Capacity Constrained Exporters: Identifying Increasing Marginal Cost*

JaeBin Ahn[†] Alexander F. McQuoid[‡]

January 2015

Abstract

This study revisits a central assumption of standard trade models: constant marginal cost technology. The presence of increasing marginal costs for exporters introduces significant market interdependence across borders missing from traditional models of international trade that rely on constant marginal cost technology. Such market interdependence represents an additional channel through which local shocks are transmitted globally. To identify increasing marginal cost at the level of the firm, we build in flexible production assumptions that nest increasing, decreasing, and constant marginal cost technology to an otherwise standard international trade model. We derive an estimating equation that can be taken directly to the data. Our structural equation explicitly guides our inference on the shape of marginal cost from estimated coefficients. The results suggest that increasing marginal cost is predominant at the firm level, and that the degree of increasing marginal cost is significantly exacerbated by both physical and financial constraints. The evidence suggests that access to larger markets through greater international integration may not have the expected welfare gains typically predicted in standard models.

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.

*This paper is a substantially revised version of the paper previously circulated under the title "Capacity Constrainted Exporters: Micro Evidence and Macro Implications". We thank Don Davis, Amit Khandelwal, Eric Verhoogen, and Jon Vogel for early comments on the project. We are grateful to George Akerlof, Martin D.D. Evans, Ina Simonovska, Catherine Thomas, and Hâle Utar as well as seminar participants at Columbia, IMF, Florida International, 2012 RMET Conference at UBC, 2012 Rimini Conference in Economics and Finance, Spring 2013 MIEG Conference, 10th IIOC meeting, and the Advances in International Trade Workshop 2014 at Georgia Tech for helpful comments and discussions.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.

[†]Research Department, International Monetary Fund, 700 19th street NW, Washington, DC 20431 (jahn@imf.org)

[‡]Economics Department, United States Naval Academy, 589 McNair Road, Annapolis, MD 21402 (mcquoid@usna.edu)

The presence of increasing marginal cost among exporters matters as it represents an additional channel through which shocks are transmitted globally. That is, capacity constrained exporters operating in a foreign country react to purely foreign shocks by adjusting behavior locally, and the response is larger when foreign shocks are larger or when exporters are more highly constrained. While previous work has shown that financial constraints are important for selection into export markets (extensive margin), and for export sales (intensive margin), we show that physical and financial constraints are important for a third dimension of adjustment between domestic sales and export sales (opportunity cost margin). The presence of increasing marginal costs for capacity constrained exporters introduces market interdependence across borders missing from traditional models of international trade that rely on constant marginal cost technology.

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. Utilizing a flexible production structure that nests increasing, decreasing, and constant marginal cost, we derive the appropriate estimating equation from an otherwise standard international trade model. The structural specification is then taken directly to the data, and provides direct evidence on the presence of increasing marginal cost as a first-order feature of the data. We further identify physical and financial capacity constraints as the primary sources of increasing marginal cost.

It is important to highlight a 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 may 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 often beyond the control of the firm, limit the ability of firms to choose the optimal level of capacity, generating 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 study begins from the notion that firms with increasing marginal cost face a trade-off between domestic and export sales — when a firm alters export sales in response to an external demand shock, it will incur a change in marginal cost, which in turn makes it optimal for the firm to alter domestic sales. Firms with constant marginal cost, on the other hand, have no incentive to alter domestic sales in response to an export demand shock since changing production to meet demand abroad has no effect on the level of marginal cost.

After providing an illustrative example of the basic idea, we turn to grounding this concept in a formal theoretical structure. Our demand side assumptions are standard in international trade theory, while our production side is flexible enough to nest increasing, decreasing, or constant marginal cost within a single parameter. We derive our estimating equation accordingly, which makes explicit that the omitted variable bias is likely to be present when estimating the primary specification. However, using properties of the structural model, we show that the key estimated coefficient is only consistent with increasing marginal cost. Our approach may understate the true magnitude of increasing marginal cost, but provides a lower bound on the scope and scale of increasing marginal cost.

We estimate key cost parameters using Indonesian plant-level data, and find robust support for the view that exporting firms are operating with increasing marginal cost technology. A particularly valuable feature of our Indonesian data is that it records plant-level capacity utilization over time, which is not available in most plant-level data. We utilize this information to construct measures of physical capacity constraints that are plant-specific and vary over time. Combined with standard measures of financial constraints from the corporate finance literature, we show that physical and financial capacity constraints are the primary sources of increasing marginal cost for firms. Increasing marginal cost is a first-order feature of the data among exporters. Our estimates and conclusions are robust to alternative measures of financial and physical capacity constraints, as well as alternative measures of productivity.

One of the 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. Similarly, it could offer a useful perspective in explaining an apparent puzzle of short-run dynamics of aggregate exports (e.g., Esteves and Rua (2013); Belke et al. (2013)) as well as asymmetric exchange rate pass-through prevalent in practice (e.g., Ahn and Park (2014); Pollard and Coughlin (2004)).

New international trade theory is grounded in the idea that access to export markets allows firms to take advantage of increasing returns to scale to production. The evidence presented here suggests that access to larger markets through greater international integration may not have the expected welfare gains typically predicted in these models. Furthermore, the short-run may not be so short if financial constraints at the firm-level are persistent.

1.1 Related Literature

The point of departure for this paper comes from the standard models of international trade that have followed from 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 seminal works of 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.

There is an emerging literature that explores the relationship between domestic and export sales as evidence for the presence of increasing marginal cost. In the management literature, there is a growing case study literature exploring tradeoffs in sales across markets. For example, Ghemawat and Mitchell (2011) document the interrelationship between foreign and domestic sales for a single large producer of beer, and conclude that sales growth in domestic markets often crowds out sales in foreign markets (and vice versa).

In the economics literature, Blum et al. (2013) find a negative correlation between domestic and export sales growth from Chilean firm-level data, which they attribute to physical capacity constraints. Soderbery (2014) 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. Unlike these papers, we derive a structural estimation equation with enough flexibility to identify the shape of marginal cost, and we consider financial dimensions (in addition to physical constraints), 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 estimation approach, we show there is no clear relationship between domestic and foreign sales.

Related papers focus on firm-level output volatility. 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, guided by a structural estimation model.

Our empirical 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 different types of marginal cost for export and domestic sales, and find a negative relationship as evidence for increasing marginal cost.

The main findings 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 (2014)) or patterns of foreign acquisitions (Spearot (2012)).

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 (2013)). 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. (2014)). Recent work by Feenstra et al. (2013) suggest that credit constraints endogenously tighten as exports become a larger share of a firm's revenue, which magnifies the significance of the opportunity cost margin discussed here.

In sum, our paper is the first to provide a theoretically-derived estimating equation that allows us to identify the presence of increasing, decreasing, or constant marginal cost at the firm level. Our approach also derives appropriate bounding techniques in the face of simultaneity bias. Lastly, we identify sources of increasing marginal cost with both physical and financial capacity constraints, which are highly prevalent in the data.

The remainder of the paper proceeds as follows: Section 2 provides an illustrative conceptual discussion, and Section 3 formally derives the estimating equation. Section 4 describes the firm-level dataset from Indonesia used in this paper, while Section 5 reports the empirical results. Section 6 concludes the paper.

2 Illustrative Theory

This section provides a simple conceptual framework to contrast different predictions on the relationship between domestic and export sales movements, depending on the underlying characteristics of the marginal cost curve. Particular emphasis should be put on the fact that such predictions neither hinge on any specific model structure, nor require sophisticated theory models. In the next section, we will show explicitly how to apply the illustrative idea to the data by deriving a model-based econometric specification.,

For each type of marginal cost curve considered below, we begin by finding the 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.[1]

Constant marginal cost When a firm's marginal cost is constant, 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 will adjust sales in that particular market, leaving sales in all other markets unchanged.[2] 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 foreign 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 will adjust the sales in that market. This, in turn, alters the marginal cost, which affects 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 foreign demand shock,

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

[2]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)).

which shifts up the marginal revenue curve in the export market. The firm responds to positive foreign 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 incurs 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 respond to export demand shocks in opposing ways.

Decreasing marginal cost For completeness, we consider the case of decreasing marginal cost. As with increasing marginal cost, foreign and domestic markets can no longer be treated in isolation since a demand shock in one market alters the optimal sales decision in the other market. In this case, however, domestic and foreign sales will be complementary rather than substitutes. The situation with decreasing marginal cost is illustrated in Figure 3.[3]

At the initial equilibrium with Q_D^*, Q_F^* and $Q^* = Q_D^* + Q_F^*$, the firm again satisfies the optimality condition by equating marginal revenue from each market with marginal cost (i.e., $MR_D(Q_D^*) = MR_F(Q_F^*) = MC(Q^*)$). Once again, suppose that there occurs a positive foreign 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. This time, however, as the firm produces more to meet the increased export sales, marginal costs decline as the firm is better able to exploit economics of scale. For unchanged domestic market conditions, the firm would see an increase in profit by keeping domestic sales at Q_D^*, as marginal revenue exceeds marginal cost at this point in domestic market. The firm's optimal response is then to increase domestic sales to recover the optimality condition in the domestic market. As a result, in the new equilibrium, the firm has higher export sales, higher domestic sales, and lower marginal cost than before (i.e., $Q_F^{**} > Q_F^*$, $Q_D^{**} > Q_D^*$, and $Q^{**} > Q^*$). Therefore, decreasing marginal cost technology predicts that firm-level export and domestic sales respond to export demand shocks in complementary ways.

Although we allow for the possibility of decreasing marginal cost in our empirical analysis, since the evidence strongly suggests the prevalence of increasing marginal costs in the data, we turn next to outlining some likely sources of increasing marginal cost.

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. (2013)). 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 capac-

[3] For the case illustrated, we assume that marginal cost decreases at a decreasing rate, and there exists some lower bound on marginal cost, making marginal revenue curve steeper than marginal cost curve in the operating domain.

ity 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.[4] [5]

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. However, the reality is more complicated because, unlike our simple comparative statics analysis, there are many possible factors that may affect domestic demand and foreign demand simultaneously, possibly in opposing ways. 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, which could bias the empirical results 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 will bias the results against finding negative trade-offs. In the empirical section below, we will derive a model-based econometric specification that explicitly and properly accounts for such biases, and further present systemic evidence that our findings are not simply driven by such negatively correlated demand shocks.

Although our conceptual discussion is most applicable 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. In our empirical analysis below, we will show that firms facing capacity constraints have more extreme interdependence between foreign and domestic markets, consistent with the idea of firms facing increasing marginal cost of production.

Lastly, it is important to note that firm productivity evolves over time. In fact, productivity growth, negative or positive, will affect export and domestic sales in the same direction. Even with increasing marginal cost, if a firm's productivity improves, the marginal cost curve will shift down in Figure 2, and the relevant marginal cost level goes down in Figure 2, possibly leading to observed increases in both domestic and export sales in the face of increasing marginal cost and positive foreign demand shocks. This force works against finding evidence for increasing marginal cost in the data. In the next section, we let theory guide how to incorporate firm productivity into our estimating equation explicitly.

Having provided an illustrative theoretical discussion of the impact different types of marginal costs have on the relationship between domestic and foreign sales for exporters, we now turn to

[4] 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.

[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 starts selling less in the domestic market because she cannot spend as much time and effort on the domestic operation as before, and vice versa.

[6] Bilateral or multilateral trade liberalization as well as exchange rate movements 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] See, for example, Verhoogen (2008) in the case of a VW plant in Mexico.

deriving an explicit econometric specification in the next section, thereby providing an appropriate structural interpretation of the estimated coefficients.

3 Econometric Specification

3.1 Model

We extend the baseline model in the seminal works on structural approaches to international trade (Das et al. (2007) and Aw et al. (2011)) by allowing for flexible marginal cost assumptions. There are two segmented markets, domestic and export markets, each of which is governed by a CES demand function. Specifically, domestic demand faced by each firm i at time t is given as:

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

where $\sigma > 0$ is the elasticity of substitution between goods. The aggregate demand level in the domestic market at each time t, Φ_t^d, determines the position of the demand curve common to every firm, and z_{it}^d is an idiosyncratic domestic demand shifter.

Similarly, firm-specific export demand curve is given as:

$$q_{it}^{ex} = \Phi_t^{ex} z_{it}^{ex} \left(p_{it}^{ex}\right)^{-\sigma} \Longleftrightarrow p_{it}^{ex} = \left(\Phi_t^{ex} z_{it}^{ex}\right)^{\frac{1}{\sigma}} \left(q_{it}^{ex}\right)^{-\frac{1}{\sigma}}, \tag{2}$$

where Φ_t^{ex} is the common aggregate export demand level, and z_{it}^{ex} is an idiosyncratic export demand shifter. Firm-level domestic and export demand shifters, z_{it}^d and z_{it}^{ex}, are exogenously drawn from a bivariate distribution.

In the presence of any import tariff imposed by foreign countries (i.e., $\tau_{ex} > 1$), the price exporters receive ($p_{it}^{*,ex}$) will deviate from the price paid by foreign consumers (i.e., $p_{it}^{ex} = p_{it}^{*,ex}\tau_{ex}$).

Domestic sales revenue and export sales revenue are then expressed as:

$$r_{it}^d = p_{it}^d q_{it}^d = \left(\Phi_t^d z_{it}^d\right)^{\frac{1}{\sigma}} \left(q_{it}^d\right)^{\frac{\sigma-1}{\sigma}}, \tag{3}$$

and

$$r_{it}^{ex} = p_{it}^{*,ex} q_{it}^{ex} = \left(\Phi_t^{ex} z_{it}^{ex}\right)^{\frac{1}{\sigma}} \left(q_{it}^{ex}\right)^{\frac{\sigma-1}{\sigma}} / \tau_{ex} \tag{4}$$

from domestic and export market demand function in equations (1) and (2), respectively.

Marginal cost is a function of firm-specific productivity level, ω_{it}, and possibly of total output level:

$$MC_{it} = \frac{1}{\omega_{it}} \left(q_{it}^d + q_{it}^{ex}\right)^{\kappa}, \tag{5}$$

where κ is a parameter that governs the type of marginal cost (i.e., constant marginal cost when $\kappa = 0$, increasing marginal cost when $\kappa > 0$, and decreasing marginal cost when $\kappa < 0$).

The optimality condition that equates marginal cost with marginal revenue in each market is given as:

$$MR_{it}^{ex} = MR_{it}^d = MC_{it}\varepsilon_{it}, \tag{6}$$

where an (random) optimization error ε_{it} is taken into account. The first equality in equation (6) (i.e., $MR_{it}^{ex} = MR_{it}^{d}$) leads to the following relation between export and domestic sales:

$$q_{it}^{d} = q_{it}^{ex} (\tau^{ex})^{\sigma} \left[\frac{z_{it}^{d}}{z_{it}^{ex}} \frac{\Phi_t^{d}}{\Phi_t^{ex}} \right] \tag{7}$$

while the second equality (i.e., $MR_{it}^{d} = MC_{it}\varepsilon_{it}$) leads to the following relation:

$$(\frac{\sigma - 1}{\sigma})(q_{it}^{d})^{\frac{-1}{\sigma}} (\Phi_t^{d} z_{it}^{d})^{\frac{1}{\sigma}} = \frac{1}{\omega_{it}} \epsilon_{it} (q_{it}^{d} + q_{it}^{ex})^{\kappa} \tag{8}$$

Finally, substituting equation (7) into equation (8) above and rearranging in logs, we reach the empirically implementable equation[8]:

$$ln\ q_{it}^{d} = \alpha + \beta\ ln\ q_{it}^{ex} + \sigma\ ln\ \omega_{it} + FE_t + \eta_{it}, \tag{9}$$

where $\alpha = \sigma ln(\frac{\sigma-1}{\sigma}) - \sigma^2 \kappa ln\,(\tau_{ex})\,, \beta = -\sigma\kappa, FE_t = ln(\Phi_t^{d}) - \sigma\kappa ln \left[\frac{\Phi_t^{d}}{\Phi_t^{ex}} \right]$, and $\eta_{it} = (1 - \sigma\kappa) ln(z_{it}^{d}) - \sigma ln\,(\epsilon_{it}) + \sigma\kappa ln(z_{it}^{ex})$.

3.2 Identification Strategy

Of particular interest to us in Equation (9) is the coefficient on export sales, β, which provides information on the shape of the marginal cost curve. In the case of constant marginal cost, $\kappa = 0$, which implies that β is zero as well. This confirms our intuition discussed above: when firms face constant marginal cost, foreign and domestic markets are treated independently, and there should be no observable relationship between foreign and domestic sales once all relevant factors are accounted for in the data.

With increasing marginal cost, $\kappa > 0$, which in turn implies that $\beta < 0$. Estimating a negative relationship between domestic and foreign sales, after properly accounting for other influences, implies that firms are facing increasing marginal costs in production, and domestic and foreign markets are effectively interdependent markets. In practice, when the baseline specification is taken to the data, the estimated coefficient of β will be biased since foreign demand shocks are not directly observable; our combined error term, η_{it}, includes the foreign demand shock via the term, $\sigma\kappa ln(z_{it}^{ex})$, which is correlated with export sales, $ln\ q_{it}^{ex}$. With constant marginal cost (i.e., $\kappa = 0$), foreign demand shocks do not enter into the specification, and there will be no bias, while with increasing marginal cost (i.e., $\kappa > 0$), the positive correlation between foreign demand shocks term and export sales, will bias the estimated coefficient of β upwards toward zero. In this particular case, however, it is assured that the magnitude of omitted variable bias is such that the sign of the estimated coefficient will never switch: even in the presence of omitted variable bias, the estimated coefficient of β will be always negative when firms face increasing marginal cost.[9]

[8] In derivation, $ln\left(1 + \tau_{ex}^{\sigma} \left[\frac{\Phi_t^{d} z_{it}^{d}}{\Phi_t^{ex} z_{it}^{ex}} \right]\right)$ is approximated to $ln\left(\tau_{ex}^{\sigma} \left[\frac{\Phi_t^{d} z_{it}^{d}}{\Phi_t^{ex} z_{it}^{ex}} \right]\right)$.

[9] The omitted variable bias is expressed as $\sigma\kappa \frac{Cov(ln\ q_{it}^{ex}, ln\ z_{it}^{ex})}{Var(ln\ q_{it}^{ex})}$, where $\sigma\kappa = -\beta$. Since $ln\ q_{it}^{ex}$ includes the exogenous foreign demand shocks $ln\ z_{it}^{ex}$ according to Equation (2), $\frac{Cov(ln\ q_{it}^{ex}, ln\ z_{it}^{ex})}{Var(ln\ q_{it}^{ex})}$ cannot be greater than 1, and hence, the bias cannot be greater than $|\beta|$ in absolute term.

Exactly opposite is true for decreasing marginal cost. With decreasing marginal cost, $\kappa < 0$, which in turn implies that $\beta > 0$. The negative correlation between between foreign demand shocks term and export sales, will bias the estimated coefficient of β downwards toward zero. However, even in the presence of omitted variable bias, the estimated coefficient of β will be always positive when firms face decreasing marginal cost.

Practically speaking, observing a negative estimated coefficient β is only consistent with increasing marginal cost, and similarly for a positive coefficient estimate with decreasing marginal cost. Furthermore, our approach will tend to understate the presence of increasing marginal cost in cases where estimates are negative but not statistically significant because of upward bias associated with omitted variables.

Despite the clear identification strategy, when it comes to the empirical implementation, there is a usual caveat that applies to this study, which is common to most studies using firm-level survey data: lack of observable physical output data (i.e., q_{it}^{d} and q_{it}^{ex}). For this reason, we follow the standard, but imperfect, solution to replace output with sales (i.e., r_{it}^{d} and r_{it}^{ex}) deflated by industry-level price index. This applies not only to domestic and export sales directly but also to the productivity estimation process as well. As De Loecker (2011) noted, productivity growth measures are less vulnerable to potential bias from this fix, so we take (yearly) differences of equation (9) as the preferred specification:[10]

$$\Delta ln\ q_{it}^{d} = \beta\ \Delta ln\ q_{it}^{ex} + \sigma\ \Delta ln\ \omega_{it} + \Delta FE_{t} + \Delta\eta_{it} \tag{10}$$

Our baseline specification will also consider industry-year fixed effects and firm fixed effects. Industry-year fixed effects will, in addition to absorbing year-specific effects ΔFE_{t}, capture any industry-year-specific effects such as tariff changes or effective exchange rate movements. Likewise, firm fixed effects will pull out any constant time trends that are firm-specific.

The last piece of our identification strategy is to verify specific sources of increasing marginal cost by controlling 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 sales and domestic sales, 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 corresponding specification will be given as:

$$\begin{aligned} \Delta ln\ q_{it}^{d} \quad = \quad & \beta_1 \Delta ln\ q_{it}^{ex} \ + \ \beta_2(\text{capacity constraint})_{it} \\ & + \ \beta_3 \Delta ln\ q_{it}^{ex} \times (\text{capacity constraint})_{it} \\ & + \ \sigma\ \Delta ln\ \omega_{it} \ \ + \Delta FE_{t} + \Delta\eta_{it} \end{aligned}$$

The capacity constraint can be a dummy variable with 1 for constrained firms and 0 otherwise. Our main focus will be on the coefficient of the interaction term, β_3. $\beta_3 < 0$ implies that constrained

[10]There are two important implications—one economic and the other for data—of using the yearly difference measure: it guides us to focus on short-run marginal cost over an annual horizon, and limits our analysis to continuing exporters. 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)

firms show a stronger negative correlation between export status and domestic sales growth, supporting the increasing marginal cost story.

4 Data

The data is drawn from a commonly used plant-level dataset collected by the Indonesia Central Bureau of Statistics (BPS).[11] 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.[12]

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

The survey is conducted at the plant-level. The BPS sends out 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. An additional survey is sent to the head office of each multi-plant firm.[13] 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.[14]

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 (i.e., "what percentage of capacity does the firm utilize?"), which forms the basis of our measure of physical capacity constraints. Our primary measure of physical capacity constraints is 100% capacity utilization, while the continuous measure of capacity utilization is 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.[15] As a robustness check, we follow Manova et al. (2014) and use an

[11] Other studies that employed the same dataset include Blalock and Gertler (2004), Blalock and Gertler (2008), Rodrigue (2014), Mobarak and Purbasari (2006), Amiti and Konings (2007), and Sethupathy (2008) among others.

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

[13] 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.

[14] 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 (see equation (10)).

[15] See for example Kaplan and Zingales (1997), Whited and Wu (2006), and Lin et al. (2011).

alternative measure of financial constraints based on ownership structure, where firms with foreign ownership share larger than 50 percent are classified as financially unconstrained firms.

The entire sample of firms over the seven-year panel includes nearly 125,000 observations, from 32,388 unique plants. Our primary analysis will focus on a panel of continuing exporters. When we restrict our sample to just continuing exporters, we are left with 3,248 plants that are observed to export in consecutive years, giving us 8,627 observations.

Table 1 provides a brief description of the sample, broken down by export classification. It is important to note that patterns observed in the Indonesian data are similar to those found in other firm level datasets. Namely, there is significant heterogeneity across firms, exporting is rare, and firm outcomes are positively correlated with export status and duration. Consistent with previous studies, exporters are bigger and better in various dimensions than non-exporters. Furthermore, continuing exporters are even bigger and better than the typical exporter in the same dimensions, accounting for 61% and 62% of total exports and domestic sales among exporters in Indonesia over the reported time period. This fractal quality of firm characteristics along exporting classification is a well-known feature of firm-level data.

What is less well-known is the relationship between capacity constraints and firm outcomes. We are interested in two dimensions of capacity constraints, physical and financial constraints. Table 2 highlights the distinct nature of these two types of capacity constraints.

In columns 1 and 2 of Table 2, firm characteristics are broken out between physically constrained and physically unconstrained continuous exporters. By comparing the two columns, we can see that physically constrained firms tend to sell more both domestically and abroad compared to their unconstrained counterparts. Moreover, physically constrained firms hire more paid worker and are more productive in terms of output per worker. One can infer from this that firms are likely to be considered physically constrained (that is, using 100% of their capacity) when they are experiencing unexpectedly high demand shocks in a given year. Despite being bigger and more productive, they are physically constrained in a given year because they cannot fully meet demand in that year. One rationalization of this observation is that firms choose optimal physical capacity given their best guess about likely demand as well as costs associated with unused capacity compared to foregone profit opportunities when firms stock out, and are ex post physically constrained for particularly large realizations of demand shocks.[16]

Financial constraints, on the other hand, could stem from imperfections in the financial market, which would be particularly relevant in developing countries like Indonesia. In this case, financially constrained firms will be unable to achieve optimal scale, and instead pick capacity with an additional borrowing constraint. In columns 3 and 4, we see that the patterns of size and productivity are reversed when compared to physically constrained firms. Financially constrained firms sell less domestically and abroad, employ fewer workers, and are less productive.

As an alternative measure of financial constraints, we follow Manova et al. (2014) who argue that particularly in countries with thin or inefficient financial markets, access to foreign capital is a good proxy for liquidity. Firms that are majority foreign-owned face less severe credit constraints since these firms have access to foreign credit markets, either internally or through access to foreign credit markets, while domestically owned firms tend to work primarily with inefficient local credit markets. In columns 5 and 6 of Table 2, domestic firms sell less domestically and abroad, hire fewer workers, and produce less per worker employed when compared to foreign firms.

[16] This observation is consistent with the evidence presented in Soderbery (2014) for Thai firms.

These two types of capacity constraints appear to be truly distinct in terms of mechanisms and observable firm characteristics. In fact, there is essentially no correlation between the two types of constraints in the data, with the partial correlations between physical and financial indicators of -0.02 for either financial classification. Given that physical capacity constraints likely arise from unexpected demand in a given year, whereas financial constraints are due to imperfect credit markets, it will be important to distinguish the source of the capacity constraint for policy implications.

In terms of identification strategy, however, we will exploit the fact that distinct sources of capacity constraints have the same observable economic effect. When a firm is constrained, either financially or physically, the ability to produce and sell one more unit is restricted, leading to increasing marginal cost of production for that next unit. As our theory developed above suggests, firms that are facing increasing marginal cost will face more severe trade-offs between sales abroad and domestically, leading to an observed negative correlation between foreign and domestic sales. To formally estimate and identify the relationship, we now take our model-based econometric specification to the data.

5 Results

Based on the structural econometric specification developed in Section 3, we evaluate the prevalence of increasing marginal cost at the firm-level, and then show that increasing marginal cost is particularly relevant for physically and/or financially constrained firms. The identification strategy is that for firms exhibiting constant marginal cost, there should be no observed relationship between domestic sales and foreign sales after properly accounting for relevant forces (such as productivity). For firms facing increasing marginal cost, on the other hand, the estimated coefficient on foreign sales should be negative, although the actual estimate will be biased upwards toward zero because of omitted variable bias driven by unobserved foreign demand shocks, which will tend to underestimate the prevalence of increasing marginal cost technology in the data.

Our first result for continuing exporters verifies that there is a significant negative relationship between export sales growth and domestic sales growth for individual firms, suggesting the prevalence of increasing marginal cost at the firm-level.

For a first glance, consider the simple correlation between domestic sales growth and export sales growth. The correlation coefficient is -0.02 in column (1) of Table 3, but is not statistically significant. One interpretation is that on average firms are best described as having constant marginal cost technology, and there is no observed relationship between foreign and domestic sales. In column (2) of Table 3, we include sector-year fixed effects with no noticeable change in our estimated coefficient. In column (3), however, incorporating firm fixed effects has the effect of correcting for firm-specific trends over time, yielding a statistically significant coefficient estimate four times larger. This is consistent with the view that firm-specific time trends, likely related to persistent demand shocks, were hiding the underlying trade-off between foreign and domestic markets, a hallmark of increasing marginal cost. Column (4) adds both firm-level and sector-year fixed effects, confirming the pattern.

As we 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 3 includes multiple measures of productivity growth (measures based on labor productivity, simple TFP growth, and a measure based on Levisohn-Petrin). As expected, the inclusion of productivity strengthens the basic story that export sales and domestic sales are negatively correlated for a firm, demonstrating that the omission of productivity was biasing upward the estimated coefficient on export sales growth by over 50%. The results are consistent across alternative measures of productivity.

Having shown the prevalence of increasing marginal cost at the firm-level, we turn to considering various sources of increasing marginal cost. Our empirical strategy takes the view that if it is increasing marginal costs that are driving the observed negative correlation between export sales and domestic sales, we should expect that this pattern will be stronger for firms that are capacity constrained since these firms are facing steeper costs associated with expanding production.

Results are reported in Table 4. Column (1) restates the initial finding of a negative correlation between export sales and domestic sales growth within the firm for reference (column (4) of Table 3). 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. First, the interaction term between financial capacity constraints and export sales growth is negative and statistically significant, suggesting that financially distressed exporters face greater trade-offs between domestic sales and export sales growth than unconstrained exporters. A second intriguing finding is that export growth is no longer separately significant with a positive coefficient estimate.

Column (4) includes both physical and financial capacity constraints. Both interaction terms are negative and statistically significant. The size of the reported coefficients implies that a physically constrained exporter experiences a .27 percent 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 -.45 (.27+.18) percent for every one percent increase in export sales growth. For unconstrained firms, there is no apparent relationship between export and domestic sales growth. 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, and that the negative correlation we observed in the baseline specification is being driven by firms that are physically or financially capacity constrained. Columns (5) through (7) show the result is robust to the inclusion of alternative productivity measures.

Overall, Table 3 and 4 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. Moreover, once capacity constraints are accounted for, there is no noticeable relationship between export sales and domestic sales growth. As our theory above makes clear, this is prima facie evidence for the prevalence of increasing marginal cost at the firm level. However, as demonstrated above, it should be emphasized that, because of attenuation bias, we are likely understating the existence of firms operating with increasing marginal cost.

Next, we repeat the analysis using an alternative measure of financial constraints, following Manova et al. (2014) who argue that foreign-owned subsidiaries, especially in underdeveloped financially markets, tend to face fewer financial constraints than domestically owned competitors.

Firms with foreign parents have access to internal capital markets (borrow from parent directly) or access to foreign financial markets through parent relations. As such, we would expect that foreign-owned firms experience less severe financial constraints, while purely domestically-owned firms are more likely to experience increasing marginal cost driven by financial constraints.

Table 5 confirms this intuition. Column (1) finds that firms that are domestically owned show a significant negative relationship between export sales and domestic sales, implying these firms face increasing marginal cost of production. Column (2) shows the result is robust to the inclusion of physical capacity constraints. Columns (3) through (5) show the results are again consistent with alternative measures of productivity. In sum, using an alternative proxy for financial constraints based on the concept introduced by Manova et al. (2014), we find strong evidence for the existence of increasing marginal cost at the firm level.

While Tables 4 and 5 provide evidence about the nature of capacity constraints and the interrelation of foreign and domestic sales, we consider a number of additional robustness checks to confirm the findings. To test the robustness of our baseline measures of capacity constraints, we consider alternative definitions. We start by using a continuous measure of capacity utilization. The intuition is that while there may be measurement error in reported capacity utilization, managers reporting higher capacity utilization are indicating greater production constraints compared to lower reported capacity utilization values. Beta coefficients on this alternative measure of physical constraints are reported in the table.

In column (1) of Table 6, the alternative measure of physical capacity constraints when interacted with export sales is again negative and statistically significant. The interpretation is that firms experiencing higher capacity utilization also experience greater trade-offs between domestic and foreign sales, consistent with increasing marginal costs of production. In column (2), our alternative measure of physical capacity constraints are robust to the inclusion of financial constraints, with no noticeable impact on estimated coefficients. Both interaction terms are negative and significant, suggesting results are robust to alternative measures of physical capacity constraints.

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, increasing the likelihood that firms that are financially distressed will be classified as financially unconstrained. Empirically, this will tend to increase the magnitude of the negative coefficient on exports, and reduce statistical significance between groups.

Column (3) of Table 6 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, and Column (5) uses both alternative measures of capacity constraints. Both interaction effects are negative and statistically significant, suggesting that the results are not being driven by the specific threshold level of firm-level financial capacity constraints. The last three columns of Table 6 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 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. Leveraging the model-driven empirical estimation to guide our interpretation, we take these results as strong evidence for the presence of increasing marginal cost, driven by financial and physical capacity constraints.[17]

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. Guided by the estimating equation derived from a structural model, we document a strong empirical pattern of a negative relationship between domestic sales and exports sales. We show an estimated negative coefficient on export sales is only consistent with increasing marginal cost, and this represents a lower bound on the true intensity and prevalence of increasing marginal cost technology firms. Given the likelihood of attenuation bias because of unobservable foreign demand shocks, the importance of increasing marginal cost is likely understated.

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. While physical capacity constraints are likely to be the result of unexpectedly large demand shocks that may dissipate quickly, financial constraints will tend to be beyond the control of the firm and therefore longer lasting. Our findings are robust to multiple measures of physical and financial constraints as well as alternative measures of productivity. This suggests that a constant marginal cost view is inappropriate for internationally active firms, and that persistent constraints at the plant level could be quite significant for understanding aggregate outcomes.

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. In this sense, our findings are expected to serve as the rationale behind the micro-foundation of a growing number of theory models in macroeconomics that adopt decreasing returns to scale technology to explain salient features of firm-level behaviors.

Once aggregated, however, it also has important macroeconomic implications. 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 an 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. Therefore, the key mechanism of this paper, the opportunity cost

[17] There are two potential concerns related to the dataset used in this paper. The first is that Indonesian firms may not be sufficiently similar to firms in other countries, and therefore our results may not be generalizable. 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. We addressed these concerns in a longer working paper version of this draft (Ahn and McQuoid (2012)) by exploring and confirming the basic results presented above using Chilean plant-level data.

of exporting, will bring alternative explanations on the observed co-movement dynamics (or lack thereof) between exports and domestic sales at the aggregate level.

After all, exporters facing increasing marginal cost provide a conduit through which shocks are transmitted across borders. Purely foreign shocks spill over into the domestic market as these firms re-optimize in each market. Such spillovers can affect all aspects of firm behavior including pricing,[18] and thus should be considered more carefully in trade models, particularly when short-run adjustment behavior are under consideration.

[18] Firms facing increasing marginal cost adjust on prices as well as quantities. The prevalence of increasing marginal cost firms is therefore likely to lead to higher prices and thus lower welfare when compared to economies with constant marginal cost firms. In a longer working paper version of this draft (Ahn and McQuoid (2012)), we show that static welfare losses via higher prices can be large.

References

Ahn, J. (2011). A theory of domestic and international trade finance. *IMF Working Paper*, (11/262).

Ahn, J. and McQuoid, A. (2012). Capacity constrained exporters: Micro evidence and macro implications. *FIU Working Paper Series*.

Ahn, J. and Park, C.-G. (2014). Exchange rate pass-through to domestic producer prices: Evidence from korean firm-level pricing survey. *Economics Letters*, 125(1):138–142.

Amiti, M. and Konings, J. (2007). Trade liberalization, intermediate inputs, and productivity: Evidence from indonesia. *The American Economic Review*, 97(5):pp. 1611–1638.

Arkolakis, C. (2010). Market penetration costs and the new consumers margin in international trade. *Journal of Political Economy*, 118(6):1151 – 1199.

Arkolakis, C., Eaton, J., and Kortum, S. (2011). Staggered adjustment and trade dynamics.

Aw, B. Y., Roberts, M., and Xu, D. (2011). R & d investment, exporting, and productivity dynamics. *American Economic Review*, 101(4):1312–44.

Belke, A., Oeking, A., and Setzer, R. (2013). Exports and capacity constraints - a smooth transition regression model for six euro area countries.

Berman, N., Berthou, A., and Hericourt, J. (2011). Export dynamics and sales at home.

Blalock, G. and Gertler, P. J. (2004). Learning from exporting revisited in a less developed setting. *Journal of Development Economics*, 75(2):397 – 416.

Blalock, G. and Gertler, P. J. (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of International Economics*, 74(2):402 – 421.

Blum, B., Claro, S., and Horstmann, I. (2013). Occasional vs perennial exporters: The impact of capacity on export mode. *Journal of International Economics*, 90, 1:65–74.

Chaney, T. (2005). Liquidity constrained exporters.

Das, S., Roberts, M. J., and Tybout, J. R. (2007). Market entry costs, producer heterogeneity, and export dynamics. *Econometrica*, 75(3):837–873.

De Loecker, J. (2011). Recovering markups from production data. *International Journal of Industrial Organization*, 29(3):350–355.

Esteves, P. and Rua, A. (2013). Is there a role for domestic demand pressure on export performance?

Fazzari, S. M., Hubbard, R. G., Petersen, B. C., Blinder, A. S., and Poterba, J. M. (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, 1988(1):pp. 141–206.

Feenstra, R. C., Li, Z., and Yu, M. (2013). Exports and credit constraints under incomplete information: Theory and evidence from china. *Review of Economics and Statistics*.

Ghemawat, P. and Mitchell, J. (2011). Grolsch: Growing globally. Technical report, Harvard Business School Case Study.

Kaplan, S. N. and Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? *The Quarterly Journal of Economics*, 112(1):pp. 169–215.

Kohn, D., Leibovici, F., and Szkup, M. (2012). Financial frictions and new exporter dynamics.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, 70(5):pp. 950–959.

Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, 9(4):469 – 479.

Lin, C., Ma, Y., and Xuan, Y. (2011). Ownership structure and financial constraints: Evidence from a structural estimation. *Journal of Financial Economics*, 102(2):416 – 431.

Lucas, Robert E., J. (1978). On the size distribution of business firms. *The Bell Journal of Economics*, 9(2):pp. 508–523.

Manova, K. (2013). Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies*, 80:711–744.

Manova, K., Wei, S.-J., and Zhang, Z. (2014). Firm exports and multinational activity under credit constraints. *Review of Economics and Statistics*.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6):pp. 1695–1725.

Mobarak, A. M. and Purbasari, D. P. (2006). Corrupt protection for sale to firms: Evidence from indonesia.

Muûls, M. (2008). Exporters and credit constraints: A firm-level approach.

Nguyen, D. and Schaur, G. (2011). Cost linkages transmit volatility across markets.

Paravisini, D., Rappoport, V., Schnabl, P., and Wolfenzon, D. (2014). Dissecting the effect of credit supply on trade: Evidence from matched credit-export data. *Review of Economic Studies*.

Pollard, P. and Coughlin, C. (2004). Size matters: Asymmetric exchange rate pass-through at the industry level.

Rho, Y.-W. and Rodrigue, J. (2014). Firm-level investment and export dynamics. *International Economic Review*.

Rodrigue, J. (2014). Multinational production, exports, and aggregate productivity. *Review of Economic Dynamics*.

Ruhl, K. and Willis, J. (2008). New exporter dynamics.

Ruhl, K. J. (2008). The international elasticity puzzle.

Sethupathy, G. (2008). Does exporting lead to productivity spillovers in horizontal or vertical industries? evidence from indonesia.

Soderbery, A. (2014). Market size, structure, and access: Trade with capacity constraints. *European Economic Review*.

Spearot, A. C. (2012). Firm heterogeneity, new investment and acquisitions. *The Journal of Industrial Economics*, 60(1):1–45.

Vannoorenberghe, G. (2012). Firm-level volatility and exports. *Journal of International Economics*, 1.

Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the mexican manufacturing sector. *The Quarterly Journal of Economics*, 123(2):489–530.

Whited, T. M. and Wu, G. (2006). Financial constraints risk. *Review of Financial Studies*, 19(2):531–559.

Figures

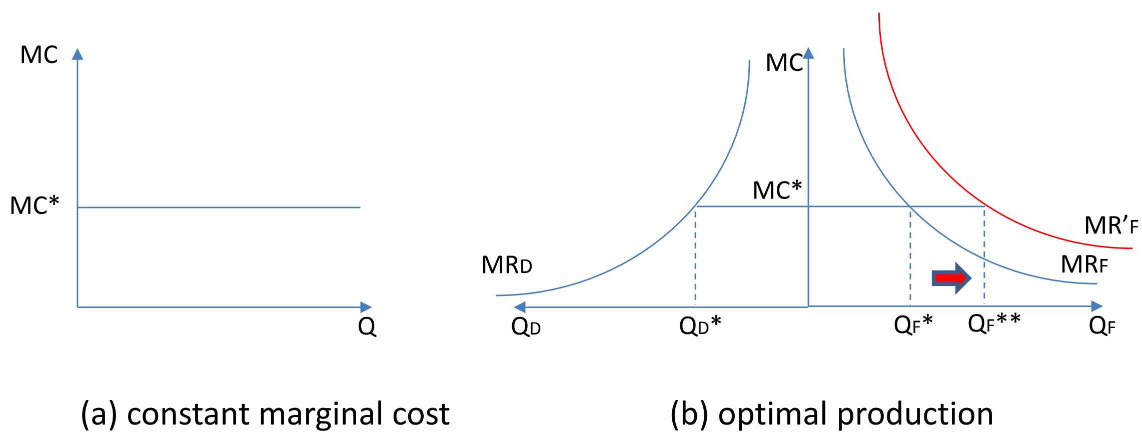


Figure 1: Constant Marginal Cost and Production

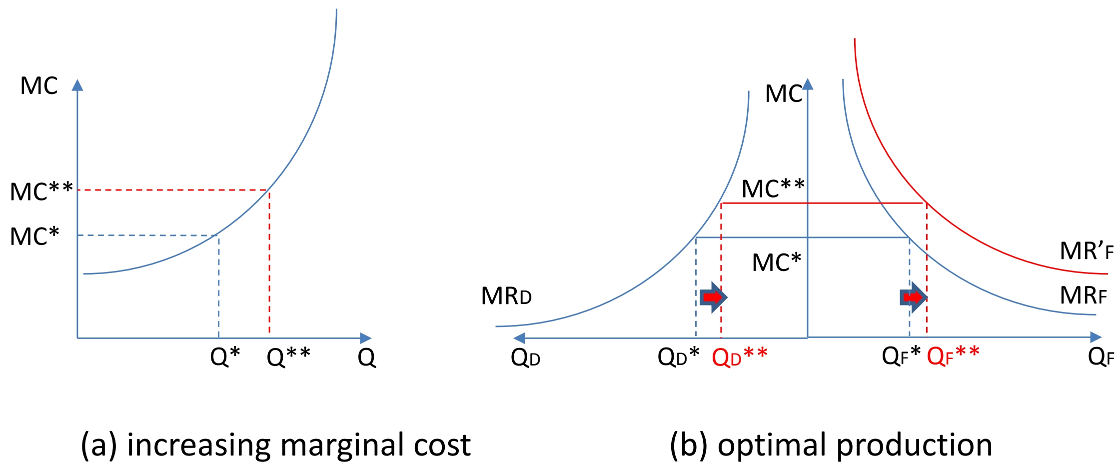
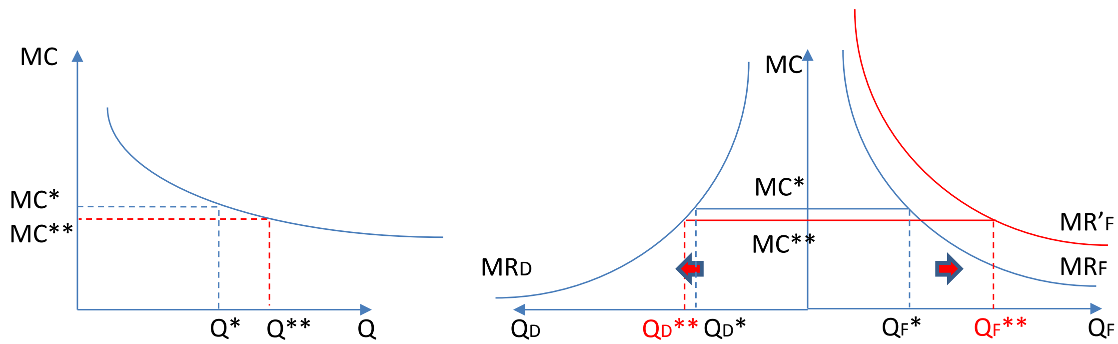


Figure 2: Increasing Marginal Cost and Production



(a) decreasing marginal cost (b) optimal production

Figure 3: Decreasing Marginal Cost and Production

Tables

	All Firms	Non-exporters	Exporters	Continuing Exporters
Total Output (in 1,000 Rupiah)	5,516	3,554	17,343	21,929
Export Sales (in 1,000 Rupiah)	1,193	0	8,383	10,493
Domestic Sales (in 1,000 Rupiah)	4,323	3,554	8,959	11,435
Paid Workers	180.4	125.5	511.3	592.8
Output per worker (in 1,000 Rupiah)	17.6	15.5	30.2	32.8
Number of Observations	124,715	106,970	17,745	8,627

Notes: Mean summary statistics are provided for alternative classifications of firms. In the first column, all firms in the dataset are included. Columns 2 and 3 split the sample into firms that are observed to export at least once in the sample, and firms that never export. Column 4 includes only observations from firms that export in at least two consecutive years.

Table 1: Mean Values by Export Classification

	Physically		Financially		Financially	
	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained (Foreign Owned)	Constrained (Domestic Owned)
Total Output (in 1,000 Rupiah)	24,515	29,832	32,448	18,600	39,846	22,504
Export Sales (in 1,000 Rupiah)	11,023	14,595	13,137	9,136	20,340	9,834
Domestic Sales (in 1,000 Rupiah)	13,491	15,237	19,312	9,464	19,506	12,671
Paid Workers	635	701	675	630	745	624
Output per worker (in 1,000 Rupiah)	35.2	43.3	38.4	29.6	75.4	29.4
Number of Observations	6,605	578	2,701	3,604	1,010	6,173

Notes: Mean summary statistics are provided for alternative classifications of continuing exporters. The first two columns split continuing exporters into unconstrained and physically constrained (defined as capacity utilization of 100%). Columns 3 and 4 split the sample into unconstrained and financially constrained based on the ratio of cash flow to assets. Columns 5 and 6 provide an alternative measure of financial constraints based on foreign ownership, where majority-owned foreign firms are classified as unconstrained.

Table 2: Mean Values for Constrained and Unconstrained Continuing Exporters

Δ ln(domestic sales)	1	2	3	4	5	6	7	8	9
Δ ln(export sales)	-0.02	-0.03	-0.08	-0.09	-0.14	-0.14	-0.19	-0.18	-0.16
	(0.03)	(0.03)	(0.03)***	(0.03) ***	(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	no	yes	no	yes	yes	yes	yes
Firm FE	no	no	yes	yes	no	no	yes	yes	yes
Observations	7,183	7,183	7,183	7,183	7,183	7,183	7,183	6,091	6,065

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. Productivity in this regression is labor productivity measured as (value added outputs)/(total labor employed) in columns 5, 6, and 7. Column 8 reports the regression result with productivity as TFP deviation from the sector-year mean. Column 9 reports the regression result with productivity estimated using the methodology of Levinsohn and Petrin (2008). All standard errors are clustered at the sector-year level and provided in parentheses. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table 3: Identifying Increasing Marginal Cost

Δ ln(domestic sales)	1	2	3	4	5 Labor Prod	6 TFP Prod	7 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 Levinsohn 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 4: Identifying Increasing Marginal Cost with Capacity Constraints

Δ ln(domestic sales)	1	2	3	4	5
			Labor Prod	TFP Prod	LP Prod
Δ ln(export sales)	0.11	0.13	0.00	0.05	0.06
	(0.13)	(0.12)	(0.10)	(0.14)	(0.14)
Financially Constrained	0.11	0.12	0.09	0.34	0.35
	(0.18)	(0.18)	(0.18)	(0.21)	(0.22)
Δ ln(export sales)*financial	-0.24	-0.24	-0.21	-0.25	-0.24
	(0.13) *	(0.13)*	(0.10)**	(0.15)*	(0.14) *
Physically Constrained		0.04	0.06	0.003	0.001
		(0.08)	(0.08)	(0.08)	(0.07)
Δ ln(export sales)*physical		-0.24	-0.23	-0.30	-0.28
		(0.09)***	(0.08)***	(0.11)***	(0.10)***
Δ ln(productivity)			0.32	0.27	0.26
			(0.03)***	(0.03)***	(0.03)***
Sector-year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	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 column 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 Levinsohn 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 domestically owned and controlled (foreign ownership share <50%) firms and 0 for foreign owned and controlled (foreign ownership share >50%) subsidiaries. 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 5: Financial Constraints - Foreign Ownership Status

Δ ln(domestic sales)	1 Alt Physical	2 Alt Physical	3 Alt Financial	4 Alt Financial	5 Alt Physical Alt Financial	6 Alt Physical Alt Financial Labor Productivity	7 Alt Physical Alt Financial TFP	8 Alt Physical Alt Financial LP
Δ ln(export sales)	-0.11	0.02	-0.05	-0.04	-0.08	-0.17	-0.16	-0.15
	(0.03)	(0.07)	(0.05)	(0.05)	(0.04)*	(0.04)***	(0.04)***	(0.04)***
Physically Constrained	0.02	0.02		0.05	0.03	0.03	0.02	0.02
	(0.03)	(0.03)		(0.07)	(0.03)	(0.03)	(0.03)	(0.03)
Δ ln(export sales)*physical	-0.08	-0.09		-0.28	-0.08	-0.07	-0.08	-0.09
	(0.03)***	(0.03)***		(0.11)**	(0.04)**	(0.03)**	(0.03)**	(0.03)***
Financially Constrained		-0.24	-0.18	-0.18	-0.18	-0.01	-0.10	-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	-0.13	-0.14	-0.13
		(0.08)***	(0.08)**	(0.08)**	(0.07)**	(0.07)*	(0.07)*	(0.07)*
Δ ln(productivity)						0.30	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 Levinsohn 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. Alternative Physical capacity constraint is continuous measure of capacity utilization, standardized so that the coefficient can be interpreted as a beta coefficient. Alternative 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 6: Identifying Increasing Marginal Cost with Alternative Measures of Financial and Physical Constraints