purbasari (2006), Amiti and Konings (2007), and Sethupathy (2008) among others.

[10] Concerns over the reliability of survey reporting during the East Asian financial crisis limits the usable data to the period between 1990 and 1996.

[11] Specifically, the Indonesian dataset records export sales as the percentage of total output. Instead of taking the remaining output, (total output-export), as domestic sales, we consider inventory adjustments by subtracting changes in inventory holdings from the remainder, (total output-export).

manufacturing of wood, and wood and cork products (ISIC 331).[12]

The Annual Manufacturing Survey (SI) is designed to record all registered manufacturing plants. The BPS submits a questionnaire each year, and when the questionnaires are not returned, field agents visit the plant to ensure compliance or verify the plant is no longer in operation. The survey is conducted at the plant-level. An additional survey is sent to the head office of each multi-plant firm. Our data does not allow us to distinguish between single and multi-plant firms. The BPS suggests that about 5% of plants are part of a multi-plant firm. For the rest of the paper, we will use plant and firm interchangeably. Government laws require that the data collected will only be used for statistical purposes and will not be disclosed to tax authorities (for further details, see Blalock and Gertler (2004)). This suggests the financial data is reasonably well reported. Using an industry-level wholesale price index published by the BPS, we deflate our measures of sales, materials, and capital used in the analysis, which effectively removes industry-level inflationary trends. Admittedly, this will not be able to remove firm-level prices, and thus we do not interpret deflated sales as quantities sold.[13]

The Indonesian dataset is particularly useful for our purposes because it contains information on both physical and financial capacity constraints, allowing us to disentangle these two possible sources of increasing marginal cost. The questionnaire asks specifically about capacity utilization, which forms the basis of our measure of physical capacity constraints. Our primary measure of physical capacity constraints is 100% capacity utilization, which maps most closely to the infinite marginal cost case in our theoretical model. Alternative cut-off values of capacity constrained firms are used for robustness checks.

We also construct a measure of financial constraints based on financial information of the firm. Specifically, our measure of financial distress uses the ratio of a firm's cash flow to assets, where financially constrained firms are defined as the bottom 50% of firms ranked by this measure. This measure of financial distress is one of the most widely-used proxies for financial constraints in the corporate finance literature (Kaplan and Zingales (1997); Whited and Wu (2006); Lin et al. (2011)).

We start our analysis by considering the entire sample of firms over the seven-year panel. This dataset includes a little under 125,000 observations, including 32,388 unique plants. Our primary analysis will focus on firm-level yearly growth in domestic sales and multiple measures of export status, which restricts our sample to just over 81,000 observations of firms that appear in the dataset in consecutive years (22,326 unique plants). For reasons that we discuss below, we will be particularly interested in a panel of continuing exports. When we restrict our sample to just continuing exporters, we are left with 3,248 plants that are observed to export in consecutive years,

[12]This industry can be considered highly differentiated according to Broda and Weinstein (2006) with demand elasticity around 2 (SITC Rev3. code 244-248).

[13]This gives rise to potential biases in productivity estimates. As De Loecker (2011) pointed out, however, productivity growth measures will not be biased under reasonable conditions. This is one reason why we use a growth regression analysis below, instead of a level regression, and include measures of productivity growth in a series of robustness checks. The other reason is due to the fact that our export sales information comes from the "percentage of total outputs" that is exported. To the extent that the information is subject to reporting errors, it is possible that such reporting errors generate a systemic negative correlation between domestic and export sales. If we believe reporting errors are persistent over time at the firm-level, growth measures will not be affected by such reporting errors (see Vannoorenberghe (2012), for example). However unlikely it may be that systematic reporting errors drive our Indonesian results, when we employ Chilean data, where sales in domestic and foreign markets are directly observable, we eliminate this concern altogether.

giving us 8,627 observations.

Table 1 provides a brief description of the sample, broken down by export classification. The patterns are consistent with previous studies in that exporters are bigger (in terms of production and sales) than non-exporters, and that continuing exporters are even bigger than occasional exporters.

Focusing just on firms that are physically constrained (Table 2), we see that exporters are more likely to be physically constrained than non-exporters. About ten percent of all exporters are classified as physically constrained. This is true for the subset of continuing exporters as well as starting firms. Stoppers and non-exporters show lower occurrences of physical capacity constraints. Physically constrained exporters tend to have higher export sales and lower domestic sales than their unconstrained counterparts. This raises the question that there may be a relationship between physical capacity constraints and sales decisions across markets, which we will explore in detail in the reduced form approach.

As described above, our measure of financially constrained firms is based on a financial distress measure of cash flow to assets ratio. By construction, firms below the median in terms of this ratio are considered constrained. From Table 3, one can see that exporting firms that are classified as financially constrained tend to sell less in both domestic and foreign markets relative to unconstrained exporters. Similar patterns hold for starters and continuing exporters who are financially constrained.

Although the Indonesian dataset is quite rich in terms of firm characteristics, there is a concern that because of the way that exports are reported in the survey, reporting errors might lead us to make spurious conclusions about the relationship between export sales and domestic sales. Furthermore, since our underlying economic mechanism of capacity constraints should be quite general, we should find firm-level evidence in any country where physical and financial constraints are likely to be significant. While we think this will be true of most countries, it is likely to be a particular problem for developing countries that often have limited or informal financial markets. To that end, we attempt to confirm our results using data from Chile.

Our complementary analysis uses a panel dataset of Chilean firms from 1995-2006. This data includes all manufacturing firms with 10 or more employees. The dataset has been used in a number of studies, and a thorough description of the data can be found in Blum et al. (2011).[14] For our purposes, the definitions of variables are essentially the same as with the Indonesian data, except for two variables of interest.

First, export sales is an actual reported value in the survey, unlike the Indonesian reported measure of percentage of total sales exported. Reporting errors in percent of total sales exported could lead to a spurious conclusion that export sales and domestic sales are negatively correlated even when they are not (see footnote 11 above). By using Chilean data, which reports export and domestic sales separately, we can address this concern. We deflate all measures of sales, materials, and capital used in the analysis with an industry-level price index.[15]

While the Chilean data provides an improvement in the data in terms of independent measurement of export and domestic sales, the survey does not include a direct measure of capacity utilization. This drawback leads us to prefer the Indonesian data for our primary analysis. The

[14]In addition to Blum et al., this dataset has been used widely in empirical studies of firm behavior, starting with Liu (1993) and Pavcnik (2002), with more recent contributions by Kohn et al. (2012) and Kasahara and Lapham (2012), among others.

[15]The industry-level price index was provided by Ana Margarida Fernandes, and has been used previously in Almeida and Fernandes (2013).

Chilean data, while limited, does increase our confidence in the robustness of our results if the general patterns found in each country are the same. When we consider physical capacity constraints in Chile, we classify firms as physically constrained using an alternative proxy measure. Firms that report an increase in machinery and equipment capital are classified as unconstrained, while all other firms are classified as constrained. The idea is that those firms that have expanded physical capacity, which is proxied by machinery and equipment capital, are less likely to face physical constraints, and the opposite will be true for other firms that have contracted physical capacity.

Table 4 provides summary statistics for our Chilean data. The patterns observed for Chilean firms are qualitatively similar to those in Indonesia, with exporters being bigger than non-exporters, and continuing exporters being even bigger than starters. Table 5 and Table 6 show summary statistics for physically constrained firms and financially constrained firms. The patterns are once again similar to those observed in Indonesia.

# 4 Reduced Form Evidence

In this section, we employ a reduced form approach to identify the presence of increasing marginal cost as well as its sources. Specifically, we explore the relationship between firm-level export and domestic sales growth. Our theoretical discussion in Section 2 suggests that we should observe no clear relationship between changes in export and domestic sales when firms have constant marginal cost technology, whereas the presence of increasing marginal cost technology would result in a negative correlation between them.

## 4.1 Plant-level Evidence from Indonesia

Focusing on evidence from Indonesia first, let's consider some simple descriptive statistics of the relationship between export sales and domestic sales. If the standard view of constant marginal cost technology is valid, there should not be any relationship between export sales and domestic sales in the data. We start by considering a sample of all Indonesian firms that are active in two consecutive periods. This gives us a sample with 81,119 observations.

In Table 7, firms are classified by export switching status.[16] From Column (1), we can see that relative to continuing exporters and non-exporters, starters have lower domestic sales growth rates, while stoppers have higher domestic sales growth rates. The difference is highly significant statistically, and economically intriguing since this is suggestive of an underlying trade-off between serving the export market and serving the domestic market, which is not predicted by the standard constant marginal cost assumption typical of most firm-level approaches.

The results presented in Table 7 are quite robust. When we include sector-year fixed effects (3-digit ISIC level), the estimated magnitudes are unaffected (column 2). Inclusion of sector-year fixed effects control for economic policies that might differ across sectors over time, for example changes in tariffs. Furthermore, accounting for firm fixed effects (column 3) has little impact on the estimated relationship between starting or stopping exporting and the domestic sales growth rate,

[16] We classify a firm-year observation as either a starter, stopper, or continuer. A firm that begins exporting in a given year is classified as a starter, while a firm that stops exporting in a given year is classified as a stopper. We classify all other firms, both continuing exporters and continuing non-exporters, as continuers.

supporting the view that this is indeed within-firm variation. In column 4, both sector-year and firm fixed effects are included with no noticeable differences. As with all specifications, standard errors are clustered at the sector-year level to account for correlated industry-year shocks.

To consider the robustness of this result, measures of productivity are included in Table 8. There is a concern that productivity growth within a firm may be driving correlations in the data between export sales and domestic sales, since firms that are becoming more productive are likely to be expanding in both markets simultaneously. Improvements in productivity within the firm would drive down the marginal cost curve, which in turn would increase the optimal output in both the domestic and foreign markets. All else equal, this would tend to create a positive correlation in the data between export status and domestic sales growth rate, although it should be noted that this is not observed in the data presented in Table 7.

Nonetheless, excluding productivity growth amounts to a typical omitted variables problem. It is important to make sure that unobserved variables are not driving the results, and firm-level productivity growth could be significant in terms of the estimated magnitudes. In columns (1)-(3) of Table 8, labor productivity growth is included in the analysis. As predicted, labor productivity growth shows up as significant with a positive impact on domestic sales growth. The coefficients on the starter and stopper indicators were biased upward marginally in the original specification.

Columns (5) and (6) of Table 8 include two alternative measures of productivity growth, a standard TFP growth measure and an additional measure of productivity growth based on the work of Levinsohn and Petrin (2003).[17] The inclusion of either measure tells the same story: even after accounting for productivity growth, there is strong evidence to support the view that export status is negatively correlated with domestic sales growth, suggesting that firms are facing trade-offs over sales to domestic and foreign markets. This implication is inconsistent with the standard theory that implicitly views markets as independent, typically through an explicit assumption of constant marginal cost technology.

One particular mechanism that can generate such trade-offs would be increasing marginal cost technology. To explore the role increasing marginal cost plays in this trade-off, we consider specific firm-level sources that could give rise to increasing marginal cost, namely physical and financial capacity constraints.

Our preferred strategy to verify specific sources of increasing marginal cost is to control for capacity constraints explicitly in addition to the analysis presented above. The idea is that if it is increasing marginal costs that are driving the observed negative correlation between export status and domestic sales growth, it is to be expected that this pattern will be stronger for firms that are capacity constrained since these firms are facing steeper costs associated with expanding production. The primary specification is:

$$\begin{aligned}\Delta ln(domestic\ sales)_{ist} &= \alpha + starter_{ist} + stopper_{ist} + \beta_1(capacity\ constraint)_{ist} + \\ &\quad \beta_2[(starter)_{ist} * (capacity\ constraint)_{ist}] + \gamma(controls_{ist}) + FE_{st} + \\ &\quad FE_i + \epsilon_{ist}\end{aligned}$$

[17] Specifically, TFP is estimated in two ways. First, regress log (value added) on log (capital) and log (labor) for each industry in year t, and estimate the industry-year level capital and labor share. Then, TFP is calculated as the firm-level residual, which can be interpreted as the deviation from industry-year mean. Second, we follow the methodology of Levinsohn and Petrin (2003) with raw material and labor as freely varying inputs, and electricity and fuels usage as well as capital as proxies for productivity.

for firm $i$ in industry $s$ in year $t$, where $FE$ stands for fixed effects. The capacity constraint is a dummy variable with 1 for constrained firms and 0 otherwise. Our main focus will be on the coefficient of the interaction term, $\beta_2$. $\beta_2 < 0$ implies that constrained firms show a stronger negative correlation between export status and domestic sales growth, supporting the increasing marginal cost story.

The analysis will be particularly interested in the interaction effects between starting exporting and different types of capacity constraints. The idea here is that firms that are beginning to export are facing critical decisions about allocating sales across markets, and this trade-off between sales will be particularly acute for firms that are facing physical and financial capacity constraints.[18] The analysis also includes indicator functions for intensive exporters, that is, firms that export over 50% of their total output in a given year. Indonesia is populated by a large number of intensive exporters, which we need to account for in the analysis.[19] Including an indicator for intensive exporters (as well as lagged intensive exports) pulls out a level effect of these specialized exporters and allows us to focus on the role of capacity constraints.

Turning to the results in Table 9, for reference column (1) reproduces the within-firm result from Table 7, controlling for sector-year fixed effects. Column (2) includes indicator functions for intensive exporters in both periods associated with the observation (since we are looking at log changes in domestic sales). We see that being an intensive exporter has a significant effect on domestic sales, and we can infer from the results that starting (stopping) as an intensive exporter reduces (increases) domestic sales growth significantly. Further, being an intensive exporter in both periods of the observation would have no effect on domestic sales growth, as the coefficients on lag and current intensive exporters are of similar magnitude but opposite sign. We should note that a standard model with constant marginal cost does not predict these pattern.

In column (3), we consider the role of physical capacity constraints and exporting. An indicator for physical capacity constraints takes on the value of 1 when capacity utilization is reported as 100% by the firm, and 0 otherwise.[20] The interaction term between starting exporting and being physically constrained is negative and statistically significant. This implies that physically constrained firms that start exporting have lower domestic sales growth than their unconstrained counterparts, which supports the view that physical capacity constraints are giving rise to increasing marginal cost.

In column (4), we consider the role of financial constraints separately. While being financially constrained has an overall negative effect on domestic sales growth, there is no clear effect of financial distress for starters. Column (5) includes both financial and physical constraints simultaneously, with similar estimated results. Column (6) includes labor productivity growth as an additional robustness check, but does not change the basic findings.

[18]The mechanisms for firms that are stopping exporting is less clear since the decision to stop exporting altogether may be correlated with physical and financial capacity constraints, making separate identification difficult. It is probable that some firms that stopped exporting should have been classified as constrained, but since they stopped exporting, they do not show up in the data as capacity constrained. This suggests that our measurement of constrained and unconstrained stoppers mixes actual firm types, thus confounding inference about the role of capacity constraints for stoppers. Firms that are starting exporting are the most clear test of the relevance of capacity constraints, and hence sources of increasing marginal cost.

[19]The importance of controlling for intensive exporters will become clear in the next section when we explore aggregate difference between Indonesian and Chilean firms.

[20]Soderbery (2011) also employs a similar capacity utilization variable from Thai data as a proxy for physical capacity constraints.

Overall, Table 9 provides some evidence that the existence of capacity constraints is giving rise to an economic trade-off between domestic and export sales. Physical constraints clearly matter for firms that are beginning to export, and the existence of such capacity constraints lowers domestic sales growth relative to unconstrained starters.

The results for financial capacity constraints appear to suggest that financial constraints are not a significant factor for firms that are starting to export. Another possibility might be that financial constraints do matter, but our measure of financial distress is not accurately measuring financial constraints. While we acknowledge these alternative stories, we suspect that the real story is that exporting requires substantial sunk costs, which can be onerous even for firms in good financial health. This would tend to generate no significant difference in domestic sales growth between starters classified as financially constrained and unconstrained.

The existence and importance of sunk costs of entry into foreign markets has been well documented and it is likely disguising the role of financial capacity constraints for firms that are starting to export. In order to separate out such effects of sunk costs, we focus on a subset of firms that have already paid the sunk cost of entry. This approach fits our primary interest in understanding the role that marginal cost plays in the decision to allocate sales between foreign and domestic markets.

To this end, to better evaluate the role of capacity constraints, we focus on a subset of firms that have already paid the sunk cost of entry. Our panel of continuing exporters includes all firms that are observed to export in consecutive periods. This allows us to sidestep issues of financing sunk costs, and focus on firms for whom the main challenge will be financing working capital rather than sunk costs of market entry.

Table 10 provides a first glance at the relationship between export sales growth and domestic sales growth. Since we are restricting our sample to a panel of continuing exporters, we are able to observe variation in domestic and export sales growth simultaneously, instead of just indicators for changes in export status.

The same basic patterns emerge, however. Column (1) shows no correlation between export sales and domestic sales, which could be interpreted as support for the constant marginal cost story. The inclusion of sector-year fixed effects in column (2) similarly finds no relation between domestic and export sales growth. Since increasing marginal cost is fundamentally a within-firm story, we should include firm fixed effects in the analysis, which is done in column (3). Export sales growth is now negative and strongly significant, and this effect is robust to the inclusion of sector-year fixed effects (column 4).

Our first result for continuing exporters is that there is a significant negative relationship between export sales growth and domestic sales growth for individual firms. This is inconsistent with the standard story of independent markets.

As was noted above, simple correlations in the data may not tell the whole story. In particular, omitted variables such as productivity might matter, though in the case of productivity growth, omission should bias upward the estimated coefficients of export sales growth. To account for this possibility, Table 11 includes multiple measures of productivity growth (measures based on labor productivity, simple TFP growth, and a measure based on Levisohn-Petrin). The inclusion of productivity does not alter the basic story that export sales and domestic sales are negatively correlated for a firm, though the omission of productivity was biasing upward the estimated coefficient on export sales growth by over 50%.

To truly uncover the role of capacity constraints, we consider the following preferred specification:

$$\begin{aligned}\Delta \ln(\text{domestic sales})_{ist} \quad = \quad & \alpha + \beta_1 \Delta \ln(\text{export})_{ist} + \beta_2(\text{capacity constraint})_{ist} \\ & + \beta_3 \Delta \ln(\text{export})_{ist} * (\text{capacity constraint})_{ist} \\ & + \beta_4 \Delta \ln(\text{productivity})_{ist} + FE_{st} + FE_i + \varepsilon_{ist}\end{aligned}$$

for firm $i$ in industry $s$ in year $t$, where $FE$ stands for fixed effects. The capacity constraint is a dummy variable with 1 for constrained firms and 0 otherwise. Our main focus is again on the coefficient of the interaction term, $\beta_3$. $\beta_3 < 0$ implies that constrained firms show a stronger negative correlation between export and domestic sales growth, supporting the increasing marginal cost story.

Results are reported in Table 12 . Column (1) restates the initial finding of a negative correlation between export sales and domestic sales growth within the firm for reference. Column (2) investigates the impact of physical capacity constraints. The interaction term between exporting and capacity constraints is negative and statistically significant. Export growth continues to be negative and statistically significant as well, suggesting that physical capacity constraints can explain part but not all of the negative relationship between export sales growth and domestic sales growth.

Column (3) considers financial constraints separately. For the panel on continuing exporters, the difference in results compared to the entire sample is illuminating. First, the interaction term between financial capacity constraints and export sales growth is negative and statistically significant, suggesting that financially distressed exporters have lower domestic sales growth than unconstrained exporters. This is different from the entire sample of firms, and we believe this difference is attributable to the challenge of financing large sunk costs.

A second intriguing difference is that export growth is no longer separately significant (and in fact the point estimate is positive). The interpretation is that the negative correlation we observed in the data is being driven by firms that are capacity constrained, especially those firms that are financially distressed.

Column (4) includes both physical and financial capacity constraints. Both interaction terms are negative and statistically significant. The point estimate on export growth is positive and insignificant. Taken together, the results presented in column (4) strongly suggest that for a subset of firms that are capacity constrained, either physical or financial, there is an economically significant negative relationship between export sales growth and domestic sales growth.

The size of the reported coefficients implies that a physically constrained exporter experiences a .27 decrease in domestic sales for every 1 percent increase in export sales compared to an unconstrained exporter. If the exporter is both physically and financially constrained, the decrease in domestic sales growth is -.49 (.27+.22) percent for every one percent increase in export sales growth. For unconstrained firms, there is no apparent relationship between export and domestic sales growth.

Columns (5) through (7) show the result is robust to the inclusion of productivity measures, although the estimated impact of financial distress on exporters is reduced somewhat.

Table 12 provides strong evidence that export sales and domestic sales growth are negatively related for individual firms, and this relationship is particularly pronounced for firms that are facing physical and financial constraints. In fact, once you account for capacity constraints, there is no noticeable relationship between export sales and domestic sales growth. We take this as evidence that capacity constrained firms are numerous and economically significant, and this calls into question the standard assumption of constant marginal cost. One of the implications of dropping this standard assumption is that markets are not independent, and shocks in foreign markets can impact firm behavior in the domestic market.

While Table 12 provides evidence about the nature of capacity constraints and the interrelation of foreign and domestic sales, we consider a number of robustness checks to confirm the findings.

To confirm the robustness of our measures of capacity constraints, we consider alternative definitions. First, we relax the physical capacity constraint by lowering the threshold associated with being categorized as physically constrained from 100%, to 70% of capacity utilization. This will tend to classify more firms that did not face physical capacity constraints as constrained, which would reduce the estimated impact of being constrained. On the other hand, since there are certainly some firms that were physically constrained even though they did not report a 100% capacity utilization, the overall effect on misclassification may not be too large.

In column (1) of Table 13, the alternative measure of physical capacity constraints shows a similar interaction effect as in Table 12, though slightly smaller as would be expected if more unconstrained firms were being reclassified as constrained. In column (2), the alternative measure of physical capacity constraints is included along with the original measure of financial distress. Once again, both interaction terms are significant, and the estimated impact for the interaction of export sales growth and physical constraints is smaller. Alternative measures of physical capacity constraints do not alter the underlying story.

As an alternative measure of financial distress, only firms in the bottom 10% in terms of ranking by cash flow to asset ratio are categorized as financially distressed. This effectively tightens up the measure of financial constraints, which means that more firms that are financially distressed are likely to be classified as unconstrained financially. Empirically, this should lower the estimated impact of the interaction effect since the unconstrained group now includes more constrained firms.

Column (3) of Table 13 looks at the alternative measure of financial capacity constraints in isolation and again finds a statistically significant and negative interaction effect. Column (4) includes the original measure of physical constraints along with the alternative measure of financial constraints. Both interaction effects are negative and statistically significant, suggesting that the results are not being driven by mismeasurement of firm-level capacity constraints.

Column (5) uses both alternative measures of capacity constraints. The interaction effects are negative and statistically significant. The only real difference is that the estimated impact of capacity constraints is about a third smaller, which is consistent with the idea that the alternative measures are now classifying groups with more within-group variation and less between-group variation. The last three columns of Table 13 include three different measures of productivity growth, which attest to the robustness of the underlying economic mechanism.

In sum, we have shown that there exists a negative relationship between domestic sales growth and export sales growth as well as export status from Indonesian plant-level data. Furthermore, our results show that such patterns are particularly acute for capacity constrained firms, be it either financially or physically. We take the results as strong evidence for the presence of increasing marginal cost, driven by financial and physical capacity constraints.

## 4.2 Plant-level Evidence From Chile

This section addresses two significant concerns. The first is that Indonesian firms may not be sufficiently similar to firms in other countries, and therefore our results may not be generalizable. In particular, we would like to have confidence in our results for firm-level responses in markets where physical and financial constraints are likely to be acute. While this is probably true even in developed markets, we think it is particularly relevant for firms in developing countries. To that end, we explore and confirm the basic results presented above using Chilean plant-level data.

A second important concern that relates to our use of the Indonesian data, above and beyond issues of generalizability, is that our key variables of interest (export and domestic sales) are constructed using a single question on the underlying survey. Firms are asked to report the percentage of total output exported, from which export and domestic sales are inferred. The concern here is that errors in reporting, including measurement error, will tend to show up mechanically as a negative relationship between export sales and domestic sales.

Although we have already provided extensive systemic evidence suggesting that the results are not simply driven by measurement error, it is nonetheless reassuring to confirm our findings using data free from such issues. Chilean data reports domestic sales and export sales separately. The evidence presented below therefore allows us to rule out measurement error definitively, and provides support that the mechanism we have identified - physical and financial capacity constraints at the firm-level - is more generally important in developing country contexts.

Focusing first on simple descriptive statistics of the data, Table 14 compares mean and median domestic sales growth by export status for both Indonesia and Chile. One should note that in both countries firms that start exporting experience slower domestic sales growth rates compared to the other three categories (stoppers, continuing exports and continuing non-exporters). Furthermore, mean and median domestic sales growth rates are actually negative for starters, compared to continuing non-exporters who experience positive domestic sales growth on average. This is consistent with the idea that starting exporters are constrained and are foregoing domestic sales in the pursuit of international sales.[21]

At the other end of the spectrum, firms classified as stoppers (i.e. those that switch from exporting to not exporting) experience the largest growth in domestic sales, higher than even continuing exporters, which typically perform the ”best” on standard measures of firm performance. This pattern is consistent with the pattern observed for Indonesian stoppers as well. For both countries, the ranking of firms by exports status and domestic sales growth is the same: stoppers, continuing exporters, continuing non-exporters, and finally starters.

While these are important similarities in the data, one glaring difference between Chilean and Indonesian firms is that the mean and median magnitudes are much greater for Indonesian starters and stoppers. Although it is possible that this observation might be due to reporting errors in Indonesian export sales, Table 15 shows that it is mostly driven by the composition of intensive switchers. We define ”intensive starters” to be firms that start exporting in a given year and are exporting more than 50% of their total output. Similarly, ”intensive stoppers” are defined to be firms that were exporting more than 50% of their output in the previous year, and have stopped exporting in the current year. We can see from Table 15 that a larger share of intensive switchers among Indonesian firms drives the stark differences observed in the aggregate.

[21] Kohn et al. (2012) and an earlier version of Blum et al. (2011) report similar patterns using Chilean data.

Table 15 makes two important points. First, the magnitudes found Indonesia are larger than in Chile, but not because of the nature of data reporting. Rather, Indonesia and Chile have similar magnitudes, once ”intensive switchers” are accounted for. Indonesia simply has disproportionately more intensive starters and intensive stoppers.

Second, classifying firms by the relative size of starting and stopping provides new evidence that firms are capacity constrained, since the standard unconstrained story would predict there should be no difference in behavior for these intensive starters and stoppers. For unconstrained firms, intensive movements in to or out of the export market would have no impact on domestic sales since output could adjust to offset foreign sales changes. This is further evidence that there are significant short-run capacity constraints, which manifests itself through domestic market fluctuations. [22]

The descriptive analysis above is suggestive that the negative correlation between domestic and export sales for financially and physically constrained firms in Indonesia is in fact a more general phenomenon. To consider this in more detail, we replicate the within-firm analysis for Chilean firms, starting with a complete panel of firms before focusing on a panel of continuing exporters. For comparative purposes, we add the corresponding column for Indonesia in the far right of each table.

Starting with a simple fixed effects regression, Table 16 shows that starter and stopper indicators are statistically significant and are the expected sign. Starters tend to be associated with declines in domestic sales growth, while stoppers see significant increases in domestic sales growth relative to non-switching firms. This effect is robust to the inclusion of firm fixed effects as well as sector-year fixed effects. In column (5), labor productivity is included to confirm the result is not being driven by omitting firm-level growth in productivity. This pattern is similar to that of Indonesia, though quantitative differences arose due to the composition of intensive switchers as discussed above.

Table 17 considers the role of capacity constraints explicitly. Column (1) shows the base relationship. In column (2), indicator functions for intensive (and lagged intensive) exporting are included. Including these indicators lowers the estimated magnitude significantly, but does not change the sign or statistical significance on either starter or stopper. Firms that start exporting see significant declines in domestic sales growth, while firms that stop exporting experience significant increases in domestic sales growth.

Moving on to measures of physical and financial capacity constraints, column (3) includes first an indicator for physically constrained as well as an interaction term for physically constrained and export status.[23] The interaction term for physical capacity constraints and starting exporting is negative and statistically significant, suggesting that the negative relationship between export status and domestic sales growth in the Chilean data is also attributable to those firms that are capacity constrained.

Column (4) looks at the independent effect of financial constraints, while column (5) includes both physical and financial constraints. It should be noted that for these specifications, the interac-

[22]Comparing firms in these two countries therefore contributes additional support for the view that firms face capacity constraints - support that comes from trying to reconcile observed differences across countries. Cross-country comparisons between firm behavior can produce interesting differences that invite greater scrutiny of the data in ways that studying firms of one country in isolation cannot. Such comparisons have not typically been included in firm-level studies, but should be included more regularly in future work.

[23]Due to limitations of the Chilean data, we construct an alternative proxy for physical capacity constraints than was used with the Indonesian data. For details, refer to the data section above.

tion effect is positive and statistically significant, which contradicts our previous results. Column (6) shows, however, that the result for financial constraints is not robust, once productivity growth is accounted for in the specification. The estimated impact on starter is essentially zero. The interaction on physical and starter is negative and statistically significant, and the estimated impact on the interaction of financial and starter is statistically insignificant. This suggests that omitting productivity growth from the regression was biasing up the estimate of the interaction of financial constraints and starting exporting.

Comparing the specification for Chile with that from Indonesia (reproduced in column (7)), we see similar patterns between the two countries. We believe the same interpretation of that result is appropriate here: sunk costs of exporting are large, even for firms that are not distressed financially, and the existence of these sunk costs may be biasing the results. To get around the issue of financing sunk costs, and more carefully consider our hypothesized role for firm-level capacity constraints, we again consider a panel of continuing exporters, for whom financial health concerns the ability to finance working capital, rather than pay sunk costs to exporting. The panel of continuing exporters have already paid these sunk costs, which should no longer influence their economic behavior regarding sales decisions in foreign and domestic markets. Narrowing the focus to a panel of continuing exporters better illuminates the role of capacity constraints and market interdependence.

As was done above with Indonesian firms, we first look at the relationship between export sales growth and domestic sales growth in the raw data. As can be seen in Table 18, for the sample of continuing exporters, there is a significant negative relationship between export sales growth and domestic sales growth. The magnitudes are similar in Chile and Indonesia, suggesting the concern over measurement of export sales is unwarranted.

Table 19 confirms that the negative correlation between foreign and domestic sales is systematically associated with firm-level capacity constraints. The relationship between export sales growth and domestic sales growth is weakened when physical capacity constraints are included, and the interaction term between export sales growth and physical capacity constraints is negative and statistically significant (column 2).

Similar patterns emerge for financially constrained firms, which once again show stronger patterns of market interdependence than unconstrained firms. Column (3) shows the effect of export sales growth is again reduced, once financial capacity constraints are accounted for explicitly. Of particular note is the negative and statistically significant interaction term between export sales and financial constraints. Firms which are capacity constrained because of financial constraints tend to experience slower export sales growth relative to those firms that are not financially constrained.

When both financial constraints and physical constraints are included, the observed negative relationship between domestic and foreign sales disappears (column 4). That is, interdependence of market sales is only observed among those firms that are capacity constrained, with the form of capacity constraints being either physical or financial (or both). This continues to be true, even after controlling for productivity growth (column 7).

The results presented in Table 19 are provocative. The effect identified earlier for Indonesian firms is confirmed in the Chilean data. While the magnitudes of the impact are larger in Indonesia than in Chile, for both sets of firms, the story is the same. Firms appear to face trade-offs between selling in foreign markets and selling domestically, and these trade-offs are particularly acute for those firms that face physical and financial capacity constraints.

In sum, we have shown that the underlying negative correlation between export sales growth (or export status) and domestic sales growth is robust to a variety of measures of productivity, and it is stronger for financially or physically constrained firms. This reduces concerns that the results are driven by a negative correlation between domestic and export demand, as it is hard to explain why the negative correlation between domestic and export demand is stronger for capacity constrained firms. Furthermore, our results show that unconstrained firms do not exhibit any such negative correlation. Most importantly, we have shown that identical patterns are observed in two different developing market contexts, Indonesia and Chile.

We take all these results as evidence for the presence of capacity constrained firms in the economy. It has yet to be shown that the existence of such capacity constrained exporters is economically important. We turn next to quantifying the effect of constrained firms in the aggregate.

# 5 Structural Form Approach

We develop a structural form analysis to quantify the aggregate implication of the presence of increasing marginal cost firms in the economy. In addition to providing quantitative implications, our contribution from this section includes a methodological one that identifies firm-level price and quantity sold in each market separately.

Specifically, our estimation framework builds heavily on the static part of the innovative structural trade model in Aw et al. (2011). Based on our findings from the reduced form approach, we modify their model by taking into account the presence of increasing marginal cost explicitly. We categorize firms into two groups: capacity constrained and unconstrained. Capacity constrained firms include those firms that used 100% of capacity or firms with a cash-flow/asset ratio below the median. All other firms are classified as unconstrained firms. Further, we assume that constrained firms face infinite marginal cost as described in Figure 3 in Section 2 at firm-specific capacity constraint level, $\overline{q}_{it}^{tot}$, which is assumed to be always binding. Consequently, we allow constrained exporters to face inter-dependent markets (i.e., export-domestic sales trade-offs). Then, we exploit optimality conditions for unconstrained exporters, and sub-optimality condition for constrained exporters, which enables us to identify firm-level demand curve in each market, and hence firm-level price and quantity in each market. Subsequent counterfactual exercises suggest that capacity constraints play a substantial role in dampening aggregate output sensitivity to demand shocks.

For the following estimation procedure, we pick one industry with ISIC code 331(Manufacture of wood and wood and cork products, except furniture), the largest exporting industry in Indonesia by volume.

## 5.1 Structural Framework

We assume that domestic and export markets are segmented, each of which is governed by a CES demand function. Specifically, domestic demand function faced by each firm $i$ at time $t$ is given as:

$$q_{it}^d = \Phi_t^d \left(p_{it}^d\right)^{-\sigma_d} \Longleftrightarrow p_{it}^d = \left(\Phi_t^d\right)^{\frac{1}{\sigma_d}} \left(q_{it}^d\right)^{-\frac{1}{\sigma_d}} \tag{1}$$

where $\sigma_d$ is the elasticity of substitution in the domestic market. The aggregate demand level in the domestic market at each time $t$, $\Phi_t^d$, determines the position of the demand curve common to every firm. For a set of firms without any capacity constraint (i.e., constant marginal cost), the optimal price is simply the markup over its marginal cost:

$$p_{it}^{j} = \frac{\sigma_j}{\sigma_j - 1} MC_{it} \tag{2}$$

for $j = D$ for domestic goods and $F$ for export goods. Therefore, the level of marginal cost becomes the sole factor determining firm-specific domestic sales along the common demand curve for this set of firms. Regarding the export demand curve, we allow idiosyncratic export demand shifters[24], $z_{it}^{ex}$, on top of the common aggregate export demand level, $\Phi_t^{ex}$, leading to firm specific export demand curve given as:

$$q_{it}^{ex} = \Phi_t^{ex} z_{it}^{ex} \left(p_{it}^{ex}\right)^{-\sigma_{ex}} \Longleftrightarrow p_{it}^{ex} = \left(\Phi_t^{ex} z_{it}^{ex}\right)^{\frac{1}{\sigma_{ex}}} \left(q_{it}^{ex}\right)^{-\frac{1}{\sigma_{ex}}} \tag{3}$$

and unconstrained firms achieve the optimal export sales with the optimal price given in equation (2).

Following Aw et al. (2011), we assume that marginal cost is independent of total output level (i.e., constant marginal cost), and is a function of the firm's own capital level, $k_{it}$, industry-wide factor prices, $w_t$, and its own unobservable productivity level, $\omega_{it}$:

$$\ln\left(MC_{it}\right) = \beta_0 + \beta_k \ln\left(k_{it}\right) + \beta_w \ln\left(w_t\right) - \omega_{it} \tag{4}$$

Since the optimal price is a markup over marginal cost for a set of unconstrained firms as shown in equation (2), total variable cost, which is simply the marginal cost times the total output, is expressed as:

$$TVC_{it} = q_{it}^{d} MC_{it} + q_{it}^{ex} MC_{it} = \frac{\sigma_d - 1}{\sigma_d} r_{it}^{d} + \frac{\sigma_{ex} - 1}{\sigma_{ex}} r_{it}^{ex} \tag{5}$$

for unconstrained firms, where $r_{it}^{d}$ and $r_{it}^{ex}$ are domestic sales revenue and export sales revenue, respectively.

Also, the optimal pricing rule in (2) allows us to express the domestic revenue of unconstrained firms as:

$$r_{it}^{d} = p_{it}^{d} q_{it}^{d} = \Phi_t^{d} \left(\frac{\sigma_d}{\sigma_d - 1} MC_{it}\right)^{1-\sigma_d} \tag{6}$$

and similarly for export sales of these firms as:

$$r_{it}^{ex} = p_{it}^{ex} q_{it}^{ex} = \Phi_t^{ex} z_{it}^{ex} \left(\frac{\sigma_{ex}}{\sigma_{ex} - 1} MC_{it}\right)^{1-\sigma_{ex}} \tag{7}$$

In fact, the optimal price in equation (2) is the outcome of the optimality condition that equates marginal cost with marginal revenue. This means that unconstrained firms satisfy the optimality condition in each market at the same time:

$$MR_{it}^{d} = MR_{it}^{ex} = MC_{it} \tag{8}$$

[24]Without this term, the model will predict a constant export-to-domestic sales ratio across firms, which is not supported in the data.

Unlike unconstrained firms, however, capacity constrained firms cannot produce more than a certain level of output, beyond which actual marginal cost becomes infinite. Under our assumption that the capacity constraint is always binding, constrained firms cannot achieve the optimality condition in (8), and instead operate at the sub-optimal point where the following condition holds:

$$MR_{it}^{d} = MR_{it}^{ex} > MC_{it} \tag{9}$$

Since equation (2) is not valid for constrained firms, equations (5), (6), and (7) will not hold for constrained firms. In what follows, we first derive estimation procedures for unconstrained firms, before turning to constrained firms.

## 5.2 Structural Estimation

**Unconstrained exporters** In order to take the theoretical framework from the previous section to the data, we begin by estimating the elasticity of substitution in each market using equation (5):

$$TVC_{it} = \left(\frac{\sigma_d - 1}{\sigma_d}\right) r_{it}^{d} + \left(\frac{\sigma_{ex} - 1}{\sigma_{ex}}\right) r_{it}^{ex} + e_{it} \tag{10}$$

Total variable cost on the left hand side of equation (10) comes from the data as the sum of intermediate input costs and total labor payment. Admittedly, parts of labor payment are associated with fixed overhead costs, and therefore, it is at best a proxy for total variable cost with measurement error $e_{it}$. Domestic sales and export sales revenue on the right hand side are taken directly from the data. Running a simple OLS regression gives coefficient estimates from which we can back out elasticities $\sigma_d$ and $\sigma_{ex}$.

Next, we turn to the optimality condition that marginal revenue in each market is equalized. Domestic sales revenue in equation (6) can be expressed alternatively as:

$$r_{it}^{d} = p_{it}^{d} q_{it}^{d} = \left(\Phi_t^{d}\right)^{\frac{1}{\sigma_d}} \left(q_{it}^{d}\right)^{\frac{\sigma_d - 1}{\sigma_d}} \tag{11}$$

by converting price as a function of quantity as expressed in demand equation (1). We can write export sales revenue in a similar way:

$$r_{it}^{ex} = p_{it}^{ex} q_{it}^{ex} = \left(\Phi_t^{ex} z_{it}^{ex}\right)^{\frac{1}{\sigma_{ex}}} \left(q_{it}^{ex}\right)^{\frac{\sigma_{ex} - 1}{\sigma_{ex}}} \tag{12}$$

and the optimality condition that equates marginal revenue across each market becomes:

$$\frac{MR_{it}^{d}}{MR_{it}^{ex}} = \frac{\left(\frac{\sigma_d - 1}{\sigma_d}\right) \left(q_{it}^{d}\right)^{\frac{-1}{\sigma_d}} \left(\Phi_t^{d}\right)^{\frac{1}{\sigma_d}}}{\left(\frac{\sigma_{ex} - 1}{\sigma_{ex}}\right) \left(q_{it}^{ex}\right)^{\frac{-1}{\sigma_{ex}}} \left(\Phi_t^{ex}\right)^{\frac{1}{\sigma_{ex}}} \left(z_{it}^{ex}\right)^{\frac{1}{\sigma_{ex}}}} = 1 \tag{13}$$

Then, we replace the quantity of domestic sales as a function of domestic sales revenue and aggregate demand from equation (11), and similarly for the quantity of export sales, to get:

$$\frac{MR_{it}^{d}}{MR_{it}^{ex}} = \frac{\left(\frac{\sigma_d - 1}{\sigma_d}\right) \left(r_{it}^{d}\right)^{\frac{-1}{\sigma_d - 1}} \left(\Phi_t^{d}\right)^{\frac{1}{\sigma_d - 1}}}{\left(\frac{\sigma_{ex} - 1}{\sigma_{ex}}\right) \left(r_{it}^{ex}\right)^{\frac{-1}{\sigma_{ex} - 1}} \left(\Phi_t^{ex}\right)^{\frac{1}{\sigma_{ex} - 1}} \left(z_{it}^{ex}\right)^{\frac{1}{\sigma_{ex} - 1}}} = 1 \tag{14}$$

As long as we have recovered firm-level export demand shifters $z_{it}^{ex}$, taking domestic sales and export sales from the data, and using the estimated elasticities, this is essentially solving the equation with unknown parameter $K_t$ for each year $t$, where

$$K_t = \frac{\left(\Phi_t^d\right)^{\frac{1}{\sigma_d - 1}}}{\left(\Phi_t^{ex}\right)^{\frac{1}{\sigma_{ex} - 1}}} \tag{15}$$

That is, the first part of the optimality condition (i.e., equalizing marginal revenue in each market) pins down a quasi-ratio between aggregate demand in the domestic and export market. In order to estimate firm-level export demand shifters $z_{it}^{ex}$, we now exploit the second part of the optimality condition (i.e., marginal revenue equals marginal cost) expressed in equation (6) and (7) with the specific marginal cost structure given in equation (4).

Substituting equation (4) for marginal cost in equation (6) and (7), domestic sales in equation (6) is rewritten in logs as:

$$\begin{aligned} \ln\left(r_{it}^d\right) &= (1-\sigma_d)\ln\left(\frac{\sigma_d}{\sigma_d - 1}\right) + \ln\left(\Phi_t^d\right) \\ &\quad + (1-\sigma_d)\left(\beta_0 + \beta_k \ln(k_{it}) + \beta_w \ln(w_t) - \omega_{it}\right) \end{aligned}$$

Rearranging constant and time specific terms,

$$\ln\left(r_{it}^d\right) = \gamma_0^d + \sum \gamma_t^d D_t + (1-\sigma_d)\left(\beta_k \ln(k_{it}) - \omega_{it}\right) \tag{16}$$

with time dummy $D_t$.

A key issue in estimating equation (16) is that firm productivity $\omega_{it}$ is not observable, and a simple regression will yield biased estimates, particularly when productivity levels are correlated with capital levels. In the spirit of Olley and Pakes (1996) and Levinsohn and Petrin (2003), and following Aw et al. (2011), we assume that the term composed of capital and productivity can be proxied by a cubic function of capital, material costs, and fuels usage:

$$(1-\sigma_d)\left(\beta_k \ln(k_{it}) - \omega_{it}\right) = h\left(k_{it}, m_{it}, n_{it}\right) + v_{it} \tag{17}$$

and consequently, we estimate the following equation:

$$\ln\left(r_{it}^d\right) = \gamma_0^d + \sum \gamma_t^d D_t + h\left(k_{it}, m_{it}, n_{it}\right) + v_{it} \tag{18}$$

with error term $v_{it}$ originating from the cubic function proxy procedure.

Likewise, export sales in equation (7) is rewritten in logs as:

$$\begin{aligned} \ln\left(r_{it}^{ex}\right) &= (1-\sigma_{ex})\ln\left(\frac{\sigma_{ex}}{\sigma_{ex} - 1}\right) + \ln\left(\Phi_t^{ex}\right) + \ln\left(z_{it}^{ex}\right) \\ &\quad + (1-\sigma_{ex})\left(\beta_0 + \beta_k \ln(k_{it}) + \beta_w \ln(w_t) - \omega_{it}\right) \end{aligned}$$

and rearranging terms gives:

$$\ln\left(r_{it}^{ex}\right) = \gamma_0^{ex} + \sum \gamma_t^{ex} D_t + (1-\sigma_{ex})\left(\beta_k \ln(k_{it}) - \omega_{it}\right) + \ln\left(z_{it}^{ex}\right) \tag{19}$$

Since equation (17) gives the following relationship:

$$(1-\sigma_{ex})\left(\beta_k \ln(k_{it}) - \omega_{it}\right) = \frac{(1-\sigma_{ex})}{(1-\sigma_d)}\left(h(k_{it}, m_{it}, n_{it}) + v_{it}\right) \tag{20}$$

plugging equation (20) into equation (19) yields the estimation equation for export sales:

$$\ln(r_{it}^{ex}) - \frac{(1-\sigma_{ex})}{(1-\sigma_d)}\left(h(k_{it}, m_{it}, n_{it}) + v_{it}\right) = \gamma_0^{ex} + \sum \gamma_t^{ex} D_t + \ln(z_{it}^{ex}) \tag{21}$$

that enables us to recover firm-specific export demand shifters as residuals from the above regression with intercepts and time dummies. Note that we have obtained the estimate of $(h(k_{it}, m_{it}, n_{it}) + v_{it})$ from the regression of equation (18) above.

Having recovered firm-specific export demand shifters $z_{it}^{ex}$, we are able to solve equation (14) and get the quasi-ratio in (15). Still, however, domestic and export market aggregate demand levels are not identified separately, and we need to take one last step of normalization. Our strategy is to back out each aggregate demand level separately, by setting the mean of log marginal costs to zero.

In practice, we plug price equation in (2) into equation (13) after using the fact that quantity is revenue divided by price (i.e., $q_{it}^j = r_{it}^j / p_{it}^j$):

$$\frac{MR_{it}^d}{MR_{it}^{ex}} = \frac{\left(\frac{\sigma_d - 1}{\sigma_d}\right)^{\frac{\sigma_d - 1}{\sigma_d}} \left(r_{it}^d\right)^{\frac{-1}{\sigma_d}} \left(\Phi_t^d\right)^{\frac{1}{\sigma_d}}}{\left(\frac{\sigma_{ex} - 1}{\sigma_{ex}}\right)^{\frac{\sigma_{ex} - 1}{\sigma_{ex}}} \left(r_{it}^{ex}\right)^{\frac{-1}{\sigma_{ex}}} \left(\Phi_t^{ex}\right)^{\frac{1}{\sigma_{ex}}} \left(z_{it}^{ex}\right)^{\frac{1}{\sigma_{ex}}}} (MC_{it})^{\left(\frac{1}{\sigma_d} - \frac{1}{\sigma_{ex}}\right)} = 1 \tag{22}$$

Taking logarithms of the above equation, and using the solution of the equation (14) provided in (15), we can get rid of domestic aggregate demand term, $\Phi_t^d$, and keep export aggregate demand, $\Phi_t^{ex}$, as the only unknown parameter:

$$\begin{aligned} &\ln\left[\left(\frac{\sigma_d - 1}{\sigma_d}\right)^{\frac{\sigma_d - 1}{\sigma_d}} \left(r_{it}^d\right)^{\frac{-1}{\sigma_d}}\right] - \ln\left[\left(\frac{\sigma_{ex} - 1}{\sigma_{ex}}\right)^{\frac{\sigma_{ex} - 1}{\sigma_{ex}}} (r_{it}^{ex})^{\frac{-1}{\sigma_{ex}}} (z_{it}^{ex})^{\frac{1}{\sigma_{ex}}}\right] + \left(\frac{\sigma_d - 1}{\sigma_d}\right) \ln K_t \\ = &\left(\frac{1}{\sigma_{ex}} - \frac{\sigma_d - 1}{\sigma_{ex} - 1}\frac{1}{\sigma_d}\right) \ln \Phi_t^{ex} + \left(\frac{1}{\sigma_d} - \frac{1}{\sigma_{ex}}\right) \ln(MC_{it}) \end{aligned} \tag{23}$$

Again, we take domestic sales and export sales from the data, and use estimated elasticities, recovered export market shifters as well as the quasi demand ratio in equation (15). Running the regression of the LHS in equation (23) with time dummies, we can recover the level of aggregate export demand in each year $t$, $\Phi_t^{ex}$, and we can also back out aggregate domestic demand, $\Phi_t^d$, from equation (15). Note that these are the normalized estimates with the mean of $\ln(MC_{it})$ being zero. Lastly, from equation (11) and its export sales equivalent in (12), we can uncover each firm's price and quantity sold in each market separately.

**Constrained exporters** Most of the above equations do not hold for the group of constrained firms because those equations are mostly derived from the fact that optimal price equals markup over marginal cost, which is not true for constrained firms. A notable exception is equation (14) since constrained firms also maximize their profits by equating marginal revenue from each market as in equation (9). In addition, although we employed only unconstrained firms to get the results, the estimated elasticities as well as aggregate demand levels are common to both unconstrained and constrained firms. Thus, by inputting appropriate values in equation (14) for constrained firms, we can recover idiosyncratic export demand shifters, $z_{it}^{ex}$, for each of these firms as in:

$$\frac{MR_{it}^{d}}{MR_{it}^{ex}} = 1 \Rightarrow \frac{\left(\frac{\sigma_d-1}{\sigma_d}\right)\left(r_{it}^{d}\right)^{\frac{-1}{\sigma_d-1}}\left(\Phi_t^{d}\right)^{\frac{1}{\sigma_d-1}}}{\left(\frac{\sigma_{ex}-1}{\sigma_{ex}}\right)\left(r_{it}^{ex}\right)^{\frac{-1}{\sigma_{ex}-1}}\left(\Phi_t^{ex}\right)^{\frac{1}{\sigma_{ex}-1}}} = \left(z_{it}^{ex}\right)^{\frac{1}{\sigma_{ex}-1}} \tag{24}$$

Now that we know everything about the firm-level demand curve for this group of firms, we can find out each firm's price and quantity sold in each market separately from equation (11) and (12). This provides information on each of these firms' actual capacity constraint since by assumption the capacity constraint is always binding:

$$\overline{q}_{it}^{tot} = q_{it}^{d} + q_{it}^{ex} \tag{25}$$

**Summary** Below, we summarize the structural estimation process:
For Unconstrained Exporters:

(a) Run a regression on equation (10), and get $\sigma_d$ and $\sigma_{ex}$
(b) Run a regression on equation (18),
and get estimated values of $h\left(k_{it}, m_{it}, n_{it}\right) + v_{it}$
(c) Plug the estimated values in steps (a) and (b) into equation (21),
run a regression,and recover $z_{it}^{ex}$ from residuals
(d) Substitute the estimated values in steps (a) and (c) into equation (14),
and get the solution $K_t$ in equation (15)
(e) Use the estimated values in steps (a), (c), and (d), run a regression
on equation (23), and recover $\Phi_t^{ex}$ and $\Phi_t^{d}$
(f) Get firm-level price and quantity using equation (11) and (12)
and values from steps (a), (c) and (e)

For Constrained Exporters:

(g) Use the values from steps (a) and (e), and get $z_{it}^{ex}$ from equation (24)
(h) Get firm-level price and quantity using equation (11), (12)
and values from steps (a), (e) and (g)

Since non-exporters share the same domestic aggregate demand level and the elasticity of substitution with exporters, we can also back out their domestic price and quantity sold from equation (9). Constrained non-exporters are assumed to face the binding constraint: $\overline{q}_{it}^{tot} = q_{it}^{d}$.

Table 20 reports key parameter estimates from the structural estimation procedure.[25]

## 5.3 Counterfactuals I

We perform counterfactual experiments to study the effects of positive export market demand shocks on total revenue at the industry-level as well as the firm-level. Our underlying assumption

[25]The estimates of $\frac{\sigma_d-1}{\sigma_d}$ and $\frac{\sigma_d-1}{\sigma_d}$ are 0.573 and 0.551 with standard errors 0.04 and 0.03, respectively.

is that unconstrained firms can adjust output freely at its own constant marginal cost, whereas constrained firms always face binding constraints at total output $\overline{q}_{it}^{tot}$ found in equation (25). Our counterfactual scenario is to imagine a one percent increase in aggregate export market demand, $\Phi_t^{ex}$, leaving aggregate domestic market demand, $\Phi_t^d$, unchanged, and calculate hypothetical firm-level responses. We consider intensive margin adjustments of incumbent exporters only, and do not account for extensive margin adjustments (i.e., switching in to or out of exporting).[26]

For unconstrained firms, it is straightforward to get new optimal total sales, because domestic sales do not change, while exports will increase exactly by one percent. For constrained firms, however, we need to find new domestic and export sales quantities that still satisfy the sub-optimality condition in equation (9) with the new aggregate export demand level and the capacity constraint in equation ( 25) at the same time. This counterfactual result is reported in Table 21.

If we aggregate domestic sales and exports by constrained firms and unconstrained firms separately, we can see that domestic sales are unchanged and exports increase by one percent for unconstrained firms. For constrained firms, however, the results indicate that domestic sales decrease by around .41%, while export sales increase by around .53%. In terms of total sales, actual domestic/export sales ratio is such that it increased by around .78% for unconstrained firms, but only by around .38% for constrained firms. This results in only a .56% increase in total aggregate sales in response to 1% positive demand shock in export markets. Noting that the industry would have experienced around a .78% increases in total sales if there were no constrained firms, this implies that the presence of capacity constrained firms reduces the aggregate sales responses by around 30% (from .78% to .56%). Looking at aggregate export responses, we find that the presence of capacity constrained firms reduces the aggregate export responses by around 27% (from 1% to .73%).This suggests a potential role for capacity constraints in explaining the short-run trade elasticity puzzle as described in Ruhl (2008) among others.

We can consider a similar exercise by introducing a 1% negative demand shock, with results reported in Table 22. This is exactly the mirror image of the earlier case with positive export demand shocks, and we find that the presence of capacity constrained firms again reduces the aggregate sales responses by around 30% (from -.78% to -.57%), and the aggregate export responses by 26% (from -1% to -.74%).

Consequently, the industry's overall output sensitivity to external demand shocks is dampened by 30% due to the presence of capacity constrained firms: the industry cannot reap the full benefits from positive external demand shocks, but can avoid being fully hit by negative external demand shocks.

## 5.4 Counterfactuals II

The presence of capacity constraints has a second significant impact on aggregate outcomes. Welfare is directly affected by the existence of capacity constrained firms, who charge higher prices than their unconstrained counterparts, thereby raising the aggregate price index and thus lowering welfare. It follows that we can calculate potential welfare losses from capacity constraints by comparing actual prices charged by constrained firms with hypothetical prices that would have

[26]To be able to account for extensive margin adjustments, we need to consider fixed and/or sunk cost estimation, which is beyond the scope of this paper.

been charged by these firms if they had not been constrained.[27] Our structural estimation process provides estimates of actual prices, but hypothetical prices are not available. Since firms would charge the optimal price as markup over marginal cost when they are not constrained, we need to estimate firm-level marginal cost, which we have not pursued in this paper. Instead, we make an assumption that constrained firms' marginal cost distribution is identical to the marginal cost distribution of unconstrained firms. Note that we do know unconstrained firms' marginal costs because their marginal costs should equal marginal revenues, which are easily recovered from equation (14) with estimated parameters.

In practice, we let constrained firms pick marginal cost draws randomly from the empirical distribution function of unconstrained firms' marginal costs, subject to the condition that constrained firms' marginal revenue is greater than the drawn marginal cost level (see equation (9)). With marginal cost draws picked, we can calculate constrained firms' optimal prices that would have been charged had it not been for capacity constraints. Then, we can construct a hypothetical domestic price index by adding unconstrained firms' actual (optimal) prices. We repeat the procedure 100 times, and compare the hypothetical domestic price index with the actual domestic price index. Our result suggests that the domestic price index would have been lower by 47% without capacity constraints. When the share of domestic goods consumption is 1/2, this implies that capacity constraints result in welfare losses of about 23%.[28]

Alternatively, imagine an economy with resource misallocation (e.g. arising from financial frictions) such that more efficient firms are capacity constrained. Specifically, we assume that constrained firms' marginal cost distribution follows the bottom 10% of unconstrained firms' marginal cost distribution. Repeating the procedure under this misallocation assumption, we find that the domestic price index would have been 71% lower without capacity constraints, implying welfare losses of 35% due to the presence of capacity constraints. This suggests that the combination of capacity constraints and resource misallocation has significant implications for the economy (additional welfare losses of 12%).

# 6 Conclusion

In this paper, we show that the assumption of constant marginal cost technology, which is implicit or explicit in most theory models of international trade, has predictions about firm-level foreign and domestic sales which are inconsistent with the data. We utilize a reduced form approach to demonstrate a strong negative relationship between domestic sales and exports, measured either by export status or export sales. Accounting for firm-level productivity growth is important since its omission tends to create an upward bias on the estimated relationship between domestic sales and exports. This is evidence against the standard constant marginal cost view.

Furthermore, we explore the sources of this increasing marginal cost technology, and find that physically and financially constrained firms have significant and large negative correlations between export and domestic sales. Financial constraints are shown to be at least as important as physical capacity constraints in contributing to the observed trade-off. This suggests that a constant marginal cost view is inappropriate for internationally integrated firms, and that short-run

[27] Again, we do not consider extensive margin adjustment effects, and assume that all incumbent firms stay in the domestic market in the absence of capacity constraints.

[28] The underlying model for this section is provided in Appendix A.1.

firm constraints could be quite significant for understanding aggregate outcomes.

Next, we attempt to quantify the importance of these micro frictions for aggregate fluctuations. Starting with the recent structural work of Aw et al. (2011)), we modify and advance this framework to include capacity constrained firms. Having derived the necessary identifying moments, we structurally estimate the impact of capacity constrained firms for macroeconomic fluctuation. Focusing on the largest exporting industry in Indonesia, we find that the presence of capacity constrained firm could reduce aggregate output responses to external demand shocks by around 30%. In addition, we show that capacity constraints could result in welfare losses by about 23%. These counterfactual estimates suggest that the existence of capacity constrained firms do indeed have significant aggregate consequences.

In future work, we seek to extend our framework to a dynamic setting, where we can structurally estimate the impact of capacity constrained firms along the extensive margin, including the recovery of sunk costs associated with exporting.

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# Appendix

## A. Underlying Model for Welfare Loss Evaluation

This section provides the underlying model framework that is used to quantify the welfare loss from capacity constraints in section 5.4. We consider a particular upper-tier utility function:

$$U = C_d^{\alpha} C_{imp}^{1-\alpha}$$

which has the corresponding total aggregate price index expressed as:

$$P = P_d^{\alpha} P_{imp}^{1-\alpha}$$

where $P_d^{\alpha}$ is the aggregate price index for domestic goods and $P_{imp}^{1-\alpha}$ is the aggregate price index for imported goods, defined respectively as:

$$P_d = \left[ \Sigma_{i \in dom} \left( p_i^d \right)^{1-\sigma_d} \right]^{\frac{1}{1-\sigma_d}}$$

and

$$P_{imp} = \left[ \Sigma_{i \in imp} \left( p_i^d \right)^{1-\sigma_d} \right]^{\frac{1}{1-\sigma_d}}$$

This utility system implies that a constant fraction, $\alpha$, of total spending is devoted to domestic goods, irrespective of relative price level of domestic goods to imported goods.[29]

We can further expand the aggregate price index for domestic goods by distinguishing the goods produced by constrained firms from those by unconstrained firms:

$$\begin{aligned} P_d &= \left[ \Sigma_{i \in dom} \left( p_i^d \right)^{1-\sigma_d} \right]^{\frac{1}{1-\sigma_d}} = \left[ \Sigma_{i \in unconstrained} \left( p_i^d \right)^{1-\sigma_d} + \Sigma_{i \in constrained} \left( p_i^d \right)^{1-\sigma_d} \right]^{\frac{1}{1-\sigma_d}} \\ &= \left[ \Sigma_{i \in unconstrained} \left( \frac{\sigma_d}{\sigma_d - 1} MC_i \right)^{1-\sigma_d} + \Sigma_{i \in constrained} \left( p_i^d \right)^{1-\sigma_d} \right]^{\frac{1}{1-\sigma_d}} \end{aligned}$$

The last expression reflects that unconstrained firms charge optimal prices, which is simply the markup over marginal costs, whereas constrained firms do not. We also construct a hypothetical domestic price index that would have been obtained if constrained firms could have charged optimal prices:

$$P_d^{hyp} = \left[ \Sigma_{i \in unconstrained} \left( \frac{\sigma_d}{\sigma_d - 1} MC_i \right)^{1-\sigma_d} + \Sigma_{i \in constrained} \left( \frac{\sigma_d}{\sigma_d - 1} MC_i \right)^{1-\sigma_d} \right]^{\frac{1}{1-\sigma_d}}$$

Welfare loss from capacity constrained domestic producers is then calculated by comparing the hypothetical and the actual domestic goods price index, weighted by the domestic goods consumption share $\alpha$ :

[29] This in turn implies that the aggregate demand level for domestic goods, $\Phi_t^d$, in equation (1) is expressed as $\Phi_t^d = \alpha R_t^d (P_d)^{\sigma_d}$, where $R_t^d$ is the total spending in the domestic economy.

$$-d \ln P = \alpha \left[ \ln P_d^{hyp} - \ln P_d \right]$$

# Figures

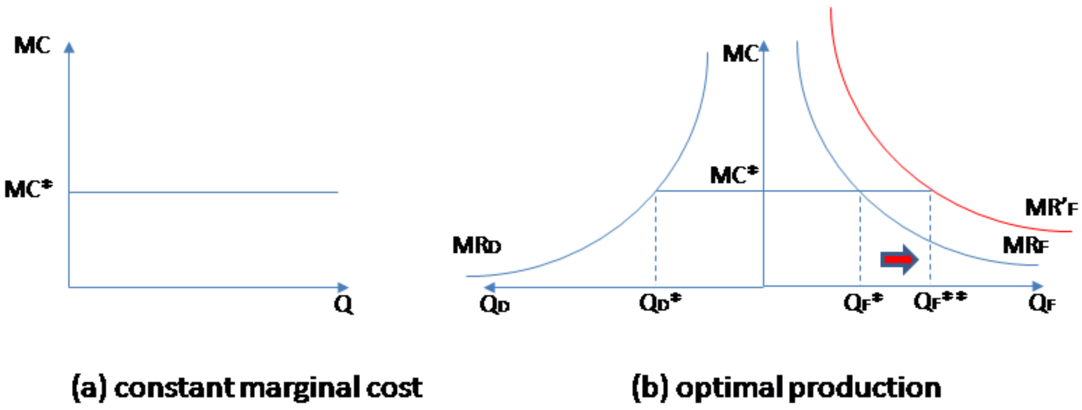


Figure 1: Constant Marginal Cost and Production

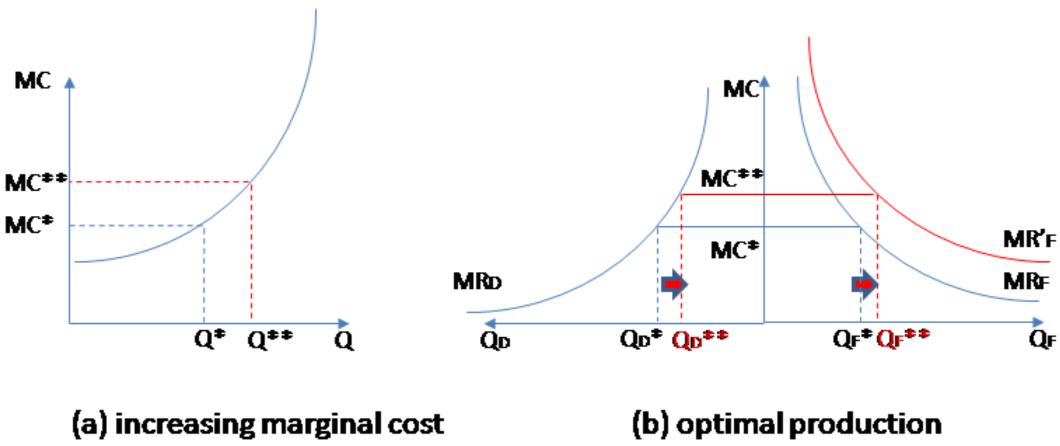


Figure 2: Increasing Marginal Cost and Production

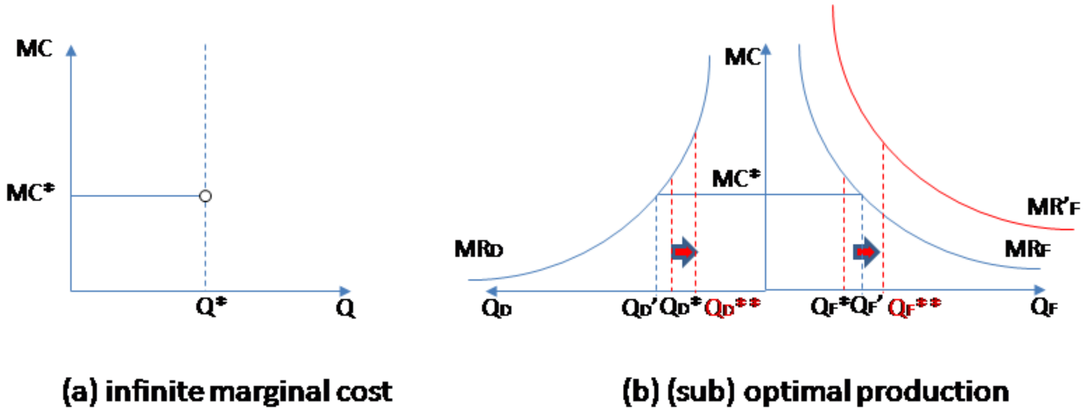


Figure 3: Infinite Marginal Cost and (Sub) Optimal Production

# Tables

| | All Firms | Non-exporters | Exporters | Continuing Exporters | Starters | Stoppers |
|---|---|---|---|---|---|---|
| Total Output (in 1,000 Rupiah) | 5,516 | 3,554 | 17,343 | 21,900 | 17,246 | 13,589 |
| Export Sales (in 1,000 Rupiah) | 1,193 | 0 | 8,383 | 10,500 | 7,123 | 0 |
| Domestic Sales (in 1,000 Rupiah) | 4,323 | 3,554 | 8,959 | 11,435 | 10,123 | 13,589 |
| Number of Observations | 124,715 | 106,970 | 17,745 | 8,627 | 3,922 | 3,085 |

Table 1: Summary Statistics by Export Status (Indonesian Firms)

| Physically Constrained | All Firms | Non-exporters | Exporters | Continuing Exporters | Starters | Stoppers |
|---|---|---|---|---|---|---|
| Total Output (in 1,000 Rupiah) | 7,060 | 4,295 | 17,851 | 23,463 | 13,909 | 17,264 |
| Export Sales (in 1,000 Rupiah) | 2,029 | 0 | 9,947 | 12,415 | 7,616 | 0 |
| Domestic Sales (in 1,000 Rupiah) | 5,031 | 4,295 | 7,904 | 11,048 | 6,293 | 17,264 |
| Number of Observations | 8,536 | 6,795 | 1,741 | 820 | 395 | 232 |

Table 2: Summary Statistics by Export Status for Physically Constrained Indonesian Firms

| Distressed Financially | All Firms | Non-exporters | Exporters | Continuing Exporters | Starters | Stoppers |
|---|---|---|---|---|---|---|
| Total Output (in 1,000 Rupiah) | 5,079 | 3,235 | 14,357 | 16,836 | 15,407 | 12,613 |
| Export Sales (in 1,000 Rupiah) | 1,205 | 0 | 7,266 | 8,594 | 6,473 | 0 |
| Domestic Sales (in 1,000 Rupiah) | 3,875 | 3,235 | 7,092 | 8,242 | 8,934 | 12,613 |
| Number of Observations | 52,250 | 43,587 | 8,663 | 4,148 | 1,905 | 1,489 |

Table 3: Summary Statistics by Export Status for Financially Distressed Indonesian Firms

| | All Firms | Non-exporters | Exporters | Continuing Exporters | Starters | Stoppers |
|---|---|---|---|---|---|---|
| Total Output (in 1,000 Pesos) | 4,282 | 1,682 | 13,966 | 15,264 | 10,851 | 11,471 |
| Export Sales (in 1,000 Pesos) | 1,455 | 0 | 6,873 | 7,521 | 6,001 | 0 |
| Domestic Sales (in 1,000 Pesos) | 2,827 | 1,682 | 7,093 | 7,743 | 4,850 | 11,471 |
| Number of Observations | 59,730 | 47,087 | 12,643 | 9,087 | 1,143 | 1,151 |

Table 4: Summary Statistics by Export Status (Chilean Firms)

| Physically Constrained | All Firms | Non-exporters | Exporters | Continuing Exporters | Starters | Stoppers |
|---|---|---|---|---|---|---|
| Total Output (in 1,000 Pesos) | 4,354 | 1,678 | 15,031 | 16,137 | 5,231 | 15,009 |
| Export Sales (in 1,000 Pesos) | 1,612 | 0 | 8,044 | 8,834 | 1,049 | 0 |
| Domestic Sales (in 1,000 Pesos) | 2,742 | 1,678 | 6,987 | 7,304 | 4,181 | 15,009 |
| Number of Observations | 20,215 | 16,164 | 4,051 | 3,640 | 411 | 489 |

Table 5: Summary Statistics by Export Status for Physically Constrained Chilean Firms

| Distressed Financially | All Firms | Non-exporters | Exporters | Continuing Exporters | Starters | Stoppers |
|---|---|---|---|---|---|---|
| Total Output (in 1,000 Pesos) | 2,518 | 1,091 | 6,620 | 7,352 | 3,984 | 2,819 |
| Export Sales (in 1,000 Pesos) | 615 | 0 | 2,383 | 2,726 | 572 | 0 |
| Domestic Sales (in 1,000 Pesos) | 1,903 | 1,091 | 4,237 | 4,626 | 3,412 | 2,819 |
| Number of Observations | 26,133 | 19,390 | 6,743 | 4,902 | 538 | 554 |

Table 6: Summary Statistics by Export Status for Financially Constrained Chilean Firms

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Starter | -0.99 | -0.99 | -0.97 | -0.98 |
| | (0.06)*** | (0.06)*** | (0.06)*** | (0.06)*** |
| Stopper | 0.98 | 0.98 | 0.94 | 0.94 |
| | (0.05)*** | (0.05)*** | (0.05)*** | (0.05)*** |
| Sector-year FE | no | yes | no | yes |
| Firm FE | no | no | yes | yes |
| Observations | 81,119 | 81,119 | 81,119 | 81,119 |

Notes: The dependent variable is the yearly change in log(domestic sales). 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. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 7: Starter/Stopper Indonesian Firms

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Starter | -1.01 | -1.01 | -0.99 | -0.96 | -0.97 |
| | (0.06)*** | (0.06)*** | (0.05)*** | (0.06)*** | (0.06)*** |
| Stopper | 1.00 | 1.00 | 0.94 | 0.91 | 0.91 |
| | (0.05)*** | (0.05)*** | (0.05)*** | (0.05)*** | (0.05)*** |
| Δ ln(productivity): | | | | | |
| Labor | 0.48 | 0.48 | 0.45 | | |
| | (0.01)*** | (0.01)*** | (0.01)*** | | |
| TFP Growth | | | | 0.34 | |
| | | | | (0.01)*** | |
| Levinsohn-Petrin | | | | | 0.31 |
| | | | | | (0.01)*** |
| Sector-year FE | no | yes | yes | yes | yes |
| Firm FE | no | no | yes | yes | yes |
| Observations | 81,119 | 81,119 | 81,119 | 65,090 | 64,909 |

Notes: The dependent variable is the yearly change in log(domestic sales). 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. Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in columns 1, 2, and 3. Column 4 reports the regression result with productivity as TFP deviation from the sector-year mean. Column 5 reports the regression result with productivity estimated using the methodology of Levisohn and Petrin (2008). A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 8: Starter/Stopper Indonesian Firms with Productivity

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Starter | -0.98 | -0.29 | -0.27 | -0.32 | -0.29 | -0.36 |
| | (0.06)*** | (0.03)*** | (0.03)*** | (0.04)*** | (0.04)*** | (0.04)*** |
| Stopper | 0.94 | 0.25 | 0.26 | 0.23 | 0.23 | 0.24 |
| | (0.05)*** | (0.03)*** | (0.03)*** | (0.03)*** | (0.03)*** | (0.03)*** |
| Intensive Exporter | | -1.42 | -1.41 | -1.41 | -1.41 | -1.39 |
| | | (0.04)*** | (0.04)*** | (0.04)*** | (0.04)*** | (0.04)*** |
| Lag Intensive Exporter | | 1.40 | 1.39 | 1.40 | 1.40 | 1.40 |
| | | (0.04)*** | (0.04)*** | (0.04)*** | (0.04)*** | (0.04)*** |
| Physically Constrained | | | 0.05 | | 0.06 | 0.04 |
| | | | (0.02)** | | (0.02)*** | (0.02)* |
| starter*physical | | | -0.30 | | -0.38 | -0.31 |
| | | | (0.09)*** | | (0.09)*** | (0.09)*** |
| Financially Constrained | | | | -0.21 | -0.21 | 0.03 |
| | | | | (0.01)*** | (0.01)*** | (0.01)*** |
| starter*financial | | | | 0.00 | -0.01 | 0.08 |
| | | | | (0.06) | (0.06) | (0.06) |
| Δ ln(productivity) | | | | | | 0.43 |
| | | | | | | (0.01)*** |
| Sector-year FE | yes | yes | yes | yes | yes | yes |
| Firm FE | yes | yes | yes | yes | yes | yes |
| Observations | 81,119 | 81,119 | 81,119 | 68,669 | 68,669 | 68,669 |

Notes: The dependent variable is the yearly change in log(domestic sales). 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. Intensive Exporter dummy is 1 for firms exporting more than 50% of total output and 0 otherwise. Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed). Intensive Exporter dummy is 1 for firms exporting more than 50% of total output and 0 otherwise. Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy is 1 for firms with a (cash-flow)/(asset) ratio in the bottom 50% for each year and 0 otherwise. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 9: Starter/Stopper Indonesian Firms with Constraints

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Δ ln(export sales) | -0.02 | -0.03 | -0.08 | -0.09 |
| | (0.03) | (0.03) | (0.03)*** | (0.03) *** |
| Sector-year FE | no | yes | no | yes |
| Firm FE | no | no | yes | yes |
| Observations | 7,183 | 7,183 | 7,183 | 7,183 |

Notes: The dependent variable is the yearly change in log(domestic sales). A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 10: Export Sales - Domestic Sales Trade-offs (Indonesian Firms)

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Δ ln(export sales) | -0.14 | -0.14 | -0.19 | -0.18 | -0.16 |
| | (0.03)*** | (0.03)*** | (0.03)*** | (0.03)*** | (0.03)*** |
| Δ ln(productivity): | | | | | |
| Labor | 0.35 | 0.34 | 0.32 | | |
| | (0.03)*** | (0.03)*** | (0.03)*** | | |
| TFP Growth | | | | 0.27 | |
| | | | | (0.03)*** | |
| Levinsohn-Petrin | | | | | 0.26 |
| | | | | | (0.03)*** |
| Sector-year FE | no | yes | yes | yes | yes |
| Firm FE | no | no | yes | yes | yes |
| Observations | 7,183 | 7,183 | 7,183 | 6,091 | 6,065 |

Notes: The dependent variable is the yearly change in log(domestic sales). Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in columns 1, 2, and 3. Column 4 reports the regression result with productivity as TFP deviation from the sector-year mean. Column 5 reports the regression result with productivity estimated using the methodology of Levisohn and Petrin (2008). A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 11: Export Sales - Domestic Sales Trade-offs with Productivity(Indonesian Firms)

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 | 5<br>Labor Prod | 6<br>TFP Prod | 7<br>LP Prod |
|---|---|---|---|---|---|---|---|
| Δ ln(export sales) | -0.09 | -0.08 | 0.03 | 0.05 | -0.07 | -0.04 | -0.03 |
| | (0.03)*** | (0.03)** | (0.08) | (0.08) | (0.07) | (0.08) | (0.08) |
| Physically Constrained | | 0.04 | | 0.04 | 0.04 | -0.01 | -0.01 |
| | | (0.08) | | (0.07) | (0.07) | (0.07) | (0.07) |
| Δ ln(export sales)*physical | | -0.23 | | -0.27 | -0.26 | -0.29 | -0.27 |
| | | (0.09)** | | (0.11)** | (0.10)** | (0.11)*** | (0.11)*** |
| Financially Constrained | | | -0.24 | -0.24 | -0.03 | -0.04 | -0.06 |
| | | | (0.05)*** | (0.05)*** | (0.05) | (0.06) | (0.06) |
| Δ ln(export sales)*financial | | | -0.22 | -0.22 | -0.16 | -0.19 | -0.18 |
| | | | (0.09)** | (0.09)** | (0.08)** | (0.09)** | (0.09)** |
| Δ ln(productivity) | | | | | 0.30 | 0.25 | 0.24 |
| | | | | | (0.03)*** | (0.03)*** | (0.03)*** |
| Sector-year FE | yes | yes | yes | yes | yes | yes | yes |
| Firm FE | yes | yes | yes | yes | yes | yes | yes |
| Observations | 7,183 | 7,183 | 6,305 | 6,305 | 6,305 | 6,091 | 6,065 |

Notes: The dependent variable is the yearly change in log(domestic sales). Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in column 5. Column 6 reports the regression result with productivity as TFP deviation from the sector-year mean. Column 7 reports the regression result with productivity estimated using the methodology of Levisohn and Petrin (2008). Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy is 1 for firms with a (cash-flow)/(asset) ratio in the bottom 50% for each year and 0 otherwise. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 12: Export Sales - Domestic Sales Trade-offs with Constraints (Indonesian Firms)

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| | Alt Physical | Alt Physical | Alt Financial | Alt Financial | Alt Physical<br>Alt Financial | Alt Physical<br>Alt Financial<br>Labor Productivity | Alt Physical<br>Alt Financial<br>TFP | Alt Physical<br>Alt Financial<br>LP |
| Δ ln(export sales) | 0.03 | 0.16 | -0.05 | -0.04 | 0.05 | -0.06 | -0.04 | -0.02 |
| | (0.05) | (0.09)* | (0.05) | (0.05) | (0.06) | (0.05) | (0.05) | (0.05) |
| Physically Constrained | 0.00 | -0.02 | | 0.05 | -0.01 | -0.01 | -0.01 | -0.03 |
| | (0.05) | (0.05) | | (0.07) | (0.05) | (0.05) | (0.05) | (0.05) |
| Δ ln(export sales)*physical | -0.18 | -0.19 | | -0.28 | -0.17 | -0.16 | -0.17 | -0.17 |
| | (0.06)*** | (0.06)*** | | (0.11)** | (0.06)*** | (0.06)*** | (0.06)*** | (0.06)*** |
| Financially Constrained | | -0.23 | -0.18 | -0.18 | -0.18 | 0.00 | -0.09 | -0.07 |
| | | (0.05)*** | (0.05)*** | (0.05)*** | (0.05)*** | (0.05) | (0.05)* | (0.05) |
| Δ ln(export sales)*financial | | -0.22 | -0.19 | -0.19 | -0.16 | -0.12 | -0.14 | -0.13 |
| | | (0.09)*** | (0.08)** | (0.08)** | (0.07)** | (0.07)* | (0.07)* | (0.07)* |
| Δ ln(productivity) | | | | | | 0.31 | 0.26 | 0.25 |
| | | | | | | (0.03)*** | (0.03)*** | (0.03)*** |
| Sector-year FE | yes | yes | yes | yes | yes | yes | yes | yes |
| Firm FE | yes | yes | yes | yes | yes | yes | yes | yes |
| Observations | 7,183 | 6,305 | 6,305 | 6,305 | 6,305 | 6,305 | 6,091 | 6,065 |

Notes: The dependent variable is the yearly change in log(domestic sales). Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in column 6. Column 7 reports the regression result with productivity as TFP deviation from the sector-year mean. Column 8 reports the regression result with productivity estimated using the methodology of Levisohn and Petrin (2008). Physical capacity constraint dummy is 1 for firms with 70% capacity utilization and 0 otherwise. Financial capacity constraint dummy is 1 for firms with a (cash-flow)/(asset) ratio in the bottom 10% for each year and 0 otherwise. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 13: Export Sales - Domestic Sales Trade-offs with Alternative Measures of Financial and Physical Constraints(Indonesian Firms)

| | Chile Mean | Chile Median | Chile N | Indonesia Mean | Indonesia Median | Indonesia N |
|---|---|---|---|---|---|---|
| Starter | -0.11 | 0.00 | 1,123 | -0.93 | -0.57 | 3,354 |
| Stopper | 0.15 | 0.08 | 1,133 | 1.04 | 0.73 | 2,566 |
| Continuer (Exporter) | 0.05 | 0.04 | 8,749 | 0.07 | 0.04 | 7,196 |
| Continuing Non-Exporter | 0.01 | 0.02 | 35,653 | 0.06 | 0.03 | 68,003 |

Table 14: Mean and Median Sales by Export Status (Chilean and Indonesian Firms)

| | Chile Mean | Chile Median | Chile N | Indonesia Mean | Indonesia Median | Indonesia N |
|---|---|---|---|---|---|---|
| Non-intensive Starters | 0.04 | 0.02 | 1,015 | -0.04 | -0.10 | 1,629 |
| Intensive Starters | -1.50 | -1.40 | 108 | -1.76 | -1.55 | 1,725 |
| Non-intensive Stoppers | 0.03 | 0.07 | 1,043 | 0.22 | 0.23 | 1,275 |
| Intensive Stoppers | 1.59 | 1.49 | 90 | 1.85 | 1.62 | 1,291 |

Notes: Intensive Starters are defined as firms that begin exporting at more than 50% of their total output. Non-intensive starters are all other firms that begin exporting. Intensive Stoppers are defined as firms that stop exporting, but in the previous year were exporting more than 50% of their total output. Non-intensive Stoppers are defined as all other firms that stop exporting.

Table 15: Mean and Median Sales by Export Status and Intensity (Chilean and Indonesian Firms)

| Δ ln(domestic sales) | 1<br>Chile | 2<br>Chile | 3<br>Chile | 4<br>Chile | 5<br>Chile | 6<br>Indonesia |
|---|---|---|---|---|---|---|
| Starter | -0.14 | -0.13 | -0.16 | -0.16 | -0.13 | -0.99 |
| | (0.04)*** | (0.03)*** | (0.03)*** | (0.03)*** | (0.02)*** | (0.05)*** |
| Stopper | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.94 |
| | (0.03)*** | (0.03)*** | (0.03)*** | (0.03)*** | (0.03)*** | (0.05)*** |
| Δ ln(productivity) | | | | | 0.19 | 0.45 |
| | | | | | (0.01)*** | (0.01)*** |
| Sector-year FE | no | yes | no | yes | yes | yes |
| Firm FE | no | no | yes | yes | yes | yes |
| Observations | 46,658 | 46,658 | 46,658 | 46,658 | 45,922 | 81,119 |

Notes: The dependent variable is the yearly change in log(domestic sales). 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. Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in columns 5 and 6. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 16: Starter/Stopper Chilean Firms

| Δ ln(domestic sales) | 1<br>Chile | 2<br>Chile | 3<br>Chile | 4<br>Chile | 5<br>Chile | 6<br>Chile | 7<br>Indonesia |
|---|---|---|---|---|---|---|---|
| Starter | -0.16 | -0.06 | -0.01 | -0.07 | -0.03 | -0.01 | -0.36 |
| | (0.03)*** | (0.02)*** | (0.03) | (0.02)*** | (0.03) | (0.03) | (0.04)*** |
| Stopper | 0.13 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.24 |
| | (0.03)*** | (0.02)*** | (0.02)*** | (0.02)*** | (0.02)*** | (0.02)*** | (0.03)*** |
| Intensive Exporter | | -0.98 | -0.96 | -0.88 | -0.87 | -0.85 | -1.39 |
| | | (0.05)*** | (0.05)*** | (0.06)*** | (0.06)*** | (0.06)*** | (0.04)*** |
| Lag Intensive Exporter | | 1.00 | 0.94 | 0.85 | 0.85 | 0.85 | 1.40 |
| | | (0.05)*** | (0.06)*** | (0.06)*** | (0.06)*** | (0.06)*** | (0.04)*** |
| Physically Constrained | | | -0.04 | | -0.03 | -0.02 | 0.04 |
| | | | (0.01)*** | | (0.01)*** | (0.01)*** | (0.02)* |
| starter*physical | | | -0.10 | | -0.12 | -0.08 | -0.31 |
| | | | (0.04)** | | (0.04)*** | (0.04)** | (0.09)*** |
| Financially Constrained | | | | -0.12 | -0.12 | -0.06 | 0.03 |
| | | | | (0.01)*** | (0.01)*** | (0.01)*** | (0.01)*** |
| starter*financial | | | | 0.08 | 0.09 | 0.02 | 0.08 |
| | | | | (0.04)** | (0.04)** | (0.03) | (0.06) |
| Δ ln(productivity) | | | | | | 0.16 | 0.43 |
| | | | | | | (0.01)*** | (0.01)*** |
| Sector-year FE | yes | yes | yes | yes | yes | yes | yes |
| Firm FE | yes | yes | yes | yes | yes | yes | yes |
| Observations | 46,658 | 46,658 | 43,285 | 40,038 | 38,788 | 38,349 | 68,669 |

Notes: The dependent variable is the yearly change in log(domestic sales). 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. Intensive Exporter dummy is 1 for firms exporting more than 50% of total output and 0 otherwise. Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed). Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy is 1 for firms with a (cash-flow)/(asset) ratio in the bottom 50% for each year and 0 otherwise. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 17: Starter/Stopper Chilean Firms with Constraints

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Δ ln(export sales) | -0.09 | -0.09 | -0.10 | -0.11 | -0.10 | -0.10 | -0.11 |
| | (0.01)*** | (0.01)*** | (0.01)*** | (0.01)*** | (0.01)*** | (0.01)*** | (0.02)*** |
| Δ ln(productivity) | | | | | 0.18 | 0.17 | 0.17 |
| | | | | | (0.02)*** | (0.02)*** | (0.02)*** |
| Sector-year FE | no | yes | no | yes | no | yes | yes |
| Firm FE | no | no | yes | yes | no | no | yes |
| Observations | 8,749 | 8,749 | 8,749 | 8,749 | 8,586 | 8,586 | 8,586 |

Notes: The dependent variable is the yearly change in log(domestic sales). Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in columns 5, 6, and 7. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 18: Export Sales - Domestic Sales Trade-offs (Chilean Firms)

| Δ ln(domestic sales) | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | Chile | Chile | Chile | Chile | Chile | Indonesia |
| Δ ln(export sales) | -0.11 | -0.08 | -0.02 | 0.00 | 0.00 | -0.07 |
| | (0.01)*** | (0.02)*** | (0.01)** | (0.01) | (0.01) | (0.07) |
| Physically Constrained | | -0.02 | | 0.00 | 0.00 | 0.04 |
| | | (0.02) | | (0.02) | (0.02) | (0.07) |
| Δ ln(export sales)*physical | | -0.06 | | -0.07 | -0.07 | -0.26 |
| | | (0.03)** | | (0.03)** | (0.03)** | (0.10)** |
| Financially Constrained | | | -0.11 | -0.11 | -0.06 | -0.03 |
| | | | (0.03)*** | (0.03)*** | (0.03)** | (0.05) |
| Δ ln(export sales)*financial | | | -0.11 | -0.11 | -0.11 | -0.16 |
| | | | (0.02)*** | (0.02)*** | (0.02)*** | (0.08)** |
| Δ ln(productivity) | | | | | 0.14 | 0.30 |
| | | | | | (0.02)*** | (0.03)*** |
| Sector-year FE | yes | yes | yes | yes | yes | yes |
| Firm FE | yes | yes | yes | yes | yes | yes |
| Observations | 8,749 | 8,257 | 7,087 | 6,974 | 6,885 | 6,305 |

Notes: The dependent variable is the yearly change in log(domestic sales). Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in columns 5 and 6. Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy is 1 for firms with a (cash-flow)/(asset) ratio in the bottom 50% for each year and 0 otherwise. A constant term is included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 19: Export Sales - Domestic Sales Trade-offs with Constraints (Chilean Firms)

| $\sigma_d = 2.35$ | $\sigma_{ex} = 2.2$ |
|---|---|
| $\Phi^d_{1990} = 1,104,561$ | $\Phi^{ex}_{1990} = 2,491,660$ |
| $\Phi^d_{1991} = 1,057,013$ | $\Phi^{ex}_{1991} = 3,723,407$ |
| $\Phi^d_{1992} = 1,415,523$ | $\Phi^{ex}_{1992} = 3,760,982$ |
| $\Phi^d_{1993} = 1,100,565$ | $\Phi^{ex}_{1993} = 4,125,749$ |
| $\Phi^d_{1994} = 1,055,139$ | $\Phi^{ex}_{1994} = 5,333,864$ |
| $\Phi^d_{1995} = 1,162,663$ | $\Phi^{ex}_{1995} = 3,917,337$ |
| $\Phi^d_{1996} = 1,126,510$ | $\Phi^{ex}_{1996} = 4,123,405$ |

Table 20: Implied Parameter Values

| year | Unconstrained firms' sales growth in Domestic | Exports | Total | Constrained firms' sales growth in Domestic | Exports | Total | Aggregate Exports | Total |
|---|---|---|---|---|---|---|---|---|
| 1990 | 0.00% | 1.00% | 0.69% | -0.40% | 0.53% | 0.38% | 0.68% | 0.50% |
| 1991 | 0.00% | 1.00% | 0.77% | -0.50% | 0.55% | 0.38% | 0.69% | 0.52% |
| 1992 | 0.00% | 1.00% | 0.75% | -0.37% | 0.53% | 0.37% | 0.75% | 0.56% |
| 1993 | 0.00% | 1.00% | 0.79% | -0.41% | 0.52% | 0.39% | 0.72% | 0.57% |
| 1994 | 0.00% | 1.00% | 0.81% | -0.43% | 0.54% | 0.38% | 0.75% | 0.58% |
| 1995 | 0.00% | 1.00% | 0.80% | -0.41% | 0.53% | 0.38% | 0.75% | 0.58% |
| 1996 | 0.00% | 1.00% | 0.83% | -0.39% | 0.54% | 0.37% | 0.80% | 0.63% |
| mean | 0.00% | 1.00% | 0.78% | -0.41% | 0.53% | 0.38% | 0.73% | 0.56% |

Table 21: One Percent Positive External Demand Shock

| year | Unconstrained firms sales growth in Domestic | Exports | Total | Constrained firms' sales growth in Domestic | Exports | Total | Aggregate Exports | Total |
|---|---|---|---|---|---|---|---|---|
| 1990 | 0.00% | -1.00% | -0.70% | 0.40% | -0.53% | -0.39% | -0.70% | -0.51% |
| 1991 | 0.00% | -1.00% | -0.78% | 0.23% | -0.50% | -0.38% | -0.70% | -0.52% |
| 1992 | 0.00% | -1.00% | -0.75% | 0.38% | -0.54% | -0.38% | -0.76% | -0.56% |
| 1993 | 0.00% | -1.00% | -0.80% | 0.41% | -0.53% | -0.39% | -0.73% | -0.57% |
| 1994 | 0.00% | -1.00% | -0.81% | 0.43% | -0.54% | -0.38% | -0.76% | -0.59% |
| 1995 | 0.00% | -1.00% | -0.80% | 0.41% | -0.54% | -0.38% | -0.75% | -0.58% |
| 1996 | 0.00% | -1.00% | -0.83% | 0.39% | -0.55% | -0.37% | -0.81% | -0.63% |
| mean | 0.00% | -1.00% | -0.78% | 0.38% | -0.53% | -0.38% | -0.74% | -0.57% |

Table 22: One Percent Negative External Demand Shock