Capacity Constrained Exporters: Micro Evidence and Macro Implications*

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PRELIMINARY DRAFT

First Draft: December 13, 2011
This Draft: April 16, 2012

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 costs. To understand and quantify the importance of increasing marginal costs 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%.

JEL classification: F1, F4, L1

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*We thank Don Davis, Amit Khandelwal and Jon Vogel for early comments on the project. We are grateful to George Akerlof, Martin D.D. Evans, Catherine Thomas, and Hâle Utar as well as seminar participants at Columbia, IMF, and the 10th IIOC meeting for helpful comments and discussions. We are especially grateful to Eric Verhoogen for sharing the dataset. The views expressed in this paper are those of the authors and should not be attributed to the International Monetary Fund, its Executive Board, or its management.

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

Our study begins from the notion that domestic sales of firms with constant marginal cost are predicted to be independent of their export sales, whereas firms with increasing marginal cost would face a trade-off between domestic and export sales. For example, 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. On the other hand, constant marginal cost implies that external demand shocks will not affect the level of marginal cost, keeping domestic sales unchanged.

Exploring Indonesian firm-level domestic and export sales 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 firms' characteristics. The underlying idea is that if increasing marginal cost prevails, we should observe a negative relationship between export and domestic sales. Furthermore, we expect stronger patterns in the data for firms that are capacity constrained, as these firms face the steepest cost of increasing production.

We confirm the idea by showing that such patterns exist in the data, once firm productivity changes are accounted for, and that these trade-offs are mostly driven by both physical and financial constraints. We use a capacity realization variable as a proxy for physical capacity constraints, and employ various financial capacity constraints measures developed in the literature. The coefficient estimates suggest that (physically and financially) unconstrained firms exhibit no or a very weak negative correlation between export and domestic sales growth, whereas being physically or financially constrained adds about a .2 percentage point reduction in domestic sales for each one percentage point growth in export sales.

Having demonstrated the robustness of this trade-off in the data, we turn next to quantifying the aggregate implication. We develop a structural form 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 bring the second contribution that provides quantitative implications of capacity constrained firms facing increasing marginal costs. Intuitively, increasing marginal cost would reduce firm output responses to external demand shocks because of offsetting movements in domestic sales. In addition, capacity constraints lead firms to charge higher price than the optimal price that would have been charged otherwise. Our structural estimates suggest that the presence of such capacity constrained firms can (1) reduce the aggregate output responses to external demand shocks by around 30%, and (2) raise aggregate price level by around 23%. To the extent that firms face capacity constraints for reasons beyond their optimal investment decisions, our counterfactual results thus present 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 costs, 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) and Aw et al. (2011)).

We demonstrate that the assumption of constant marginal costs, and hence final 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.

[1] In fact, capacity constraints could be direct consequences of firms' optimal investment decisions in the presence of demand uncertainty. Firms set their own *ex ante* optimal capacity levels, which are hit by firms with *ex post* positive demand shocks. If this were the only cause of capacity constraints, there will not be much policy implications. However, we note that financial constraints would exacerbate the degree of capacity constraints by preventing firms from achieving their optimal capacity levels in the first place, which opens room for policy implications. In this sense, our finding that identifies financial capacity constraint in addition to physical capacity constraint is especially noteworthy.

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 conjecture is being driven by physical capacity constraints. Soderbery (2011) finds a similar pattern of export and domestic sales 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 does not consider financial dimensions unlike our paper.

Berman et al. (2011) on the other hand, find the opposite pattern from French firm level data when they instrument for export sales growth using information on the number and location of export markets. They interpret this finding as evidence of complementarity between exogenous changes in foreign demand and domestic 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 (2011) further explores firm level output volatility, and concludes that constant marginal cost assumptions may be inappropriate. Nguyen & 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.

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 implications of constant marginal costs for export and domestic sales, and find an interrelationship as evidence for increasing marginal costs.

Our finding can serve as direct micro-evidence that justifies the modelling 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, Leibovici, and Szkup (2012), and Rho and Rodrigue (2012)) or patterns of foreign aquisitions (Spearot (2011, forthcoming)).[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)

[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 costs across all firms, we separate out constrained and unconstrained firms based on our reduced-form evidence. Also, their focus is on firm-dynamics, while we explore static issues.

among others). Our paper complements the literature by studying the intensive margin, and showing that credit constraints affect incumbent exporters as well through the marginal cost channel. This is also consistent with trade finance literature that studies intensive margin adjustments during the great trade collapse (e.g., Ahn (2010), Paravisini, Rappoport, Schnabl, and Wolfenzon (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 (2005) 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, Eaton, and Kortum (2012) introduces switching frictions from customers' side to generate staggered short-run trade dynamics. Our finding suggests that export cannot fully respond to external demand shocks due to inherent capacity constraints at the firm level.

The other aggregate implication of capacity constraints relates to the finance and misallocation literature (e.g., Buera and Shin (2010), Buera, Kaboski, and Shin (2011), Midrigan and Xu (2010), Moll (2012)). Compared to the literature that studies TFP losses from misallocation induced by financial frictions in a dynamic model, we present 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 costs, both physical and financial, to incorporate these micro frictions into a structural estimation framework, and to use this procedure to quantify aggregate implications.

The remainder of the paper proceeds as follows: Section 2 illustrates background theoretical discussion, and Section 3 describes the Indonesian firm level data used in this paper. Section 4 reports empirical findings from the reduced form approach, and Section 5 develops a structural estimation process, and provides quantifying example to gauge the macroeconomic implications. Section 6 concludes the paper.

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 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

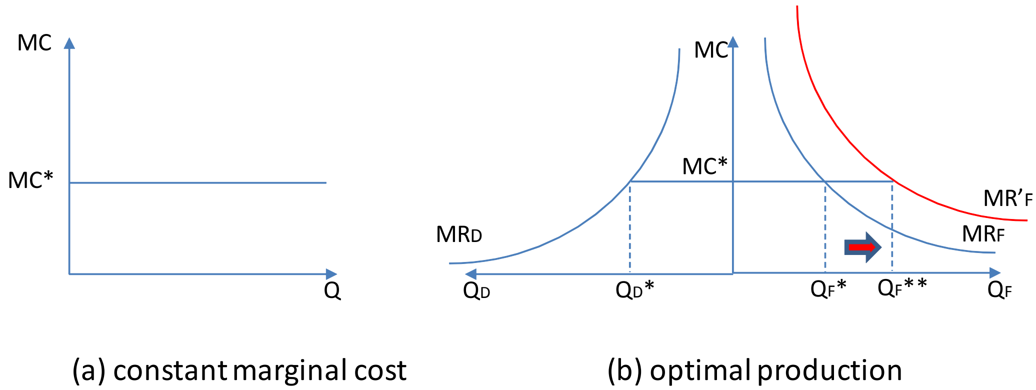

Figure 1: Constant Marginal Cost and Optimal Production

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.

[3] More precisely, this will be valid as long as price elasticity of demand is greater than 1. This will be relevant for our empirical exercises because the dataset provides the information on sales revenues instead of the quantity sold.

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

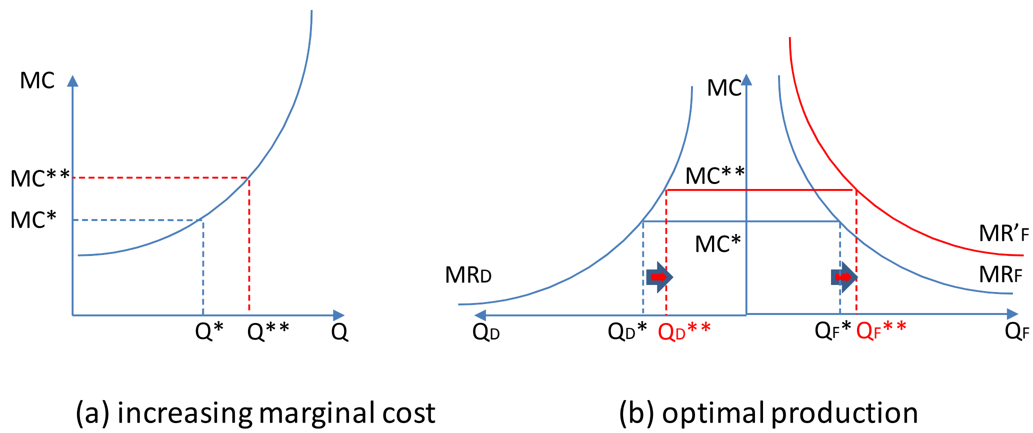

Figure 2: Increasing Marginal Cost and Optimal Production

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 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 equates marginal revenue in each market to marginal cost with 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 example of increasing marginal cost technology, namely, infinite marginal cost. This

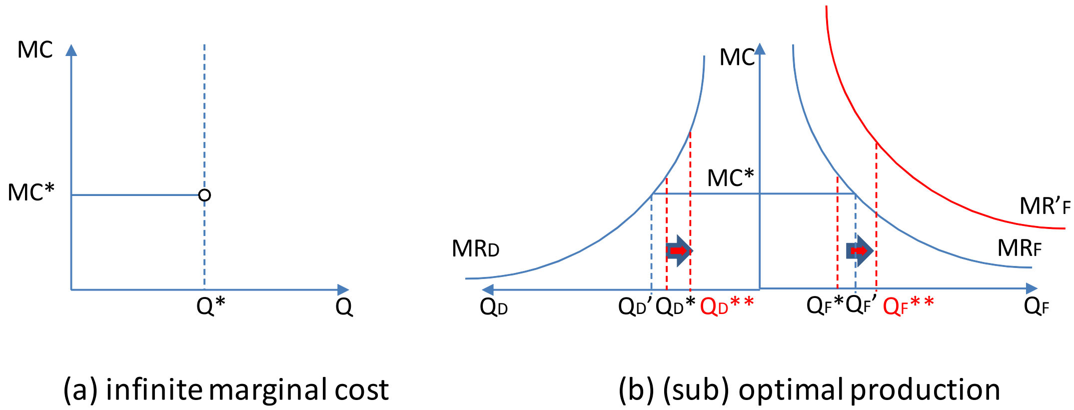

Figure 3: Infinite Marginal Cost and (Sub) Optimal Production

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.[5]

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, because it reduces to the earlier constant marginal cost case otherwise. 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 the case with the more general case above, we conclude that the presence of capacity constraints, unlike constant marginal

[5] We present this special case here because our empirical section below shows this is the closest to the patterns observed in the data.

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.

Regarding capacity constraints, we can think of various factors, which may come from physical or financial dimension. 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.[6]

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 this is not very likely according to the literature on business cycle co-movements, we acknowledge that it is not entirely implausible.[7] On the other hand, if they are positively correlated, it would bias the results against finding negative tradeoffs. In the empirical section below, we will present systemic evidence that our findings are not simply driven by such negatively correlated demand shocks.

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

[7] Bilateral or multilateral trade liberalization may generate such patterns, affecting domestic and export sales in opposing ways.

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[8] will face such tradeoffs 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 costs but rather as a result of extensive margin adjustments (Bernard, Redding, and Schott (2011)).

Exchange rate movements would work against finding evidence for export-domestic sales tradeoffs. In the case of producer currency pricing, effective marginal costs for exporting should be multiplied by 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 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 shift right in <Figure 2-(a)>, and the relevant marginal cost level goes down in <Figure 2-(b)>, 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.

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>, its direct consequence is that the price charged by

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

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 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 wasn't included in the questionnaire until 1990. We choose to start our analysis in 1990 for this reason, leaving us with a seven year panel.

The dataset is quite rich, with information on sector of main product, type of ownership (public, private, and foreign), 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.[10] There are over 300 five-digit ISIC manufacturing industries in the dataset. For our structural estimation, we will focus on the largest exporting industry, manufacturing of wood, and wood and cork products (ISIC 331).[11]

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. This suggests the financial data is reasonable 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.[12]

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

[10] Specifically, the 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 substracting changes in inventory holdings from the remainder, (total output-export).

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

[12] This gives rise to potential biases in productivity estimates. As De Loecker (2011) pointed out, however, productivity growth measures will not be biased under the assumption that input variation is not correlated

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 costs. 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. We try alternative cut-off values of capacity constrained firms for robustness.

We also construct measures of financial constraints based on financial information of the firm, including cash flow and assets, access to foreign loans and foreign ownership status. Specifically, we construct a financial distress measure as the cash-flow/asset ratio, and define financially constrained firms as the bottom 50% of firms ranked by this measure. Alternatively, we assign foreign owned firms as unconstrained, and domestic firms as constrained firms, with a threshold level of 50% in the share of stocks held by foreigners. We define the third financial capacity constraint measure based on outstanding foreign loans. <Table 1> reports cross-correlation between physical and financial capacity constraints measures.

	physical	financial_1	financial_2	financial_3
physical	1			
financial_1	-0.0191	1		
financial_2	-0.0214	-0.03	1	
financial_3	-0.008	-0.0043	0.2417	1

Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy, "financial_1", is 1 for firms with the (cash-flow)/(asset) ratio being bottom 50% for each year, and 0 otherwise. Financial capacity constraint dummy, "financial_2", is 1 for firms with the share of stocks held by foreigners below 50%, and 0 otherwise. Financial capacity constraint dummy, "financial_3", is 1 for firms without access to foreign loans and 0 otherwise.

Table 1: Cross Correlation of Constraint Measures

The cleaned dataset includes a little over 100,000 observations, including 3,241 unique plants. Our primary analysis focuses on the firm level yearly growth in export and domestic sales, thereby restricing our samples to firms that export in consecutive years. This leaves us with 7,540 observations. <Table 2> provides a brief description of our primary sample, continuing exporters, in comparison to all exporters and all non-exporters. On average, continuing exporters are bigger in terms of total output, domestic sales, and export sales.

with the price deviation when every firm's price relative to the industry price index does not change over time. This is one reason why we run growth regressions with productivity growth measures in our analysis below. 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 systemic negative correlation between domestic and export sales. However, if we believe reporting errors are persistent over time at firm level, growth measures will not be affected by such reporting errors.

They tend to have a larger share of foreign owned stocks and larger foreign loans, whereas cash-flow/asset ratio is lower for these firms. Capacity utilization does not seem to vary significantly across different groups.

Average of	Continuing Exporters	Exporters	Non-exporters
Total Output (in 1,000 Rupiah)	24571.07	17601.41	3529.52
Export Sales (in 1,000 Rupiah)	11178.97	8518.22	0.00
Domestic Sales (in 1,000 Rupiah)	13392.10	9083.19	3529.52
% Capacity Utilized	73	72	67
Cash-Flow/Asset Ratio	0.91	1.49	1.65
% Share of Stocks Held by Foreigners	11.93	11.65	1.87
Foreign Loan (in 1,000 Rupiah)	913.54	731.34	238.69
Number of Observations	7540	17760	108834

Table 2: Summary Statistics

Among continuing exporters, there are 608 observations with physical capacity constraints, which consist of 8% of total sample. The first financial constraint measure classifies, by construction, 50% of sample observations into constrained firms. On the other hand, the other two measures include about 91-93% of samples as constrained firms. By comparing continuing exporters in <Table 2> to each column in <Table 3>, physically constrained firms, on average, tend to sell more both domestically and abroad, whereas financially constrained firms sell less in both markets.

Average of	physical=1	financial_1=1	financial_2=1	financial_3=1
Total Output (in 1,000 Rupiah)	29458.8	18138.52	22196.21	20742.77
Export Sales (in 1,000 Rupiah)	14502.53	8914.534	9741.221	9910.039
Domestic Sales (in 1,000 Rupiah)	14956.27	9223.984	12454.99	10832.73
Number of Observations	608	3761	6474	7031

Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy, "financial_1", is 1 for firms with the (cash-flow)/(asset) ratio being bottom 50% for each year, and 0 otherwise. Financial capacity constraint dummy, "financial_2", is 1 for firms with the share of stocks held by foreigners below 50%, and 0 otherwise. Financial capacity constraint dummy, "financial_3", is 1 for firms without access to foreign loans and 0 otherwise.

Table 3: Summary Statistics for Constrained Firms

4. Reduced Form Evidence

In this section, we follow a reduced form approach to identify the presence of increasing marginal cost as well as the 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 growth when firms have constant marginal cost technology, whereas the presence of increasing marginal cost technology would result in a negative correlation between them.

	(1)	(2)	(3)	(4)	(5)	(6)
Δln(export sales)	-0.016	-0.131 ***	-0.130 ***	-0.178 ***	-0.158 ***	-0.144 ***
	(0.030)	(0.027)	(0.027)	(0.025)	(0.032)	(0.032)
Δln(productivity)		0.347 ***	0.340 ***	0.329 ***		
: labor productivity		(0.030)	(0.031)	(0.029)		
Δln(productivity)					0.266 ***	
: TFP					(0.026)	
Δln(productivity)						0.273 ***
: Levinsohn-Petrin						(0.027)
sector-year FE	No	No	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	Yes	Yes
Observations	7540	7540	7540	7540	6408	6382

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 2,3, and 4. Column 5 reports the regression result with productivity as TFP deviation from the sector-year mean. Column 6 reports the regression result with productivity estimated by Levisohn and Petrin (2003) methodology. 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 parenthesis. Significance: * 10 percent; ** 5 percent; *** 1percent.

Table 4: Domestic and Export Sales Tradeoffs

<Table 4> reports correlation patterns between export and domestic sales growth. Column 1 shows almost zero correlation between export and domestic sales growth. This may suggest that constant marginal cost technology prevails the economy, and is not a particularly bad assumption. However, it is important to note that this simple correlation does not account for productivity growth, which affects export and domestic sales in the same direction: improvement in productivity shifts down the marginal cost curve, which in turn raises optimal output in both domestic and export markets. Failing to control for productivity growth, thus, amounts to a typical omitted variable problem, resulting in upward bias. Column 2 confirms this idea. After controlling for productivity growth (measured as labor productivity), the data reveals a strong negative correlation between export and domestic sales growth: a 1 percentage point increase in export growth is associated with .13 percentage point decrease in domestic sales. Adding sector-year level (column 3) does not change the result, reflecting that the observed negative correlation is not driven by particular sector-year level variations such as tariff changes. Adding firm level fixed effects (column 4) confirms that it is indeed the within-firm phenomenon consistent with our comparative statics illustrated in section 2. The result is not sensitive to the choice of productivity measures (column 5 and 6).[13] We take this as *suggestive* evidence that marginal cost is, on average, increasing rather than constant.

It is only suggestive because there are alternative explanations consistent with the observed correlation patterns in <Table 4> as discussed in section 2. Our preferred strategy

[13] Specifically, we estimate TFP in the following two ways. First, we 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 apply the methodology of Levinsohn & Petrin (2003) with raw material and labor as freely varying inputs, and electricity and fuels usage as well as capital as proxies for productivity.

to verify specific sources of increasing marginal cost is to control for capacity constraints explicitly on top of the basic simple correlation analysis. The idea is that if it is indeed increasing marginal cost that drives the observed patterns, we expect to find even stronger patterns for capacity constrained firms, because they are more likely to face increasing marginal cost. The corresponding specification is given as:[14]

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

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 on the coefficient of the interaction term, β_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. As discussed in section 2, capacity constraints can come from either physical or financial dimension. In what follows, we will control for these two types of capacity constraints separately.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δln(productivity)	0.329 ***	0.316 ***	0.316 ***	0.326 ***	0.326 ***	0.326 ***	0.326 ***
	(0.029)	(0.031)	(0.031)	(0.027)	(0.027)	(0.027)	(0.027)
Δln(export sales)	-0.166 ***	-0.093	-0.079	-0.002	-0.012	0.019	0.030
	(0.024)	(0.063)	(0.063)	(0.024)	(0.024)	(0.135)	(0.024)
Δln(export sales)*physical	-0.202 **		-0.224 **		-0.207 **		-0.200 **
	(0.082)		(0.099)		(0.080)		(0.082)
Δln(export sales)*financial_1		-0.127 *	-0.130 *				
		(0.075)	(0.074)				
Δln(export sales)*financial_2				-0.207 **	-0.209 **		
				(0.100)	(0.098)		
Δln(export sales)*financial_3						-0.220	-0.219
						(0.143)	(0.142)
sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7540	6638	6638	7540	7540	7540	7540

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). Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy in column (2) and (3), "financial_1", is 1 for firms with the (cash-flow)/(asset) ratio being bottom 50% for each year, and 0 otherwise. Financial capacity constraint dummy in column (4) and (5), "financial_2", is 1 for firms with the share of stocks held by foreigners below 50%, and 0 otherwise. Financial capacity constraint dummy in column (6) and (7), "financial_3", is 1 for firms without access to foreign loans and 0 otherwise. Corresponding dummy variables and a constant term are included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parenthesis. Significance: * 10 percent; ** 5 percent; *** 1percent.

Table 5: Capacity Constraints and Domestic-Export Sales Trade Offs

We begin with physical capacity constraints. As a proxy for physical capacity constraints, we employ the capacity utilization variable, and treat those firms that report 100% of capacity realization as physically constrained, and all other firms as unconstrained.[15] Column 1 in <Table 5> confirms that physical capacity constraints are indeed a relevant source

[14] Throughout the section, we will report main coefficients $\beta_1, \beta_3, \beta_4$ only, but all the regressions include a constant term and capacity constraint dummies as well.

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

of increasing marginal cost. The size of the coefficients is such that firms with no such physical constraint reduces domestic sales by .16 percentage point per every 1 percentage point growth in export sales, whereas physically constrained firms contract domestic sales by .36 percentage point (.16+.20). In other words, those firms that are subject to physical capacity constraints tend to exhibit a tradeoff between export and domestic sales more than twice as strong as unconstrained firms.

To check if financial capacity constraint also matters, we use three different measures of financial capacity constraints. We construct a financial distress measure as the cash-flow/asset ratio, and define financially constrained firms as the bottom 50% of firms ranked by this measure. Cash-flow/asset ratio is one of the most popular proxies for financial constraints in corporate finance literature (Kaplan & Zingales (1997); Whited & Wu (2006); Lin et al. (2011)). Alternatively, we assign foreign owned firms as unconstrained, and domestic firms as constrained firms, with a threshold level of 50% in the share of stocks held by foreigners. There is numerous evidence that foreign owned firms are least likely to face credit constraints (e.g., Manova et al. (2011) for China, and Blalock et al. (2008) for Indonesia among others). The last measure builds on the idea that those firms that have access to an extra source of financing, notably foreign loans, are less likely to be financially constrained (Fanelli et al. (2002)). Accordingly, we define the third financial capacity constraint measure based on outstanding foreign loans.

Column 2 in <Table 5> shows that it is only financially distressed firms that exhibit a negative correlation between export and domestic sales growth. As we include both physical and financial capacity constraints in the regression, column 3 reports that export-doemstic sales trade-offs are entirely driven by either physically or financially constrained firms. When we use foreign/domestic ownership as a proxy for financial constraints, the results look very similar. Such a negative relationship between export and domestic sales disappears for foreign firms, and it is only domestic firms that exhibit export-domestic sales trade-offs (column 4). Adding physical capacity constraint in column 5, we find that domestic firms with physical constraints contract domestic sales by .4 percentage points for every 1 percentage point reduction in exports. Domestic firms without physical constraints or foreign firms with physical constraints reduces domestic sales by .2 percentage points for every 1 percentage point growth in exports. Foreign firms without any constraints do not face any trade-offs between export and domestic sales. Access to foreign loans, as an alternative proxy for firms' financial constraints, gives basically the same result except that the financial constraint effect becomes statistically insignificant (column 6 and 7). <Table 5> thus suggests that the observed negative tradeoffs come mainly from physical and financial capacity constraints.

To check if the results are robust to alternative productivity measures, we repeat baseline regressions with different measures of productivity. <Table 6> summarizes the regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δln(productivity)	0.266 ***	0.259 ***	0.258 ***	0.265 ***	0.264 ***	0.265 ***	0.264 ***
	(0.026)	(0.027)	(0.027)	(0.025)	(0.025)	(0.025)	(0.025)
Δln(export sales)	-0.145 ***	-0.061	-0.047	0.062	0.079	0.077	0.090
	(0.033)	(0.072)	(0.073)	(0.131)	(0.131)	(0.168)	(0.168)
Δln(export sales)*physical	-0.240 **		-0.245 **		-0.253 **		-0.242 **
	(0.106)		(0.105)		(0.104)		(0.105)
Δln(export sales)*financial_1		-0.157 *	-0.159 *				
		(0.085)	(0.084)				
Δln(export sales)*financial_2				-0.259 *	-0.262 *		
				(0.137)	(0.134)		
Δln(export sales)*financial_3						-0.266	-0.266
						(0.175)	(0.173)
sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6408	6408	6408	6408	6408	6408	6408

Notes: The dependent variable is the yearly change in log (domestic sales). Productivity in this regression is TFP productivity deviation from the sector-year mean. Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy in column (2) and (3), "financial_1", is 1 for firms with the (cash-flow)/(asset) ratio being bottom 50% for each year, and 0 otherwise. Financial capacity constraint dummy in column (4) and (5), "financial_2", is 1 for firms with the share of stocks held by foreigners below 50%, and 0 otherwise. Financial capacity constraint dummy in column (6) and (7), "financial_3", is 1 for firms without access to foreign loans and 0 otherwise. Corresponding dummy variables and a constant term are included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parenthesis. Significance: * 10 percent; ** 5 percent; *** 1percent.

Table 6: Robustness Check with Productivity as TFP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δln(productivity)	0.272 ***	0.262 ***	0.262 ***	0.271 ***	0.269 ***	0.269 ***	0.268 ***
	(0.027)	(0.029)	(0.028)	(0.026)	(0.026)	(0.026)	(0.026)
Δln(export sales)	-0.132 ***	-0.050	-0.036	0.070	0.086	0.103	0.115
	(0.032)	(0.072)	(0.072)	(0.130)	(0.129)	(0.162)	(0.162)
Δln(export sales)*physical	-0.227 **		-0.232 **		-0.240 **		-0.230 **
	(0.104)		(0.103)		(0.102)		(0.104)
Δln(export sales)*financial_1		-0.154 *	-0.156 *				
		(0.085)	(0.084)				
Δln(export sales)*financial_2				-0.252 *	-0.256 *		
				(0.135)	(0.133)		
Δln(export sales)*financial_3						-0.278 *	-0.279 *
						(0.168)	(0.166)
sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6382	6382	6382	6382	6382	6382	6382

Notes: The dependent variable is the yearly change in log (domestic sales). Productivity in this regression is estimated by Levinsohn and Petrin (2003)' methodology. Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy in column (2) and (3), "financial_1", is 1 for firms with the (cash-flow)/(asset) ratio being bottom 50% for each year, and 0 otherwise. Financial capacity constraint dummy in column (4) and (5), "financial_2", is 1 for firms with the share of stocks held by foreigners below 50%, and 0 otherwise. Financial capacity constraint dummy in column (6) and (7), "financial_3", is 1 for firms without access to foreign loans and 0 otherwise. Corresponding dummy variables and a constant term are included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parenthesis. Significance: * 10 percent; ** 5 percent; *** 1percent.

Table 7: Robustness Check with Productivity as Levinsohn and Petrin Methodology

results when we use TFP instead of labor productivity. They are very similar to the ones with labor productivity in <Table 5>, confirming that unconstrained firms show no clear trade-off patterns, whereas physically or financially constrained firms experience a strong negative correlation between export and domestic sales growth. The results with an alternative measure of TFP (following Levinsohn & Petrin (2003)), summarized in <Table 7>, are very similar to the ones presented in <Table 6>.

As additional robustness checks, we apply different criteria for physical and financial capacity constraints. For physical capacity constraints, we relax the threshold level of 100% capacity utilization to 70%, and <Table 8> summarizes the regression results with the new 70% threshold. Similarly, alternative definitions of financial constraints are used in regressions reported in <Table 9>. Column 1 and 2 show the results with a lower threshold level of the bottom 10% in the financial distress measure, and column 3 and 4 are the results

	(1)	(2)	(3)	(4)
Δln(productivity)	0.329 ***	0.317 ***	0.326 ***	0.326 ***
	(0.028)	(0.031)	(0.027)	(0.027)
Δln(export sales)	-0.164 ***	-0.081	0.011	0.033
	(0.027)	(0.064)	(0.093)	(0.134)
Δln(export sales)*physical	-0.170 **	-0.163 *	-0.167 **	-0.170 **
	(0.086)	(0.090)	(0.084)	(0.085)
Δln(export sales)*financial_1		-0.125 *		
		(0.074)		
Δln(export sales)*financial_2			-0.207 **	
			(0.098)	
Δln(export sales)*financial_3				-0.221
				(0.140)
sector-year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Observations	7540	6638	7540	7540

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). Physical capacity constraint dummy is 1 for firms with 70% capacity utilization and 0 otherwise. Financial capacity constraint dummy in column (2), "financial_1", is 1 for firms with the (cash-flow)/(asset) ratio being bottom 50% for each year, and 0 otherwise. Financial capacity constraint dummy in column (3), "financial_2", is 1 for firms with the share of stocks held by foreigners below 50%, and 0 otherwise. Financial capacity constraint dummy in column (4), "financial_3", is 1 for firms without access to foreign loans and 0 otherwise. Corresponding dummy variables and a constant term are included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parenthesis. Significance: * 10 percent; ** 5 percent; *** 1percent.

Table 8: Robustness Check with Alternative Physical Capacity Constraint Measure

with a new foreign/domestic ownership criterion of 20% share of stocks held by foreigners. Both measures effectively tighten up the measure of financial capacity constraints. Overall, the results are robust to alternative capacity constraints measures.

Lastly, we consider the inventory adjustment process. The idea is that if a firm faces tradeoffs between domestic and export sales due to increasing marginal costs, it will first turn to inventory holdings before substituting domestic sales with exports, and vice versa. When a firm with increasing marginal cost faces positive external demand shocks, for example, the firm would raise exports and cut domestic sales. In fact, however, this will happen only *after* the firm uses existing inventory stocks to raise exports *before* incurring an increase in marginal cost by producing more. Therefore, if the observed negative correlation between export and domestic sales indeed reflects the presence of increasing marginal cost, we should expect such export-domestic sales trade-offs to prevail especially for those firms that actually reduced their inventory holdings. To check this, we add an inventory adjustment dummy that takes 1 for firms with a decrease in inventory holdings and 0 otherwise, and its interaction term with export sales growth. The results reported in <Table 10> support the idea. Column 1 shows that those firms that reduced inventory stocks indeed experienced .22 percentage point larger reduction in domestic sales for a percentage point increase in exports. This is true even after controlling for other various capacity constraints

	(1)	(2)	(3)	(4)
Δln(productivity)	0.324 ***	0.323 ***	0.327 ***	0.327 ***
	(0.030)	(0.030)	(0.027)	(0.027)
Δln(export sales)	-0.144 ***	-0.131 ***	-0.035	-0.023
	(0.036)	(0.037)	(0.080)	(0.079)
Δln(export sales)*physical		-0.223 **		-0.203 **
		(0.099)		(0.081)
Δln(export sales)*financial_1	-0.125 *	-0.129 **		
	(0.065)	(0.065)		
Δln(export sales)*financial_2			-0.175 *	-0.176 **
			(0.089)	(0.087)
sector-year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Observations	6638	6638	7540	7540

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). Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint dummy in column (1) and (2), "financial_1", is 1 for firms with the (cash-flow)/(asset) ratio being bottom 10% for each year, and 0 otherwise. Financial capacity constraint dummy in column (3) and (4), "financial_2", is 1 for firms with the share of stocks held by foreigners below 20%, and 0 otherwise. Corresponding dummy variables and a constant term are included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parenthesis. Significance: * 10 percent; ** 5 percent; *** 1percent.

Table 9: Robustness Checks with Alternative Financial Capacity Constraints Measures

measures (Column 2-5).

In sum, we have shown that the underlying negative correlation between export sales growth and domestic sales growth is robust to a variety of measures of productivity, and it is stronger for financially or physically constrained firms, which is also robust to alternative measures of constraints. This reduces concerns that the results are driven by a negative correlation between domestic and export demand, because it is hard to explain why the negative correlation between domestic and export demand is stronger for capacity constrained firms. We have also shown that inventory adjustment behavior is consistent with our increasing marginal cost view of firm production. More importantly, our results show that unconstrained firms do not exhibit any such negative correlation. We take the results as evidence for the presence of capacity constrained firms in the economy. It has yet to be shown that it 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 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.

	(1)	(2)	(3)	(4)
Δln(productivity)	0.328 ***	0.315 ***	0.325 ***	0.325 ***
	(0.028)	(0.030)	(0.026)	(0.026)
Δln(export sales)	-0.109 ***	-0.030	0.056	0.107
	(0.030)	(0.061)	(0.088)	(0.120)
Δln(export sales)*physical		-0.210 **	-0.196 **	-0.186 **
		(0.100)	(0.083)	(0.085)
Δln(export sales)*financial		-0.113	-0.189 **	-0.230 *
		(0.071)	(0.093)	(0.126)
Δln(export sales)*inventory	-0.226 ***	-0.203 ***	-0.206 ***	-0.226 ***
	(0.054)	(0.059)	(0.053)	(0.054)
sector-year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Observations	7540	6638	7540	7540

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). Physical capacity constraint dummy is 1 for firms with 100% capacity utilization and 0 otherwise. Financial capacity constraint is proxied as financial distress measure in column 2, foreign/domestic ownership in column 3, and foreign loan access status in column 4. Inventory dummy is 1 for firms experiencing inventory destocking. A constant term and corresponding dummy variables are included in each regression and omitted in the table. All standard errors are clustered at the sector-year level and provided in parenthesis. Significance: * 10 percent; ** 5 percent; *** 1percent.

Table 10: Robustness Checks with Inventory Adjustments

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 the firms with cash-flow/asset ratio being bottom 50%. 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 the 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 the substantial role of capacity constraints in dampening the 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 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 σ_d is the elasticity of substitution in domestic market. The aggregate demand level in domestic market at each time t, Φ_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[16], z_{it}^{ex}, on top of the common aggregate export demand level, Φ_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 firm's own capital level, k_{it}, industry-wide factor prices, w_t, and its own unobservable productivity level, ω_{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 the 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.

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

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 as below:

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

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 constraint is always binding, constrained firms cannot achieve the optimality condition above, and instead operate at the sub-optimal point at which the following condition holds:

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

Since equation (2) is not valid for constrained firms, equation (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 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 right hand side are taken directly from the data. Running a simple OLS regression gives coefficient estimates from which we can back out elasticities σ_d and σ_{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 down 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 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 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 log as:

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

Rearraging constant and time specific terms, it is reduced to:

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

with time dummy D_t.

A key issue in estimating equation (16) is that firm's productivity ω_{it} is not observable to us, and especially when productivity levels are correlated with capital level, simple regression yields biased estimates. In spirit of Olley & Pakes (1996) and Levinsohn & Petrin (2003), and following Aw et al. (2011), we assume that the term composed of capital and productivity can be proxied by cubic function of capital, material costs, and fuels usage:

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

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} orginating from the cubic function proxy procedure.

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

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

and rearranging terms gives:

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

Since equation (17) gives the following relationship:

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

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

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

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 $\left(h\left(k_{it}, m_{it}, n_{it}\right) + v_{it}\right)$ from the regression of equation (18) above.

Having recovered firm specific export demand shifters z_{it}^{ex}, we are able to solve the 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 of aggregate demand levels 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., $q_{it}^j = r_{it}^j / p_{it}^j$):

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

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

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

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 LHS in equation (23) with time dummies, we can recover aggregate export demand level in each year t, Φ_t^{ex}, and we can also back out aggregate domestic demand level, Φ_t^d, from equation (15). Note that these are the normalized estimates with the mean of $\ln\left(MC_{it}\right)$ being zero. Lastly, from equation (11) and its export sales equivalent in (12), we can find out 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), because 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 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 automatically gives us information on each of these firms' actual capacity constraint because, from our assumption, their output 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 in equation (10), and get σ_d and σ_{ex}
(b) Run a regression in equation (18),
and get estimated values of $h(k_{it}, m_{it}, n_{it}) + v_{it}$
(c) Plug the estimated values in step (a) and (b) into equation (21),
run a regression,and recover z_{it}^{ex} from residuals
(d) Substitute the estimated values in step (a) and (c) into equation (14),
and get the solution K_t in equation (15)
(e) Use the estimated values in step (a), (c), and (d), run a regression
in equation (23), and recover Φ_t^{ex} and Φ_t^{d}
(f) Get firm level price and quantity using equation (11) and (12)
and values from Step (a), (c) and (e)

For Constrained Exporters:

(g) Use the values from Step (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 Step (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 11> reports key parameter estimates from the structural estimation procedure.[17]

5.3. Counterfactuals I

We perform counterfactual analysis to study the effects of positive export market demand shocks on total revenue at industry level as well as firm level. Our underlying assumption 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 one percent increase in aggregate

[17] 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.

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

Table 11: Implied Parameter Values

export market demand, Φ^{ex}_t, leaving aggregate domestic market demand, Φ^d_t, unchanged, and calculate hypothetical firm level responses. We do not account for extensive margin adjustments (i.e., switching to or out of exporting), and consider intensive margin adjustments of incumbent exporters only.[18]

For unconstrained firms, it is quite simple to get new optimal total sales, because domestic sales would not change at all, while exports will increase exactly by one percent. For constrained firms, however, we need to find out new sub-optimal domestic sales quantity and exports quantity that still satisfy the sub-optimality condition in equation (9) with new aggregate export demand level and the capacity constraint in equation (25) at the same time. This counterfactual result is reported in <Table 12>.

	unconstrained firms' sales growth in			constrained firms' sales growth in			aggregate
year	domestic	exports	total	domestic	exports	total	total
1990	0.00%	1.00%	0.69%	-0.40%	0.53%	0.38%	0.50%
1991	0.00%	1.00%	0.77%	-0.50%	0.55%	0.38%	0.52%
1992	0.00%	1.00%	0.75%	-0.37%	0.53%	0.37%	0.56%
1993	0.00%	1.00%	0.79%	-0.41%	0.52%	0.39%	0.57%
1994	0.00%	1.00%	0.81%	-0.43%	0.54%	0.38%	0.58%
1995	0.00%	1.00%	0.80%	-0.41%	0.53%	0.38%	0.58%
1996	0.00%	1.00%	0.83%	-0.39%	0.54%	0.37%	0.63%
mean	0.00%	1.00%	0.78%	-0.41%	0.53%	0.38%	0.56%

Table 12: One Percent Positive External Demand Shock

If we aggregate domestic sales and exports by constrained firms and unconstrained firms separately, we can see that domestic sales stay the same level, but exports increase by one percent for unconstrained firms, as we expected. For constrained firms, however, the results indicate that domestic sales decrease by around .41%, while export sales increases by around .53%. In terms of total sales, actual domestic sales/export ratio is such that it increase by around .78% for unconstrained firms, but only by around .38% for constrained

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

firms. This results in only about .56% increase in total aggregate sales in response to 1% positive demand shock in export markets. Noting that the industry would have experienced about .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%).

We can do the same exercise by introducing 1% negative demand shocks, of which results are reported in <Table 13>. 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%).

	unconstrained firms' sales growth in			constrained firms' sales growth in			aggregate
year	domestic	exports	total	domestic	exports	total	total
1990	0.00%	-1.00%	-0.70%	0.40%	-0.53%	-0.39%	-0.51%
1991	0.00%	-1.00%	-0.78%	0.23%	-0.50%	-0.38%	-0.52%
1992	0.00%	-1.00%	-0.75%	0.38%	-0.54%	-0.38%	-0.56%
1993	0.00%	-1.00%	-0.80%	0.41%	-0.53%	-0.39%	-0.57%
1994	0.00%	-1.00%	-0.81%	0.43%	-0.54%	-0.38%	-0.59%
1995	0.00%	-1.00%	-0.80%	0.41%	-0.54%	-0.38%	-0.58%
1996	0.00%	-1.00%	-0.83%	0.39%	-0.55%	-0.37%	-0.63%
mean	0.00%	-1.00%	-0.78%	0.38%	-0.53%	-0.38%	-0.57%

Table 13: One Percent Negative External Demand Shock

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 from being fully hit by negative external demand shocks. It should be clear that we would reach the same conclusion if we considered domestic demand shocks instead of export demand shocks.

5.4. Counterfactuals II

Another important aspect of capacity constraints is that welfare of the economy would deteriorate as a result of higher prices charged by capacity constrained firms. It is straightforward that we can calculate the welfare losses from capacity constraints, by comparing actual prices charged by constrained firms with hypothetical prices that would have been charged by these firms if they had not been constrained.[19] Our structural estimation process provides 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

[19] 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.

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 domestic price index would have been lowered by 47% without capacity constraints. When domestic goods consumption share is given by 1/2, this implies that capacity constraints result in about 23% welfare losses.[20]

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 export and domestic sales growth rates. We show that once productivity is properly accounted for, a significant trade-off at the firm level is apparent. 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 firm constraints could be quite significant for understanding aggregate outcomes.

Next, we attempt to quantify the importance of this micro level friction 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

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

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.1 Underlying Model for Welfare Loss Evaluation

This section provides an 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^{α} is the aggregate price index for domestic goods and $P_{imp}^{1-\alpha}$ is the aggregate price index for imported goods, defined respectively as:

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

and

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

This utility system implies that a constant fraction, α, of total spending is devoted to domestic goods, irrespective of relative price level of domestic goods to imported goods.[21]

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

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

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

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:

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

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 α :

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