Managing Trade: Evidence from China and the US*

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Abstract

We present a heterogeneous-firm model in which management ability increases both production efficiency and product quality. Combining six micro-datasets on management practices, production and trade in Chinese and American firms, we find broad support for the model's predictions. First, better managed firms are more likely to export, sell more products to more destination countries, and earn higher export revenues and profits. Second, better managed exporters have higher prices, higher quality, and lower quality-adjusted prices. Finally, they also use a wider range of inputs, higher quality and more expensive inputs, and imported inputs from more advanced countries. The structural estimates indicate that management is important for improving production efficiency and product quality in both countries, but it matters more in China than in the US, especially for product quality. Panel analysis for the US and a randomized control trial in India suggest that management exerts causal effects on product quality, production efficiency, and exports. Poor management practices may thus hinder trade and growth, especially in developing countries.

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1 Introduction

Productivity, management practices and international trade activity vary dramatically across firms and countries (Bernard, Jensen, Redding, and Schott, 2007; Syverson, 2011). In the literature, higher measured Total Factor Productivity (TFP) has been associated with export success and superior management with higher profits. However, measured TFP is subject to estimation biases and constitutes a residual "black box", while the mechanisms through which management operates remain largely unknown. From a policy perspective, improving firm capabilities is important for stimulating firm performance and aggregate growth, but this requires knowledge of the determinants of firm productivity. While it is widely believed that management strategies play a central role, especially in emerging economies trying to move up the quality ladder (Sutton, 2012), the scant evidence for this is primarily from case studies.

In this paper we perform what we believe is the first large-scale analysis of the role of management practices for export performance and in the process shed light on these questions. We uncover novel empirical facts and interpret them through the lens of a heterogeneous-firm theoretical model that disciplines the estimation approach. We study the world's two largest export economies - China and the United States - and find consistent empirical patterns in both countries despite their very different income levels, institutional quality and market frictions. In particular, we exploit unique new data on plant-level production, plant-level management practices, and transaction-level international trade activity for 485 Chinese firms in 1999-2008 and over 10,000 US firms in 2010.

We first establish that better managed firms have superior export performance. Companies with more effective management practices are systematically more likely to engage in exporting. Conditional on exporting, they sell more products to more destination countries and earn higher export revenues and profits. In addition, our findings for management survive when we explicitly control for revenue-based firm TFP as commonly constructed in the literature.

We then present a collection of independent results that jointly inform the mechanisms through which management strategies affect firm performance. On the sales side, better managed firms charge higher export prices within narrowly defined destination-product markets. We estimate a model-consistent indicator of product quality, and show that management competence is associated with higher output quality and lower quality-adjusted prices. On the production side, better managed companies use more expensive, higher-quality imported inputs and more inputs from suppliers located in developed economies. They also source a wider range of distinct inputs from more countries of origin.

We propose that these empirical patterns are consistent with management competence being an important component of firms' total factor productivity, whereby more effective managerial practices increase both production efficiency and quality capacity. Superior management enables firms to use more sophisticated, higher-quality inputs and more complex assembly technologies that increase output quality. At the same time, advanced management allows firms to process inputs and execute assembly more cheaply. When both the efficiency and quality channels are active, they push marginal costs in opposite directions, such that the net effect of management competence on prices and quantities is ambiguous, but it unambiguously raises product quality, sales and profits. These predictions are preserved when we extend the baseline model to incorporate endogenous input choice, endogenous management practices, or non-management components of TFP.

Our main empirical analysis explores the cross-sectional variation in management and trade activity across Chinese and American firms. We therefore do not distinguish between a causal effect of good management and an equilibrium relationship between joint outcomes of the firm's profit maximization problem. Instead, we view our baseline results as conditional correlations that inform the mechanisms through which management operates. We also provide two additional pieces of evidence that suggest a causal role for management competence. These are based on panel analysis of changes within US firms over time and on a randomized control trial that offered management consulting to Indian firms. Both exercises reveal patterns closely in line with the cross-section.

Our findings address two open questions in two separate, active literatures. A large theoretical and empirical literature in international trade emphasizes the role of firm productivity as a key determinant of firms' export performance (Melitz, 2003; Bernard, Eaton, Jensen, and Kortum, 2003; Melitz and Ottaviano, 2008; Bernard, Jensen, Redding, and Schott, 2007). More productive firms have been found to export more products to more destinations, thereby generating higher export revenues and profits. This body of work conceptualizes firm productivity as TFPQ, or the ability to manufacture at low marginal costs, such that more productive firms are more successful exporters because they set lower prices. Recent analyses point to the importance of product quality as well, showing that more successful exporters use higher-quality manufactured inputs and more skilled workers in order to produce higher-quality output that sells at higher prices (Verhoogen, 2008; Kugler and Verhoogen, 2012; Khandelwal, 2010; Manova and Zhang, 2012; Johnson, 2012; Bastos, Silva, and Verhoogen, 2018). Yet productivity is typically measured as TFPR, or a revenue-based residual from production function estimates. This makes it subject to estimation bias and complicates the interpretation of trade-TFPR regression analyses (Ackerberg, Caves, and Frazer, 2015; De Loecker, 2011). Thus, an important open question in the trade literature is what constitutes productivity, how it should be measured, and what explains its vast variation across firms.

A separate and older literature has examined the relationship between firm management, productivity and performance (Walker, 1887; Taylor, 1911; Syverson, 2011). One likely route for this management-productivity link emphasized by the management literature is through lean manufacturing and improved quality (Deming, 1950; Womack, Jones, and Roos, 1990; Drew, McCallum, and Roggenhofer, 2016; Sutton, 2007). Yet there is no systematic, direct evidence on the mechanisms through which management operates.[1]

Our work informs both of these open questions. We conclude that effective management enhances firm performance by enabling firms to manufacture higher-quality goods more efficiently, such that both production efficiency and quality capability increase with management competence. We also unpack the black box of TFPR and identify management practices as a concrete, tangible and directly measured TFPQ component that accounts for the heterogeneity in firm performance. Studying management practices thus circumvents concerns with estimation biases in trade-productivity regressions and delivers clearer policy lessons.

This paper also adds to recent research on the impact of trade liberalization on the organization of production inside firms. Evidence indicates that trade reforms incentivize firms to change the number of management layers, adjust the number and wages of managers and workers along the occupational hierarchy, and upgrade management practices (Caliendo and Rossi-Hansberg, 2012; Caliendo, Monte, and Rossi-Hansberg, 2017; Chakraborty and Raveh, 2018; Chen and Steinwender, 2016). At the same time, improved access to imported inputs is important to the product quality, product scope and export success of firms in developing countries, because of the limited domestic supply of high-quality specialized inputs and equipment (Goldberg, Khandelwal, Pavcnik, and Topalova, 2010; Fieler, Eslava, and Xu, 2018; Manova and Zhang, 2012). This matters since poor economies often rely on international trade for growth, and specifically on exporting to large, developed and profitable markets that maintain high quality standards. In light of these two lines of work, our results suggest that poor managerial practices may impede trade, growth and entrepreneurship in the world's poorest economies.

Finally, our findings speak to the active literature on the implications of firm heterogeneity for aggregate productivity, welfare and the gains from trade (Hsieh and Klenow, 2009; Arkolakis, Costinot, and Rodríguez-Clare, 2012; Melitz and Redding, 2013). Evidence indicates that reallocations across firms and across products within firms, as well as productivity upgrading within firms contribute significantly to the aggregate adjustment to trade reforms and macroeconomic shocks (Pavcnik, 2002; Bernard, Eaton, Jensen, and Kortum, 2003; Bustos, 2011; Berthou, Chung, Manova, and Bragard, 2016). Understanding the sources of firm heterogeneity is thus important for understanding aggregate outcomes. In addition, given evidence on the complementarity between manufactured input quality and skilled labor in the production of output quality (Verhoogen, 2008), quality differentiation across firms and its interplay with management competence also has implications for the differential effects of shocks across the firm size and worker skill distributions.

The remainder of the paper is organized as follows. Section 2 theoretically models the role of management competence for firms' export performance. Section 3 introduces the Chinese and

[1] The most popular management systems - Six-Sigma, Lean, and the Toyota Production System - all emphasize that improving productivity and quality is best achieved by an ongoing focus on reducing defects. In fact, this approach is now so popular that it has spread from manufacturing across most sectors, for example to Lean Retail (Myerson, 2014), Lean Healthcare (Group, 2014) and even Lean Government (Teeuwen, 2010).

US data on firms' balance sheets, trade activity, and management practices. Section 4 examines the relationship between firms' management competence and export performance, and explores how managerial strategies contribute to firm productivity. Section 5 analyzes the efficiency and quality mechanisms through which superior management operates. Section 6 provides evidence from both a randomized control trial and within-firm changes in the panel that is consistent with causal effects of good management. The last section concludes.

2 Theoretical Framework

We develop a theoretical model of international trade in which heterogeneous firms choose how many products to manufacture, what markets to enter, and which products to sell in each market. In the baseline set-up, firms receive an exogenous draw of management competence which uniquely determines firm choices and performance outcomes. We consider the endogenous adoption of management practices in an extension to this benchmark model in Appendix 2.1. We posit that effective management can enhance firm performance by increasing production efficiency and/or quality capacity. We characterize the relationship between firms' management competence and trade activity under alternative assumptions about the relative importance of these two channels, and derive testable predictions that allow us to empirically assess their relevance in practice. We relegate all detailed proofs to Appendix 1.

We incorporate management competence in a partial-equilibrium trade model that features quality and efficiency differentiation across firms and across products within multi-product firms. In our baseline, we treat management effectiveness as equivalent to TFP, such that our model closely resembles that in Bernard, Redding, and Schott (2010)(BRS), Kugler and Verhoogen (2012), and Manova and Yu (2017). We examine the alternative in which management practices are one of multiple components of firm productivity in Appendix 2.2.

2.1 Set Up

Consider a world with $J+1$ countries. In each country, a continuum of heterogeneous firms produce horizontally and vertically differentiated goods which they sell at home and potentially export abroad. Consumers exhibit love of variety such that the representative consumer in country j has CES utility $U_j = \left[\int_{i\in\Omega_j} (q_{ji}x_{ji})^{\alpha}\, di\right]^{\frac{1}{\alpha}}$, where q_{ji} and x_{ji} are the quality and quantity consumed by country j of variety i, and Ω_j is the set of goods available to j. The elasticity of substitution across products is $\sigma \equiv 1/(1-\alpha) > 1$ with $0 < \alpha < 1$. If total expenditure in country j is R_j, j's demand for variety i is $x_{ji} = R_j P_j^{\sigma-1} q_{ji}^{\sigma-1} p_{ji}^{-\sigma}$, where $P_j = \left[\int_{i\in\Omega_j} \left(\frac{p_{ji}}{q_{ji}}\right)^{1-\sigma} di\right]^{\frac{1}{1-\sigma}}$ is a quality-adjusted ideal price index and p_{ji} is the price of variety i in country j. Quality is thus defined as any objective attribute, subjective taste preference or other demand shock that increases the consumer appeal of a product given its price. Note that a sufficient statistic for unobserved product quality $\ln q_{ji}$ within market j can be constructed from observed price and quantity data as $\sigma \ln p_{ji} + \ln x_{ji}$, since R_j and P_j do not vary across products sold in j (Khandelwal, 2010; Khandelwal, Schott, and Wei, 2013).

2.2 Production and Sales Technology

The production technology is characterized by a production function for physical units of output and a production function for output quality. Firms' management competence can affect both the ability to assemble given inputs at low cost and the capacity to make high-quality goods. We refer to these two mechanisms as *production efficiency* and *quality capacity*.

In order to begin manufacturing, entrepreneurs have to incur sunk entry costs associated with research and product development. They face uncertainty about their production efficiency and product quality, and observe them only after completing this irreversible investment. At that point they decide whether to exit immediately or commence production and possibly export.

Upon entry, firms draw firm-wide managerial ability $\varphi \in (0, \infty)$ from distribution $g(\varphi)$ and a vector of firm-product specific expertise levels $\lambda_i \in (0, \infty)$ from distribution $z(\lambda)$. We will think of better managed firms as having a higher ability draw φ.[2],[3] Since the success of research and product development may differ across products within a firm, we assume that $g(\varphi)$ and $z(\lambda)$ are independent of each other and common across firms with continuous cumulative distribution functions $G(\varphi)$ and $Z(\lambda)$ respectively, while λ is i.i.d. across products and firms.

Producing one unit of physical output requires $(\varphi\lambda_i)^{-\delta}$ units of labor whose wage is normalized to 1 to serve as the numeraire. The parameter $\delta > 0$ governs the extent to which good management practices can lower unit input requirements and increase the efficiency with which these inputs are assembled into final goods. Intuitively, effective management can improve production efficiency by optimizing inventory control, synchronizing and monitoring production targets across manufacturing stages, reducing wastage, incentivizing workers, etc.

At a marginal cost of $(\varphi\lambda_i)^{\theta-\delta}$ workers, the firm produces one unit of product i with quality $q_i(\varphi, \lambda_i) = (\varphi\lambda_i)^{\theta}$, $\theta > 0$. This reduced-form quality production function captures the idea that manufacturing goods of higher quality is associated with higher marginal costs because it requires the use of more complex assembly processes and more expensive intermediate inputs of higher quality. For example, while sewing a dress using unskilled labor, cotton and plastic buttons might entail the same assembly process as sewing a dress using skilled labor, silk and mother-of-pearl buttons, the latter utilizes more expensive inputs and is considered higher quality. Similarly,

[2] As we show in Appendix 2.1, one can endogenize management practices while retaining the key features of the model. For example, entrepreneurs might receive an exogenous talent draw ϕ, choose management practice $m(\phi)$, and face marginal costs and quality that depend on $\varphi = \phi m(\phi)\lambda_i$. If the cost f_m of adopting m satisfies $df_m/dm > 0$ and $d^2 f_m/dm^2 > 0$, then Propositions 1-4 hold both for effective firm ability φ and for management $m(\phi)$.

[3] We show in Appendix 2.2 that our theoretical predictions would continue to hold if management is one of multiple draws that jointly determine firm ability. For example, firm ability $\varphi = m \cdot \phi$ may depend on the entrepreneur's intrinsic talent ϕ and the manager's competence for implementing effective management practices m. If entrepreneurs and managers do not match perfectly assortatively due to labor market frictions, then $|corr(m, \phi)| \neq 1$. While all firm outcomes would now be pinned down by φ instead of m alone, management competence would have the same effects as in our baseline model *ceteris paribus*.

while a printer built from 50 components might only be able to print, the sophisticated assembly of 150 parts might produce a multi-functional printer that can print, scan and photocopy. The parameter θ reflects the degree to which superior management enables firms to produce higher-quality products. Intuitively, effective management can enhance quality capacity by tightening quality control, facilitating specialized assembly, minimizing costly mistakes, etc.

For expositional simplicity, we do not explicitly model firms' input choice in our baseline set-up, but follow Baldwin and Harrigan (2011) in assuming that product quality is fixed by exogenous draws. In Appendix 2.3, we formally establish that endogenizing input quality in a richer framework would preserve our theoretical predictions. Following Kugler and Verhoogen (2012), we show how complementarity between firm ability and input quality in the production function for output quality would induce more capable firms to use higher-quality inputs in order to produce higher-quality goods.

Firms' marginal cost thus reflects two opposing forces: On the one hand, better managed firms have higher production efficiency. On the other hand, better managed firms produce higher quality using more expensive inputs and/or more complex assembly. The net effect of these two forces on marginal costs is theoretically ambiguous and depends on the relative magnitudes of θ and δ.

We make a number of standard assumptions about firms' production and sales costs that are motivated by salient patterns in the data. Firms incur a fixed operation cost of headquarter services f_h and a fixed overhead cost f_p for each active product line, in units of labor. This will imply that companies with different ability draws will choose to produce a different number of products. Entering each foreign market j is associated with additional headquarter services f_{hj} necessary for complying with customs and other regulations, as well as for the maintenance of distribution networks. As a result, some low-ability sellers in the domestic market will not become exporters or will supply some but not all countries. Finally, exporting entails destination-product specific fixed costs f_{pj} (constant across products within j, but varying across countries), which reflect market research, product customization and standardization, and advertising. There are also variable transportation costs such that τ_j units of a good need to be shipped for 1 unit to arrive. These trade costs will ensure that firms might not offer every product they sell at home in every foreign market they enter.

2.3 Profit Maximization

Firms must decide which products to produce, where to sell them and at what prices in order to maximize profits from their global operations. With monopolistic competition and a continuum of varieties, individual producers take all aggregate expenditures R_j and price indices P_j as given, and separately maximize profits in each country-product market.[4] A firm with management competence φ will choose the sales price and quantity of a product with expertise draw λ_i in

[4]See Eckel, Iacovone, Javorcik, and Neary (2015) and Eckel and Neary (2010) for an alternative model which incorporates product cannibalization effects.

country j by solving

$$\begin{aligned}\max_{p_{ji},x_{ji}} \pi_{ji}(\varphi,\lambda_i) &= p_{ji}(\varphi,\lambda_i)\,x_{ji}(\varphi,\lambda_i) - \tau_j x_{ji}(\varphi,\lambda_i)(\varphi\lambda_i)^{\theta-\delta} - f_{pj} \\ \text{s.t. } x_{ji}(\varphi,\lambda_i) &= R_j P_j^{\sigma-1} q_{ji}(\varphi,\lambda_i)^{\sigma-1} p_{ji}(\varphi,\lambda_i)^{-\sigma}\,.\end{aligned} \tag{1}$$

Producers therefore charge a constant mark-up $\frac{1}{\alpha}$ over marginal cost, and have the following price, quantity, quality, quality-adjusted price, revenues and profits for product i in market j:

$$p_{ji}(\varphi,\lambda_i) = \frac{\tau_j(\varphi\lambda_i)^{\theta-\delta}}{\alpha}, \qquad x_{ji}(\varphi,\lambda_i) = R_j P_j^{\sigma-1}\left(\frac{\alpha}{\tau_j}\right)^{\sigma}(\varphi\lambda_i)^{\delta\sigma-\theta}, \tag{2}$$

$$q_i(\varphi,\lambda_i) = (\varphi\lambda_i)^{\theta}, \qquad p_{ji}(\varphi,\lambda_i)/q_i(\varphi,\lambda_i) = \frac{\tau_j(\varphi\lambda_i)^{-\delta}}{\alpha}, \tag{3}$$

$$r_{ji}(\varphi,\lambda_i) = R_j\left(\frac{P_j\alpha}{\tau_j}\right)^{\sigma-1}(\varphi\lambda_i)^{\delta(\sigma-1)}, \qquad \pi_{ji}(\varphi,\lambda_i) = \frac{r_{ji}(\varphi,\lambda_i)}{\sigma} - f_{pj}. \tag{4}$$

When j corresponds to the firm's home market, there are no iceberg costs ($\tau_j = 1$) and the destination-product fixed cost f_{pj} is replaced by the product-specific overhead cost f_p. Note that the empirical analysis examines free-on-board export prices and revenues, that is $p_{ji}^{fob}(\varphi,\lambda_i) = \frac{(\varphi\lambda_i)^{\theta-\delta}}{\alpha}$ and $r_{ji}^{fob}(\varphi,\lambda_i) = R_j(P_j\alpha)^{\sigma-1}(\varphi\lambda_i)^{\delta(\sigma-1)}$.

If $\theta = 0$ and $\delta > 0$, effective management improves firm performance only by increasing production efficiency but the quality channel is moot. The model then reduces to the BRS framework in which all firms offer the same product quality level, but better managed firms have lower marginal costs and therefore set lower prices, sell higher quantities, and earn higher revenues and profits. While formally $\delta = 1$ in BRS, this normalization is immaterial when $\theta = 0$.

Conversely, if $\theta > 0$ and $\delta = 0$, management competence benefits firm performance by improving product quality but the production efficiency mechanism is not active. Now all firms share the same quality-adjusted prices, revenues and profits, but better managed companies charge higher prices, offer higher quality and sell lower quantities.

The most interesting scenario arises when $\theta > 0$ and $\delta > 0$, such that management operates through both the production efficiency and the product quality channels. We focus on this scenario below as it is most relevant empirically. In this case, superior management is unambiguously associated with higher product quality, lower quality-adjusted prices, higher revenues and higher profits. However, the implications for quantity and price levels are theoretically ambiguous. If $\theta > \delta$, as management competence grows, product quality rises sufficiently quickly with the cost of sophisticated inputs and assembly to overturn the effects of improved production efficiency. As a result, effective management corresponds to *higher* output prices. If $\theta < \delta$ by contrast, good management practices translate into *lower* prices. In the knife-edge case of $\theta = \delta$, production efficiency and product quality are equally elastic in management capacity, and prices are invariant across the firm management distribution. Finally, better managed firms sell higher quantities if and only if $\sigma\delta > \theta$.

2.4 Selection into Products and Markets

Consumers' love of variety and the presence of product-specific overhead costs f_p imply that no firm will export a product without also selling it at home. In turn, firms optimally manufacture only goods for which they can earn non-negative profits domestically. Since profits increase with product expertise λ_i, there is a zero-profit expertise level $\lambda^*(\varphi)$ for each management ability draw φ below which firm φ will not make i. This value is defined by:

$$\pi_d(\varphi, \lambda^*(\varphi)) = 0 \Leftrightarrow r_d(\varphi, \lambda^*(\varphi)) = \sigma f_p, \tag{5}$$

where d indicates that revenues are calculated for the domestic market.

Recall that product expertise is independently and identically distributed across goods. By the law of large numbers, the measure of varieties that a firm with ability φ produces equals the probability of an expertise draw above $\lambda^*(\varphi)$, or $[1 - Z(\lambda^*(\varphi))]$. Since $d\lambda^*(\varphi)/d\varphi < 0$, better managed firms have a lower zero-profit expertise cut-off and offer more products. One interpretation of this result is that better managed firms bring superior quality control to any product line. This can partially offset using less skilled workers or inputs of lower quality such that output quality and consumer appeal remain high.

Following the same logic, a firm with ability φ will export product i to country j only if its expertise draw is no lower than $\lambda_j^*(\varphi)$ given by:

$$\pi_{ji}\left(\varphi, \lambda_j^*(\varphi)\right) = 0 \Leftrightarrow r_j\left(\varphi, \lambda_j^*(\varphi)\right) = \sigma f_{pj}. \tag{6}$$

The measure of products that firm φ sells to j is thus $\left[1 - Z\left(\lambda_j^*(\varphi)\right)\right]$. Since $d\lambda_j^*(\varphi)/d\varphi < 0$, better managed firms export more products than worse run firms to any given destination.

When the exporting expertise cut-off lies above the zero-profit expertise cut-off, $\lambda_j^*(\varphi) > \lambda^*(\varphi)$, there will be selection into exporting. Across products within a firm, not all goods sold at home will be shipped to j. Similarly, across firms supplying a product domestically, not all will be able to market it abroad. Given the overwhelming evidence for both patterns in the prior literature, we assume that $\lambda_j^*(\varphi) > \lambda^*(\varphi)$ holds for all j.

For every management level φ, the expertise cut-off for exporting generally varies across destinations because the market size R_j, price index P_j, variable τ_j and fixed f_{pj} trade costs are country specific. Firms therefore adjust their product range across markets. Each exporter follows a product hierarchy and adds goods in decreasing order of expertise until it reaches the marginal product that brings zero profits. Within a supplier, higher-quality goods are shipped to more countries, earn higher revenues in any given market, and generate higher worldwide sales.

Firms enter a market only if total expected revenues there exceed all associated costs. The export profits in country j of a firm with management competence φ are:

$$\pi_j(\varphi) = \int_{\lambda_j^*(\varphi)}^{\infty} \pi_j(\varphi, \lambda)\, z(\lambda)\, d\lambda - f_{hj}. \tag{7}$$

Export profits $\pi_j(\varphi)$ increase with management ability because better managed firms sell more products in j (i.e. lower $\lambda_j^*(\varphi)$) and earn higher revenues from each good (i.e. higher $\pi_j(\varphi,\lambda)$) than firms with the same product expertise draws but worse management. Therefore only firms with management level above a cut-off φ_j^* will service destination j, where φ_j^* satisfies:

$$\pi_j\left(\varphi_j^*\right) = 0. \tag{8}$$

With asymmetric countries, φ_j^* varies across destinations and better managed firms enter more markets because they are above the export ability cut-off for more countries. Better managed exporters thus outperform worse run producers along all three margins: number of export destinations, product scope in each destination, and sales in each destination-product market.

Finally, not all firms that incur the sunk cost of entry survive. Once they observe their management ability and expertise draws, firms begin production only if their expected profits from all domestic and foreign operations are non-negative. Firm φ's global profits are given by:

$$\pi(\varphi) = \int_{\lambda^*(\varphi)}^{\infty} \pi_d(\varphi,\lambda)\, z(\lambda)\, d\lambda + \sum\nolimits_j \left(\int_{\lambda_j^*(\varphi)}^{\infty} \pi_j(\varphi,\lambda)\, z(\lambda)\, d\lambda - f_{hj} \right) - f_h. \tag{9}$$

The first integral in this expression captures the firm's domestic profits from all products above its expertise cut-off for production $\lambda^*(\varphi)$, while the summation represents worldwide export profits from all traded products and destinations.

Total profits increase in φ because better managed firms sell more products domestically, earn higher domestic revenues for each product, and have superior export performance as described above. Companies below a minimum management level φ^* are thus unable to break even and exit immediately upon learning their attributes. This cut-off is defined by the zero-profit condition:

$$\pi(\varphi^*) = 0. \tag{10}$$

2.5 Empirical Predictions

We summarize the key empirical predictions of the model with the following propositions. We take these predictions to the data, which we turn to next.

Proposition 1 *Better managed firms are more likely to export.*

Proposition 2 *Better managed firms export more products to more destination markets and earn higher export revenues and profits.*

Proposition 3 *Better managed firms offer higher-quality products if $\theta > 0$, but quality is invariant across firms if $\theta = 0$. Better managed firms set lower quality-adjusted prices if $\delta > 0$, but quality-adjusted prices are invariant across firms if $\delta = 0$. Better managed firms charge higher prices if $\theta > \delta$ and lower prices if $\delta > \theta$, but prices are invariant across firms if $\theta = \delta$.*

Proposition 4 *Better managed firms use more expensive inputs of higher quality and/or more expensive assembly of higher complexity if $\theta > 0$, but input quality and assembly complexity are invariant across firms if $\theta = 0$.*

3 Data

Our analysis makes use of unique, matched establishment- or firm-level data for the world's two largest exporters - China and the US - on production (ASIE and ASM), international trade (CCTS and LFTTD), and management practices (WMS and MOPS) respectively. We exploit six proprietary micro-data sources in total, three for each country, to assemble a dataset that is unprecedented in its coverage and detail. This section describes how management practices are evaluated, introduces the data, and summarizes key features of firm activity.

3.1 Measuring Management Practices

Systematic data on firms' management practices have only recently become available. Since the first major wave in 2004, the World Management Survey (WMS) has developed standardized measures of management competence for over 20,000 manufacturing firms located in 34 countries. It considers multiple aspects of firm management, and evaluates the relative effectiveness of different practices within each aspect. WMS is conducted via double-blind phone interviews with plant managers, and covers representative firm samples in a large number of countries.[5] The Management and Organizational Practices Survey (MOPS), which was introduced by the US Census in 2010, is modeled after WMS and provides management scores for around 32,000 US manufacturing establishments.

WMS (MOPS) includes 18 (16) questions about the management of physical capital (*monitoring* and *targets*) and human resources (*incentives*) inside a firm, examples of which appear in Figure 1. A first set of questions pertain to the *monitoring* of progress towards production targets via the frequent collection, analysis and dissemination of multiple performance metrics. A second set of questions characterize the design, integration and realism of production *targets*. These questions assess to what extent targets are consistently set across production stages and tightly connected to performance, both in the short-run and long-run, for managers and non-managers. A final set of questions capture the use of *incentives* mechanisms to identify, promote and reward high performers with bonuses, while sanctioning underperformers.

Each management question is scored on a scale of 1 to 5 in WMS and 0 to 1 in MOPS, with higher values indicating more structured management involving greater monitoring, more aggressive targets and stronger performance incentives. For each country, we first standardize the responses to each question across all firms to be mean 0 and standard deviation 1. We then average across questions to obtain a single *management score* for each firm in order to be

[5] See Bloom and Van Reenen (2007) for full details of the survey process.

comprehensive. Finally, we standardize these management scores across firms in each country to be mean 0 and have standard deviation 1.

WMS and MOPS are based on the lean manufacturing and modern human resource management practices, as used by leading international firms of management consultants, to focus on core management practices that should benefit firm performance regardless of the industry or economic environment. Our analysis will nevertheless account for the possibility that the relevance of specific management practices might vary across industries with industry fixed effects. We also conduct all estimations separately for China and the US. This addresses potential concerns that the effectiveness of certain management practices might depend on the formal and informal institutions in a country (e.g. labor market flexibility, cultural norms, respect for managerial hierarchy). To the extent that the management surveys are biased towards successful production practices in the West, measurement error would introduce downward bias and work against us finding consistent patterns for both China and the US. In practice, evidence indicates that the introduction of more effective management practices according to WMS criteria significantly improved firm performance in a randomized control trial in India (see Section 6 below).

3.2 United States

We employ three comprehensive datasets on the activities of US firms. First, US management is assessed using MOPS, the first and only comprehensive management dataset of its kind. Introduced as a mandatory part of the US Census's 2010 Annual Survey of Manufacturing, it documents the management practices of about 32,000 manufacturing establishments in 2010 and 2005 (as a recall). The sample captures 5.6 million employees, which is more than half of US manufacturing employment. The distribution of the management score across plants is plotted in Figure 2A. MOPS also includes several variables that we use to control for potential noise in the management score, namely an indicator for filing census forms online, the tenure and seniority of the respondent, and the discrepancy between employment data reported in MOPS and ASM.

Second, we obtain standard balance-sheet data on these establishments from the US Annual Survey of Manufacturers (ASM), available from 1973-2012[6]. The ASM records the total output, value added, profits and production inputs (such as employment, capital expenditures, energy inputs and materials purchases) for about 45,000 plants that correspond to over 10,000 firms. We also observe firms' age, location (out of 50 states), and primary industry of activity in the US NAICS 6-digit industry classification. We measure the skill intensity of firms' production technology with the log average wage and the share of workers with a college degree, and firms' capital intensity with log net fixed assets per worker. We construct two proxies for firm productivity, log value added per worker and the revenue-based TFP residual from production function

[6]The 2010 MOPS was part of the 2009-2013 ASM panel, so all establishments in the MOPS were surveyed every year over this period. In prior years establishments are surveyed in years ending with a "2" or "7" as part of the Economic Census, and otherwise if they are part of that year's ASM panel. Since the ASM panel over-samples larger establishments, it tends to include a large fraction of export activity.

regressions à la Levinsohn-Petrin performed separately for each NAICS-6 industry.

Third, we use the US Longitudinal Federal Trade Transaction Database (LFTTD), which contains detailed information about the universe of US international trade transactions in 1992-2012, at over 100 million transactions a year. LFTTD reports the value, quantity, unit (e.g. dozens, kilograms, etc.) and organization (intra-firm vs. arm's length) of all firm-level exports (free on board) and all firm-level imports (cost, insurance and freight included) by country and product for around 7,000 different products in the 10-digit Harmonized System and around 5,000 product categories at the HS 8-digit level. The raw data enables us to compute transaction-level unit values to proxy prices. To ensure comparability, whenever we study product-level data, a product is defined by both its HS code and unit. Given the lumpiness and seasonality of international trade, we analyze annual trade flows at various levels of aggregation such as the firm, firm-product, firm-destination, and firm-product-destination.

We link ASM, LFTTD and MOPS using firms' tax identifier that is common to all three datasets.[7] We perform our baseline analysis for the resultant cross-section of about 32,000 US establishments in 2010 with contemporaneous production, trade and management data. The firms in this matched sample are on average bigger and better performing than firms without management data, but appear representative in that the relationship between standard productivity, size and performance metrics is the same in both subsamples. We analyze recall MOPS data for 2005 and panel ASM and LFTTD data in robustness checks.

3.3 China

We exploit three comprehensive datasets on the activities of Chinese firms that closely mirror those for the US. First, we observe the management practices of 507 Chinese firms collected in 2006-2007 as part of the World Management Survey (WMS). The distribution of the management score across firms is plotted in Figure 2B. Unlike MOPS, WMS is run as a telephone survey, relying on endorsements by respected institutions and highly-trained interviewers (e.g. MBAs) to achieve a response rate of 45% in China. Firms with 100 to 5000 employees are sampled randomly, and interviews employ double-blind techniques to obtain unbiased responses from plant managers. WMS also gathers additional firm and interview demographics. Of these, we use information on firms' primary industry of affiliation (out of 82 SIC 3-digit industries) and a set of controls for potential survey noise (interviews' duration, day of week and time of day; interviewer ID; interviewee gender, reliability and competence as perceived by the interviewer).

Second, we access production data at the firm level for the 1999-2007 period from China's Annual Survey of Industrial Enterprises (ASIE). ASIE is collected by the National Bureau of Statistics and provides standard balance-sheet information for all state-owned firms and all

[7] For firms with multiple establishments in ASM, we aggregate up to the firm level by summing production variables across all establishments belonging to the same firm. In the case of MOPS, we take the employment-weighted average management score across plants within a firm, but our results are robust to using the simple average instead. We use the age, location and primary industry of activity of the firm headquarters.

private firms with sales above 5 million Chinese Yuan, for over 200,000 firms a year. In addition to output, profits, value added and production inputs, we also observe firms' age, ownership structure (private domestic, state-owned domestic, foreign-owned), location (out of 31 provinces), and primary industry of activity in the Chinese SIC 3-digit industry classification.

Third, we utilize comprehensive data on the universe of Chinese firms' cross-border transactions in 2000-2008 from the Chinese Customs Trade Statistics (CCTS), spanning over 100 million transactions a year. CCTS is collected by the Chinese Customs Office and reports the value and quantity of firm exports (free on board) and imports (cost, insurance and freight included) in U.S. dollars by product and trade partner for 243 destination/source countries and about 7,500 products in the 8-digit Harmonized System.[8] We calculate unit values as the ratio of shipment values and quantities, and analyze trade flows at different levels of aggregation. While CCTS does not distinguish between arm's-length and intra-firm transactions, it indicates the trade regime under which each export and import flow occurs. China recognizes a formal processing trade regime that permits duty-free imports of inputs for further processing, assembly and re-exporting on behalf of a foreign buyer. Each trade transaction is thus labeled as ordinary or processing trade, and firms can and do legally engage in both operation modes.

Of the 507 Chinese firms in WMS, we are able to match 485 to ASIE using the unique firm identifier that is common to both databases. We obtain the complete ASIE record for these 485 firms during 1999-2007, which produces an unbalanced panel of 3,233 firm-year observations.

Since CCTS maintains an independent system of firm registration codes, it cannot be mapped directly into ASIE or WMS. We follow standard practice in the literature and match CCTS to ASIE using an algorithm based on firms' name, address and phone number. Using ASIE as a bridge, we match 296 companies from WMS to CCTS. We then match 58 of the remaining unmatched companies in WMS directly to CCTS firms by postcode and translated Chinese-to-English company names. We ensure match quality by manually researching company webpages and reports, etc. With this two-step matching procedure, we locate detailed CCTS trade data for 354 of the 507 WMS companies, for a match rate of 70%. Of these 354 firms, 11% only export, 17% only import, and 72% both export and import according to CCTS. This is consistent with the fact that about 60% of the matched WMS-ASIE firms report positive exports on their balance sheets, while more firms may appear in the comprehensive CCTS records.

3.4 Summary Statistics

As a first glance at the data, we summarize the substantial variation in management practices, production and trade activity across firms in China and the US in Appendix Table 1. Starting with the US, 45% of the 32,000 US establishments in our 2010 matched sample export. The

[8] While the US and China both adhere to a standardized international HS 6-digit product classification system, countries are free to record their trade activity at finer levels of disaggregation that are not readily comparable across nations. Our baseline analysis exploits the granularity of the US and Chinese customs data at the HS-8 digit level, but our results are robust to using aggregated trade flows at the common HS-6 digit level or the most disaggregated data for the US at the HS-10 digit level.

typical exporter sells 19 different HS-8 digit products to 13 destinations and, conditional on using imported inputs, imports 20 distinct products from 6 countries, with large dispersion around these means.[9] These numbers are generally similar for the sample of 485 firms in our baseline 2000-2008 panel for China, where 58% of all firms export. On average, Chinese exporters ship 9 HS-8 digit products to 13 markets and, conditional on using foreign inputs, source 33 different products from 6 countries of origin.

Figure 3 illustrates the vast dispersion in average management practices across countries in WMS. The US comes out on top, followed closely by Japan, Germany, Sweden, Canada and the UK. In the middle of the country distribution, Chinese firms are on average significantly less well managed than North American and European companies, but better than firms in Latin America, Africa and other emerging giants such as Brazil and India. These cross-country averages mask substantial variation in management practices across firms in each economy, as shown in Figure 2 for China and the US.

Sample means in Appendix Table 1 corroborate stylized facts in the prior literature that exporters are on average significantly larger and more productive than non-exporters. We document that exporters are on average also better managed than non-exporters: The unconditional export management premium equals 15% of a standard deviation in China and 38% of a standard deviation in the US. In comparison, the export size premia in China and the US stand at 19% and 186% respectively based on firm output and 36% and 123% based on employment.

4 Management Practices and Export Performance

The empirical analysis proceeds in two steps. We first examine the relationship between firms' management practices and export performance. This exercise constitutes a direct test of Propositions 1 and 2. While it informs some of the mechanisms through which management operates, it remains agnostic about the importance of good management for production efficiency and product quality. In Section 5, we study these issues by confronting Propositions 3 and 4 with the data.

We perform the entire analysis separately for China and the US. Given the vast difference in income, institutional quality and factor market frictions between the two countries, this allows us to assess whether management plays a fundamental role in firm activities, and if so, whether its function depends on the specific economic environment.

4.1 Empirical Strategy

To evaluate the empirical validity of Propositions 1 and 2, we investigate the link between firms' management competence and export performance with the following estimating equa-

[9] For the US, we report summary statistics for balance-sheet variables at the establishment level and for trade activity at the firm level, since this is the level at which such data are collected in ASM and LFTTD respectively. The patterns in Appendix Table 1 Panel A look similar if we instead aggregate across establishments up to the firm level.

tion:

$$ExportOutcome_f = \beta Management_f + \Gamma Z_f + \phi_l + \phi_i + \varepsilon_f \tag{11}$$

We consider multiple dimensions of firms' export activity as guided by theory. In different specifications, $ExportOutcome_f$ refers to firm f's exporter status, log global export revenues, and various extensive and intensive margins of exporting. We measure f's managerial competence $Management_f$ with the comprehensive z-score across all management practices surveyed.

We account for any systematic variation in supply and demand conditions across firms in the same location l or industry i with fixed effects, ϕ_l and ϕ_i. These capture differences in factor costs, factor intensities, infrastructure, institutional frictions, tax treatment, etc. that might impact export performance. In the case of China, we add dummies for 31 provinces and 82 sectors based on the primary SIC 3-digit affiliation of each manufacturer. In the case of the US, we use indicator variables for 50 states and about 300 NAICS 6-digit industries.

We further condition on a vector of firm characteristics Z_f. In all specifications, Z_f includes the full set of noise controls pertaining to the management surveys to alleviate potential measurement error in $Management_f$. We subsume the role of firms' ownership type with fixed effects that distinguish between private domestic companies, state-owned enterprises and foreign-owned multinational affiliates in the case of China; firm ownership data is not available for the US. We also report results with an extended set of firm controls Z_f such as firm age, capital and skill intensity, standard productivity measures, and domestic sales. As discussed below, this helps address concerns with omitted variable bias and reverse causality while also shedding light on relevant mechanisms.

The coefficient of interest β reflects the sign of the conditional correlation between firms' management competence and export performance. Given the fixed-effects structure, it is identified from the variation across companies within narrow segments of the economy. This correlation can be interpreted in two ways through the lens of our model. If management corresponds to firms' exogenous productivity draw or one component of it, then β would in principle capture the causal impact of management on export activity. Alternatively, if a primitive firm attribute such as an exogenous productivity draw determines both the choice of management technology and export activity, β would reflect the equilibrium relationship between a production input and output that are joint outcomes of the firm's maximization problem. These two alternatives are isomorphic for our purposes and we do not seek to distinguish between them. Instead, we aim to establish that effective management is a qualitatively and quantitatively important factor in firms' export success (this section), and to examine its role for production efficiency and product quality (Sections 5 and 6).[10]

While the US MOPS provides management data for a large cross-section of over 10,000 US

[10] Note that reverse causality also does not pose classical estimation bias. If higher export revenues induce firms to adopt better management practices because of economies of scale in management use, this would be consistent with our argument. This mechanism may be amplified if firms learn about novel managerial practices from their experience with foreign buyers and markets (Atkin, Khandelwal, and Osman, 2017).

firms in 2010, WMS covers only about 500 Chinese firms in 2007. In order to fully exploit the information in the Chinese panel data, we therefore estimate specification (11) at the firm-year level, letting all variables but $Management_f$ vary both across firms and over time, and controlling for changes in macroeconomic conditions with year fixed effects ϕ_t. This is motivated by the evidence in Bloom, Mahajan, McKenzie, and Roberts (2018) and patterns in our own MOPS data that management practices evolve slowly within firms over time, such that the cross-sectional dispersion dwarfs the time-series variation. We report standard errors clustered by firm since our key variable $Management_f$ is measured at the firm level.

4.2 Export Status, Revenues and Profits

We first establish that better managed firms are significantly more likely to export. Conditional on exporting, they also earn higher export revenues. These findings provide empirical support for Propositions 1 and 2.

Table 1 presents these baseline results. In Columns (1) and (5), we examine firms' export status by setting the dependent variable $ExportOutcome_f$ equal to 1 if a firm lists positive exports on its balance sheets and 0 otherwise. We estimate equation (11) in the matched ASIE-WMS sample for China and the matched ASM-MOPS sample for the US, respectively.[11] Firms employing more effective management practices are systematically more likely to enter foreign markets.[12]

We explore the relationship between managerial competence and the scale of export operations in the subset of exporting firms in Columns 3 and 7. We re-estimate specification (11) using the log value of global exports as the outcome variable $ExportOutcome_f$ in the matched CCTS-WMS sample for China and the matched LFTTD-MOPS sample for the US.[13] We observe that well-run exporters realize substantially higher sales abroad.[14]

The strong association between management competence and export activity persists when we add an extended set of firm characteristics Z_f in Columns 2, 4, 6 and 8. We control for firm age using information on the year in which companies were established from ASIE and ASM. We find some evidence that older manufacturers are more likely to be exporters and generate higher export revenues, although these patterns are significant only for the US. We further condition

[11]For the US, we observe export status at the plant level from ASM and all other trade indicators at the firm level from LFTTD. To exploit the full granularity of the data, we run the baseline US regressions for export status at the plant level. Our results are robust to aggregating up to the firm level, when the coefficient magnitudes increase by 30%-50% in the cross-section in Table 1 and more than double in the panel in Table 7.

[12]We report OLS results, but similar patterns hold with other estimators such as Probit or Logit.

[13]We measure a firm's worldwide exports with the combined value of all its export transactions in the customs records that cover the universe of trade transactions. This arguably gives a more accurate account of exporters' activity than the value of total exports reported on their balance sheets. We have confirmed that the latter produces similar results.

[14]Our results for China indicate that multinational companies are more likely to export and have higher export revenues conditional on trading. However, management plays an independent role from foreign ownership that cannot be attributed to multinational affiliates being better managed. State-owned enterprises do not display markedly different outcomes from private domestic firms.

on firms' production technology as reflected in their capital intensity (log net fixed assets per worker) and skill intensity (share of workers with a college degree; log average wage). The results corroborate prior evidence in the literature that more skill- and capital intensive firms are more active exporters, although the point estimates are not always precisely estimated.[15] To guard against omitted variable bias, we always include this broader vector of controls Z_f in the rest of the analysis, but note that the point estimates for $Management_f$ are typically qualitatively and quantitatively close with and without these additional controls.

Our findings point to potentially large economic consequences from improving management practices. Based on our estimates with the extended set of controls, a one-standard-deviation rise in the management z-score is associated with a 5% higher probability of exporting and 23% higher export revenues in China; these numbers are 3% and 37% for the US. Given the large management gaps across countries shown in Figure 3, this implies that variations in management competence could account for substantial differences in trade intensity across countries. These magnitudes are also sizeable compared to the role of firm age, skill- and capital intensity (comparable statistics for these are in the range of 2% to 28%).

In addition to export status and revenues, Proposition 2 also has implications for firms' export profits. As standard with balance-sheet data, however, we observe firms' consolidated profits from worldwide sales that cannot be broken down by market. In Appendix Table 2, we exploit the available information as best we can, and find indicative evidence of a positive link between effective management and export profits. We first confirm that superior managerial practices are associated with higher firm profits, with and without the expanded set of firm controls (Columns 1-2 and 4-5). We then document that this holds even conditioning on domestic sales, calculated as the difference between total turnover and total exports (columns 3 and 6).

4.3 Extensive and Intensive Export Margins

As a first step to understanding the mechanisms through which management contributes to export success, we decompose exporters' trade activity into the number of foreign markets they enter and the sales they make in each market. We find that better managed firms have the capacity both to serve more export markets and to sell more in individual markets.

We measure the extensive margin of firms' exports with the log number of destination countries they supply, the log number of products they ship to at least one destination, and the log total number of destination-product markets they penetrate. We quantify the intensive margin with average log exports per destination-product. We define products at a very granular level, namely HS 8-digit categories. We re-estimate equation (11) using each export margin in place of $ExportOutcome_f$, and report our findings in Table 2. Appendix Table 3 contains symmetric regressions without the wider set of firm controls Z_f.

[15] The positive correlation between average wages and the share of skilled workers across Chinese firms generates multicollinearity in Columns 2 and 4 and a negative coefficient on the skilled labor share. Both measures of skill intensity enter positively and significantly when included one at a time.

We consistently observe positive coefficients on $Management_f$ across all specifications that are statistically significant in all but one case (the intensive margin in China). For Chinese firms, a one-standard-deviation improvement in managerial competence is associated with 19% more export destinations, 17% more export products, 22% more destination-product markets, and 2% higher exports in the average market (Columns 1-4 of Table 2). For American companies, these magnitudes stand respectively at 13%, 17%, 20%, and 18% (Columns 6-9).

Overall, the extensive margin of market entry accounts for just over half of the contribution of management to firm exports in the US. In the case of China, this share reaches 90% when we condition on the full set of firm controls and 75% when we do not.[16]

These results are in line with the theoretical predictions for the margins of firms' export activity summarized in Proposition 2. As a final check on internal consistency, we consider the variation in export sales across a firm's destination-product markets. In our model, exporters add foreign markets in decreasing order of profitability. As a result, better managed firms servicing more markets do so by entering progressively smaller markets where they earn lower sales. This composition effect implies that our intensive-margin results underestimate the relationship between management and exports to any given market. Further analysis supports this. For each firm, we identify its largest destination-product market by sales revenues, and regress log exports to this top market on $Management_f$. We obtain much larger coefficients than those for the intensive margin that are moreover significant for both China and the US (Columns 5 and 10). As we repeat this exercise replacing the outcome variable with log average sales to the top two, top three, etc. export markets, we record progressively lower point estimates as anticipated.

4.4 Exports vs. Domestic Activity

We are interested in whether the positive association between management quality and export performance reflects a general beneficial effect of good management on firm activity. Through the lens of our model, effective management practices improve firm performance both at home and abroad, such that better managed firms have higher domestic sales, higher probability of exporting, and higher export revenues. The elasticities of these three outcomes with respect to management differ and, as with productivity elasticities in workhorse trade models, generally depend on modeling assumptions about demand.[17] In our CES set-up, better management increases firm revenues proportionately in all markets served, but it also induces entry into more markets. As a result, total exports rise faster with management competence than domestic sales.

Appendix Table 4 corroborates these patterns in the data, further validating our model. We compute firms' log domestic sales by taking the difference between total sales and total exports as reported on companies' balance sheets and matched customs records. Columns 1 and 6 confirm

[16]These calculations are based on comparing regression coefficients across specifications for different export outcomes, such as Column 8 of Table 1 and Column 8 of Table 2.

[17]For example, the ratio of a firm's sales in two markets is independent of firm productivity with CES but not with linear demand or with non-homothetic preferences (Melitz, 2003; Melitz and Ottaviano, 2008).

that producers with advanced management practices sell more at home. In the rest of Appendix Table 4, we repeat the main regressions for manufacturers' export status, global export revenues and various export margins controlling for their domestic sales in addition to the extended set of firm characteristics Z_f. We continue to record positive significant coefficients on $Management_f$ (except for average exports per destination-product for China as before).

4.5 Interpretation: Management as Productivity

The results indicate that successful export performance is closely related to the use of sophisticated management practices. Through the lens of the model, we interpret this as evidence that managing capital and labor resources effectively is critical to firm productivity. In this sub-section, we explore this management-productivity nexus.

The theoretical notion of productivity in the literature is quantity-based total factor productivity TFPQ. In our model, this corresponds to firms' capacity to produce a given quantity and quality of output at lower cost. We thus view management competence as a measurable, tangible counterpart to the theoretical concept of TFPQ, or at least an important component of TFPQ.

Standard revenue-based proxies for productivity, TFPR, are constructed from data on sales revenues and input costs (capital, labor, materials). This approach faces two challenges. First, TFPR is a noisy measure of TFPQ because it incorporates input and output prices and markups (Hsieh and Klenow, 2009; De Loecker, 2011; Bartelsman, Haltiwanger, and Scarpetta, 2013). This introduces bias in regressions of firm outcomes such as export activity on TFPR. Second, TFPR constitutes a residual from a production function and is thus a black box with no precise economic content or actionable policy implication.

Being able to observe and quantify management practices helps overcome both of these challenges. Management effectiveness identifies specific practices that firms use in production, such as setting targets, monitoring operations, and incentivizing workers. This unpacks the black box of TFPR residuals to isolate well-defined economic mechanisms. Management measures also circumvent estimation biases associated with TFPR since they are obtained independently from data on firms' production and trade activity.

Question 1: Where does good management come from? Observed management practices may have both an exogenous and an endogenous component. On the one hand, management competence may be an exogenous draw at the firm level as in our baseline model. In this case, β in specification (11) would capture the causal impact of management quality on firm performance from, for example, exogenous variation in managers' ability or style (Bertrand and Schoar, 2003).

On the other hand, firms may endogenously choose their managerial quality based on an exogenous firm primitive. Estimates of β would then reflect the equilibrium relationship between joint outcomes of the firm's maximization problem, for example if exogenously different founder-entrepreneurs endogenously hire managers of different skill levels.

While we do not distinguish between these two theoretical alternatives, we establish that management matters for firm performance and uncover the mechanisms through which it operates.

Question 2: How does management relate to TFP? Heterogeneous-firm theory traditionally focuses on TFPQ productivity as the firm attribute that uniquely determines all outcomes of the firm's problem, including all aspects of trade activity. In practice, evidence for many countries indicates that measured TFPR is positively but imperfectly correlated with measured firm outcomes. There are two possible explanations for this discrepancy: TFPR and/or firm outcomes are measured with error, or multiple firm attributes matter. For example, two different draws may fix firms' cost of producing respectively physical units and quality, and aggregate into composite capability that pins down firm outcomes (Hallak and Sivadasan, 2013). We investigate the relationship between management practices and firm productivity in Appendix Table 5. We construct $TFPR_f$ as in Levinsohn and Petrin (2003) using balance-sheet data on companies' total sales, capital expenditures, labor costs and material purchases, and accounting for differences in production technology across industries and ownership types.

We first estimate the conditional correlation between $Management_f$ and $TFPR_f$ by setting $TFPR_f$ as the left-hand side variable in specification (11) (Column 1). TFPR is indeed higher in firms employing more sophisticated management practices. We then replicate regression (11) for $TFPR_f$ in place of $Management_f$ (Columns 2-3). TFPR systematically enters positively and significantly, except for Chinese firms' export status.

Finally, we decompose TFPR into two components by regressing $TFPR_f$ on $Management_f$ with no other controls: the projection onto $Management_f$ and the residual term which we call $nonManagementTFPR_f$. In Columns 4-5, we compare the contribution of $Management_f$ and $nonManagementTFPR_f$ to the variation in trade outcomes by adding both to the right-hand side of equation (11). The estimates for $Management_f$ are very similar to the baseline in Table 1, and imply that the management component of TFP has economically large explanatory power in absolute and in relative terms. The rest of Appendix Table 5 documents similar patterns for indicators of product quality and production efficiency which we introduce in Section 5.

Question 3: Which management components matter most? A policy-relevant question is whether certain management practices are more instrumental to firm performance than others. While the baseline management z-score we use is an average across all practices surveyed, we can unbundle this average into sub-components in order to shed light on this policy question. To this end, we distinguish between "targets & monitoring" (information collection and processing) and "incentives" (hiring, firing, pay and promotions). The results in Appendix Table 7 indicate that both sets of practices are significant, although perhaps with slightly stronger effects on the targets & monitoring practices.

5 Management Mechanisms: Efficiency and Quality

5.1 Structural Estimates

Having established that advanced managerial practices are associated with superior export performance, we next assess the empirical validity of Propositions 3 and 4 to inform the underlying mechanisms through which management operates. In particular, we are interested in whether effective management improves firms' production efficiency, capacity to manufacture high-quality products, or both. The results we establish lead us to conclude that management acts through both these efficiency and quality channels.

We first consider the predictions of Proposition 3 for the relationship between firms' management practices, product quality, and quality-adjusted prices. We exploit the rich dimensionality of the data and examine firms' behavior in finely disaggregated export markets. This allows us to study the role of management while accounting for various supply and demand conditions with an extensive set of fixed effects in the following estimating equations:

$$\ln(Quality_{fdp}) = \beta^q Management_f + \Gamma^q Z_f + \phi_l^q + \phi_{dp}^q + \varepsilon_{fdp}^q \tag{12}$$

$$\ln(Price_{fdp}/Quality_{fdp}) = \beta^{p/q} Management_f + \Gamma^{p/q} Z_f + \phi_l^{p/q} + \phi_{dp}^{p/q} + \varepsilon_{fdp}^{p/q} \tag{13}$$

Through the lens of our model, the coefficient on management in the quality equation (β^q) identifies the structural parameter θ, which governs the effect of management on product quality. Similarly, the coefficient on management in the quality-adjusted price equation ($\beta^{p/q}$) identifies the structural parameter δ, which captures the effect of management on productive efficiency. Specifications (12) and (13) reveal whether management operates through both the quality and the efficiency mechanisms: According to Proposition 3, we should observe $\beta^q > 0$ and $\beta^{p/q} < 0$ if and only if the quality and efficiency channels are active, respectively. Moreover, this interpretation is conservative given the potential for variable mark-ups.[18]

The unit of observation is now the firm–destination–HS8 product(-year).[19] $Price_{fdp}$ is the export unit value that firm f charges for product p in destination country d (in year t). We use free-on-board export prices that exclude trade duties, transportation costs and retailers' mark-up, such that $Price_{fdp}$ corresponds to the sum of the exporter's marginal cost and mark-up. We construct model-consistent proxies for firms' export product quality and quality-adjusted price using data on export prices and quantities by firm, product, destination (and year). As discussed in Section 2.1, $\ln q_{ji} \propto \sigma \ln p_{ji}^{fob} + \ln x_{ji}$, such that log quality $\ln q_{ji}$ can be inferred as the sum of log quantity x_{ji} and log free-on-board price p_{ji}^{fob}, adjusted for the elasticity of substitution across

[18] If better managed firms set higher mark-ups, our conclusions for β^q would be unaffected, but p_{ji}^{fob}/q_{ji} would be inflated and we would be less likely to find $\beta^{p/q} < 0$.

[19] All results for China hold when we distinguigh between processing and ordinary exports. We find similar patterns when we consider the firm–destination–product-trade regime–year quintuplet as the unit of observation and include a complete set of destination–product–trade regime triple fixed effects.

varieties σ. We set $\sigma = 5$ (the median value in calibration exercises in the prior literature), but our results are robust to alternative assumptions about this elasticity (Khandelwal, Schott, and Wei, 2013).

We continue to include fixed effects for firms' provincial or state location ϕ_l and the full set of firm controls Z_f, as well as year fixed effects for China. Instead of the fixed effects for firms' primary industry ϕ_i in equation (11), we now condition on destination-product pair fixed effects ϕ_{dp}. These subsume the variation in total expenditure, consumer price indices and trade costs across countries and products in the model, as well as any observable and unobservable differences in consumer preferences, institutional frictions and other forces outside the model. Specifications (12) and (13) are thus a very stringent test of our theory, as the coefficient on $Management_f$ is identified from the variation across firms within very narrow segments of the global economy, such as Chinese exporters of men's leather shoes to Germany or US exporters of cellular phones to Japan. We conservatively cluster standard errors by firm to accommodate correlated shocks across destinations and products within firms.

Equations (12) and (13) are in the spirit of prior studies of the relationship between measured firm productivity (TFPR), prices and revenues (Kugler and Verhoogen, 2009; Manova and Zhang, 2012). Since these variables are all constructed from the same raw data on sales and quantities, a common challenge in this literature has been ruling out estimation biases arising from correlated non-classical measurement error in the right- and left-hand side variables. We circumvent this problem by using direct measures of management practices that are entirely independent of the sales and quantity data.

The evidence in Table 3 lends strong support to managerial competence improving both production efficiency and product quality. In both China and the US, we observe that management is associated with significantly higher export quality (Columns 1 and 5) and significantly lower quality-adjusted prices (Columns 2 and 6). Formally, we find that $\theta^{CH} = 0.531$, $\delta^{CH} = 0.385$, $\theta^{US} = 0.048$ and $\delta^{US} = 0.045$. Based on these estimates, upgrading management practices by one standard deviation is associated with a 53% increase in product quality and a 39% decline in quality-adjusted prices in China. In the case of the US, quality and quality-adjusted prices are equally elastic with respect to management competence: a one-standard-deviation rise in the management score is accompanied with roughly a 5% change in both.

Comparing the magnitude of the management effects across countries should be done with caution, because of the different survey methodologies and sample sizes. However, the relative effect of management on quality and efficiency within each country is arguably informative. We draw two conclusions from our results.

First, management appears to have a larger impact on both productive efficiency and product quality in China than in the US, $\delta^{CH} > \delta^{US}$ and $\theta^{CH} > \theta^{US}$. One possible explanation is diminishing returns to management, since management practices are on average substantially worse in China: Initial improvements in management yield large gains, but additional improvements address more and more marginal issues with progressively smaller incremental benefit to quality and efficiency.

Second, the parameters suggest that management has a relatively bigger effect on product quality than on productive efficiency in China compared to the US, $\theta^{CH} - \delta^{CH} > \theta^{US} - \delta^{US} = 0$. We explore this further by directly estimating the following price equation in Columns 3 and 7:

$$\ln(Price_{fdp}) = \beta^p Management_f + \Gamma^p Z_f + \phi_l^p + \phi_{dp}^p + \varepsilon_{fdp}^p \tag{14}$$

Our theory implies that $\beta^p = \beta^q - \beta^{p/q} = \theta - \delta$ reflects the relative impact of management on quality vs. efficiency. Consistently with the findings from specifications (12) and (13), the relationship between prices and management is significantly positive in China and insignificantly different from 0 in the US. The greater impact of management on quality relative to efficiency in China is intuitive. When quality levels are relatively low (as they are in China compared to the US), a marginal change in managerial competence is likely to have much larger impacts on product quality. This is consistent with the hypothesis of Sutton (2007) that moving up the product quality ladder through improved management practices is critical for emerging economies.

For completeness, Columns 4 and 8 document the elasticity of export quantity with respect to management. In the model, this elasticity is $\delta\sigma - \theta$ and its sign theoretically ambiguous. In practice, quantity is invariant with management effectiveness in China and increasing in the US.

5.2 Robustness

In this subsection, we perform several robustness checks and extensions to alleviate concerns with alternative interpretations of the results for export prices and product quality.

5.2.1 Demand Elasticity

In order to infer a model-consistent proxy for product quality $\ln q_{ji} \propto \sigma \ln p_{ji}^{fob} + \ln x_{ji}$, we need the price elasticity of demand σ, which with CES preferences corresponds to the elasticity of substitution across varieties in consumption. While our baseline analysis takes a standard parameter value from the literature, $\sigma = 5$, our findings are robust to alternative assumptions. We have confirmed that qualitatively similar patterns obtain when we instead set σ equal to 4, 7, or 10. The results also remain unchanged when we allow σ to vary across SIC 3-digit industries using estimates from Broda and Weinstein (2006) (Panel A of Appendix Table 6).

5.2.2 Variable Mark-ups

Management practices may affect not only production efficiency and product quality, but also firms' mark-ups and thereby prices. This channel is moot in our model because CES preferences generate constant mark-ups, but it may be important in practice. Consider a world with no quality differentiation across firms. The prior theoretical literature has shown that in certain environments with variable mark-ups, more productive firms charge lower prices even though they set higher mark-ups (Melitz and Ottaviano, 2008; Eaton and Kortum, 2002). With alternative market structures or strategic behavior, however, mark-ups could in principle rise sufficiently quickly with firm productivity to dominate the associated decline in marginal costs and result in higher prices.

In the presence of quality differentiation across firms, variable mark-ups might therefore confound the inference of product quality from price and quantity data. In the former case, they might lead us to underestimate the impact of good management on production efficiency, while overestimating its effect on product quality. In the latter case, our findings for inferred quality and quality-adjusted prices might be driven by better managed firms extracting higher mark-ups rather than offering more sophisticated products that they assemble more efficiently.

As a step towards addressing this concern, we establish that similar results hold when we control for firms' market share as a proxy for their ability to impose higher mark-ups (Panel B of Appendix Table 6). We use a Chinese (US) firm's share of total Chinese (US) exports to a given destination-product, $\frac{Exports_{fdp}}{\sum_f Exports_{fdp}}$, as an indicator of its market power in that market. The results for management remain robust.

5.3 Input Characteristics

We next test the predictions of Proposition 4 for the quality of firms' intermediate inputs and the complexity of their assembly technology. Since we do not directly observe input quality and assembly complexity in the data, we proxy them with a variety of observed input characteristics. We construct these using balance-sheet data on firms' total material purchases and customs records on the universe of firms' imported input purchases by product and country of origin; as common with production data, we cannot access information on firms's domestic inputs.

We estimate specifications of the following two types:

$$InputCharacteristic_f = \beta Management_f + \Gamma Z_f + \phi_l + \phi_i + \varepsilon_f \tag{15}$$

$$InputCharacteristic_{fop} = \beta Management_f + \Gamma Z_f + \phi_l + \phi_{op} + \varepsilon_{fop} \tag{16}$$

As in equation (11), the unit of observation in regression (15) is the firm, and we include the same set of controls (location and industry fixed effects; full set of noise and firm controls). Similar to equation (12), the unit of observation in regression (16) is the firm-country of origin-product, and we include the same set of controls (location fixed effects; country of origin-product pair fixed effects; full set of noise and firm controls). In the case of China, we again exploit the panel and add year fixed effects. We cluster error terms by firm as before.

5.3.1 Input Quality

The quality production technology in the model stipulates that making goods of higher quality is associated with higher marginal costs. One possibility is that this reflects the need for high-quality intermediate inputs.[20] Table 4 provides evidence consistent with better managed firms sourcing more expensive, higher-quality inputs from richer countries of origin ($\theta > 0$).[21] In Columns 1-2 and 6-7, we estimate regression (15) for the log value of imports and the log share of imports in total input purchases. For both China and the US, we find that better managed firms have higher imports, consistent with their operating on a bigger scale and using more inputs in absolute terms. Unlike American producers, however, better managed Chinese producers also import a systematically higher share of their inputs, in line with priors about the paucity of specialized, high-quality domestic inputs in China. The insignificant estimates for the US thus serve as a corroborating placebo test.

Columns 3 and 8 confirm that well-run companies in both China and the US buy inputs from suppliers located in richer, more developed economies. Such economies are believed to produce higher-quality, more sophisticated goods because they employ advanced technologies and more skilled workers (Schott, 2004). In these specifications, the outcome variable is the weighted average log GDP per capita across a firm's foreign suppliers, using imports by origin country as weights. A one-standard-deviation rise in management competence is associated with 4%-5% higher average source-country income.

In Columns 4 and 9 of Table 4, we estimate regression (16) for the log unit value of firm imports by product and country of origin. Advanced management practices are accompanied by higher imported input prices in China, but not significantly so in the US. In Columns 5 and 10, we apply the structural transformation to import unit values to obtain inferred input quality, in the same manner as we did with inferred export quality. We find that better managed firms in both countries use higher-quality imported inputs, with a significantly higher elasticity for China than for the US. Improving management effectiveness by one standard deviation corresponds respectively to 10% and 58% higher imported input price and quality among Chinese manufacturers, but only 0% and 5% among their US counterparts. These results suggest that at lower levels of management competence and product quality - such as the Chinese context - good management can help firms to not only more effectively source and process inputs from advanced countries, but also to better identify high-quality suppliers within each origin country. This additional channel might contribute towards the significantly higher elasticity of output quality with respect to management that we documented above for China relative to the US.

5.3.2 Assembly Complexity

A body of work has proposed that manufacturing more sophisticated products entails the assembly of a wider range of specialized inputs, possibly through the completion of more manufacturing

[20]Recall the dress example: A garment producer can choose what materials to use in order to make a dress according to preset designs and assembly steps. He could use cheap cotton and plastic buttons to make a cheap, low-quality dress or expensive silk and mother-of-pearl buttons to make an expensive, high-quality dress.

[21]As we show in Appendix 2.3, one justification for the quality production function in our model is complementarity between input quality and management competence in the production of output quality. We find some evidence consistent with this mechanism in unreported results for the US.

stages (Hummels, Ishii, and Yi, 2001; Yi, 2003; Johnson and Noguera, 2012). This provides a second possible rationalization for the quality production function in the model. We therefore use the variety of a firms' imported inputs as a proxy for the complexity of their assembly technology. We also account for product differentiation across countries supplying the same product (Krugman, 1980). In particular, we measure input variety with the log number of different HS-8 products, countries of origin, or origin country-product pairs in a firm's import portfolio, and estimate specification (15) for each of these measures. As Table 5 demonstrates, better managed companies systematically source more distinct inputs from more suppliers, in terms of more origin-product combinations. These results obtain conditioning on firms' log number of export products. This ensures that the range of imported inputs does not rise with management competence simply because of a commensurate increase in the number of output products, rather than the use of more complex assembly.

In light of Proposition 4, the patterns in Tables 4 and 5 corroborate the idea that effective management enables firms to produce higher-quality products using higher-quality inputs and more complex production processes. Intuitively, this could be attributed to good management improving quality control and reducing the incidence of costly mistakes in manufacturing, which is especially relevant when using expensive, high-quality inputs. Superior management may also enhance the processing of specialized inputs that need to be mutually compatible for final assembly, the coordination of multiple production stages, and the implementation of efficient inventory practices. These practices are particularly important when the manufacturing process is more complex.

6 Causal Effect of Management

The model in Section 2 has a range of empirical implications for the co-variation we expect to see between firms' management practices and multiple aspects of their trade activity. These are broadly supported by the data. Although we can extend the model to capture endogenous choice of management practice (see Appendix 2.1), we cannot empirically test this alternative model as its predictions are observationally equivalent to those of the baseline framework with exogenous management draws.

In this section, we provide two pieces of independent evidence which suggest that management competence indeed exerts a causal effect on firms' production efficiency and quality capacity, and thereby on their export performance: one based on a management intervention in a randomized control trial in India, and one based on the panel dimension of our data for the US.

6.1 RCT Evidence

A growing body of work using randomized control trials (RCT) indicates that some aspects of management have a causal effect on firm TFP, production efficiency and product quality (e.g. see the survey in McKenzie and Woodruff (2013)). Perhaps the best evidence comes from Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013), who worked with the company *Accenture* to provide free management consulting services to large firms (average of 273 employees) in the textile industry in Mumbai, India. The study examined three groups of plants over the 2008-2011 period. 11 plants owned by 6 firms served as a pure control group, while 20 plants owned by 11 firms constituted the treatment group. In the treated group, 14 plants were randomly selected to receive the management intervention. They had one month of diagnostic assessment of management practices in place and four months of consulting on 38 core management practices across 6 key areas (factory operations, quality control, inventory control, loom planning, human resources, and sales and orders). The remaining 6 plants in the treated firms were given only the one-month diagnostic without any intervention. All three groups of plants were followed for a further 3 years with monthly visits to collect detailed production data. In 2017, Bloom, Mahajan, McKenzie, and Roberts (2018) went back to these firms to assess the long-term impact of the intervention 8 years on. They collected various follow-up performance metrics for 2014 and 2017, including trade activity that we are the first to analyze here.

Three lessons emerge from the India RCT. First, the consulting intervention had a large long-lasting effect on the management practices that firms actually adopted. The management practice adoption rate in the treatment plants rose from 25.6% to 63.4% in the first year, with this slipping back somewhat over the next eight years back to 46%, but still significantly above its initial level (or the control firms).

Second, the management intervention led to a large causal improvement in firms' TFP and product quality. Figure 4 plots the change in TFP during the experiment against the change in management competence for both treatment and control plants, displaying a highly significant positive relationship. Figure 5 similarly plots the change in the product defect rate (an inverse measure of quality) against the change in the management score, and shows a strongly significant downward slope. As Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013) discuss, the intervention led to a 37.8% improvement in management effectiveness. This caused a 43% drop in product defects, and was itself one of the major drivers of the 17% increase in TFP.

Third, the management intervention significantly increased firms' export participation. In the 2017 long-run follow-up, we asked firms about their export activity over the prior 10 years. In Panel A of Table 6, we explore the intention-to-treat effect of the management consulting in a reduced-form regression of various export outcomes on a plant-level treatment dummy. We see in Column 1 that treatment plants were 0.189 more likely to export in the post-treatment period, suggesting that better management practices increase the extensive margin of exporting. In Columns 2 and 3, we examine export levels respectively with the log of (1+exports) or (exports), and find highly significant positive effects for both. The results for the pure intensive margin in Column 3 imply a 51.6% increase in export revenues from the management intervention. We document similarly strong positive impacts in Panel B, where we use the treatment indicator as an instrument for the management score in a two-stage IV specification.

These three pieces of causal RCT evidence highlight how adopting superior management strategies can lead to improvements in firms' product quality, production efficiency, and ultimately export performance in environments with weak management practices such as India.

6.2 Panel Evidence

We shed further light on the possible causal effect of firm management on trade activity by exploiting the panel dimension in our data for the US. In Panel A of Table 7, we replicate all of our key results when regressing firms' export and import outcomes in year 2011 on their lagged management score (from year 2010). Conditioning as before on the full set of state fixed effects, industry fixed effects, noise and firm controls, we establish broadly similar results.

Using even more stringent estimation, we show that within-firm upgrading of management practices is associated with significant improvements in export performance, production efficiency and output quality, and imported input quality and complexity. In particular, in Panel B of Table 7 we regress the change in all relevant trade outcomes within firms from 2005 to 2010 on the concurrent change in their management practices.[22] We include state and industry fixed effects, which now absorb not only level differences, but also systematic differences in time trends across space and manufacturing sectors. Controlling for the full set of firm and noise controls as above, we record significant coefficients across the board. Their magnitudes are occasionally slightly reduced, consistent with management exerting greater effects on the level of firm performance than on its growth trajectory. The only point estimate that changes sign in these first-difference regressions is that for the average GDP per capita of firms' source countries. We believe this may be related to the rise of China over the 2005-2010 period - a country with relatively low income but nevertheless steadily increasing product quality over time.

7 Conclusion

This paper examines for the first time the role of management practices for firms' export performance. We theoretically and empirically establish that management ability can affect both productive efficiency and quality capacity. Good managerial practices thereby enhance export participation, intensity and number of markets served. These results suggest that effective management is an important aspect of firm productivity which has typically been treated as a black box in the prior literature. We show that although better management is associated with greater efficiency and quality capacity in both China and the US, it matters relatively more in China, and especially so for the quality channel. This is consistent with the idea that enhanced managerial capabilities are critical for helping emerging economies move up the quality ladder and become richer (Sutton, 2007).

[22] In 2010, US firms completing MOPS were asked about their management practices in both 2005 and 2010. In 2015, they likewise reported on their management practices in 2015 and 2010. The contemporaneous and recall data for 2010 line up well (Bloom, Brynjolfsson, Foster, Jarmin, Patnaik, Saporta-Eksten, and Van Reenen, 2017), which gives us confidence in using recall data.

Our findings have broader implications for the microeconomics of firm operations and inform active literatures on the nature, origin and welfare consequences of firm heterogeneity. They also speak to policy concerns about the impact of limited management know-how on growth and entrepreneurship in developing economies. A limitation of the work is that we have not examined the reasons for weaker managerial ability in some firms and countries compared to others. We believe that strengthening managerial capabilities is an important policy issue, and researchers are starting to make in-roads into the key question of what determines management and how policy-makers can influence it.

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Table 1. Export Status and Export Revenues

	China				US			
Dep Variable:	Exporter Dummy		Log Exports		Exporter Dummy		Log Exports	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Management	0.040**	0.048***	0.260**	0.231*	0.042***	0.031***	0.488***	0.373***
	(2.30)	(2.75)	(2.14)	(1.81)	(13.92)	(10.13)	(21.72)	(16.79)
Capital Intensity		-0.010		0.145		-0.020***		0.193***
		(-0.76)		(1.43)		(-6.04)		(7.35)
Wage		0.041*		0.401**		0.106***		0.904***
		(1.82)		(2.17)		(9.82)		(11.84)
Age		0.030		0.153		0.044***		0.411***
		(1.53)		(1.01)		(11.47)		(13.29)
Fixed Effects	Province, SIC-3 Industry, Own, Year				State, NAICS-6 Industry			
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.41	0.43	0.40	0.43	0.26	0.27	0.33	0.37
# observations	3,233	3,123	2,236	1,935	32,000	32,000	13,000	13,000

This table examines the relationship between firms' management practices, probability of exporting, and global export revenues. In Columns 1-2 and 5-6, the sample includes all Chinese firms and US establishments in the matched sample with balance sheet and management data, and the dependent variable is a binary indicator equal to 1 for exporters. In Columns 3-4 and 7-8, the sample includes all exporters in the matched sample with trade and management data, and the dependent variable is log total exports. *Management Score* is the standardized average score across all questions about firms' management practices. *Capital Intensity* is log net fixed asset per worker. *Wage* is log labor cost per employee. *Age* is log firm age in years. All columns control for the share of workers with a college degree; noise controls (interview duration and time of day; interviewer dummies; interviewee gender, reliability and competence as perceived by the interviewer). All regressions for China include fixed effects for firm province, main SIC-3 industry, year, and ownership status (private domestic, state-owned, foreign-owned). All regressions for the US include fixed effects for firm state and main NAICS-6 industry. Standard errors clustered by firm (China) and robust (US). US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 2. Extensive and Intensive Margins of Exports

	China					US				
Dep Variable:	Log # Dest	Log # Prod	Log # Dest-Prod	Log Avg Exports per Dest-Prod	Log Exports Top Dest-Prod	Log # Dest	Log # Prod	Log # Dest-Prod	Log Avg Exports per Dest-Prod	Log Exports Top Dest-Prod
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Management	0.185***	0.166***	0.215***	0.017	0.196*	0.134***	0.165***	0.195***	0.177***	0.320***
	(2.80)	(3.33)	(2.89)	(0.20)	(1.74)	(13.08)	(15.32)	(15.13)	(12.75)	(16.05)
Fixed Effects	Province, SIC-3 Industry, Own, Year					State, NAICS-6 Industry				
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.44	0.42	0.40	0.45	0.43	0.37	0.33	0.37	0.32	0.36
# observations	1,935	1,935	1,935	1,935	1,935	13,000	13,000	13,000	13,000	13,000

This table examines the relationship between firms' management practices and the extensive and intensive margins of their exports. The dependent variable is firms' log number of export destinations in Columns 1 and 6, log number of export products in Columns 2 and 7, log number of destination-product pairs in Columns 3 and 8, log average exports per destination-product in Columns 4 and 9, and log exports in a firm's highest-revenue destination-product in Columns 5 and 10. A product is HS 8-digit. All regressions for China include fixed effects for firm province, main SIC-3 industry, year, and ownership status. All regressions for the US include fixed effects for firm state and main NAICS-6 industry. All columns also include a full set of firm and noise controls as described in Table 1. Standard errors clustered by firm (China) and robust (US). US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 3. Production Efficiency and Product Quality

	China				US			
Dep Variable:	Log Export Quality	Log Qual-Adj Export Price	Log Export Price	Log Export Quantity	Log Export Quality	Log Qual-Adj Export Price	Log Export Price	Log Export Quantity
Structural Parameter:	θ^{CH}	$-\delta^{CH}$	$\theta^{CH} - \delta^{CH}$		θ^{US}	$-\delta^{US}$	$\theta^{US} - \delta^{US}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Management	0.531*	-0.385*	0.146**	-0.200	0.048***	-0.045***	0.003	0.034***
	(1.95)	(-1.82)	(2.16)	(-1.49)	(2.60)	(-2.91)	(0.68)	(2.83)
Fixed Effects	Province, Dest-Product, Own, Year				State, Dest-Product			
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.92	0.89	0.92	0.79	0.96	0.95	0.97	0.83
# observations	58,101	58,101	58,101	58,101	290,000	290,000	290,000	290,000

This table examines the relationship between firms' management practices and the price, quality, quality-adjusted price and quantity of their exports. The dependent variable is log export product quality in Columns 1 and 5, quality-adjusted log export unit value in Columns 2 and 6, log export unit value in Columns 3 and 7, and log export quantity in Columns 4 and 8, by firm-destination-product. Quality is estimated as demand elasticity (set to 5) x unit value + quantity as descrbed in the text. *Structural Parameter* is the model parameter identified from the reduced form coefficient on *Management*. A product is HS 8-digit. All regressions for China include fixed effects for firm province, destination-product pair, year, and ownership status. All regressions for the US include fixed effects for firm state and destination-product pair. All columns also include a full set of firm and noise controls as described in Table 1. Standard errors clustered by firm. US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 4. Imported Input Quality

	China					US				
Dep Variable:	Log Imports	Log $\frac{\text{Imports}}{\text{Inputs}}$	Log Avg Origin Income	Log Import Input Price	Log Import Input Quality	Log Imports	Log $\frac{\text{Imports}}{\text{Inputs}}$	Log Avg Origin Income	Log Import Input Price	Log Import Input Quality
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Management	0.550***	0.222*	0.046**	0.101**	0.576***	0.344***	-0.003	0.037***	-0.001	0.051**
	(4.32)	(1.86)	(2.11)	(2.36)	(3.03)	(11.83)	(-0.03)	(3.89)	(-0.34)	(2.55)
Fixed Effects	Province, SIC-3 Industry, Own, Year					State, NAICS-6 Industry				
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Origin-Prod FE	--	--	--	Y	Y	--	--	--	Y	Y
R-squared	0.56	0.50	0.38	0.81	0.78	0.31	0.27	0.21	0.97	0.93
# observations	1,778	1,778	1,778	76,626	76,626	10,000	10,000	10,000	140,000	140,000

This table examines the relationship between firms' management practices and imported input quality. The dependent variable is log firm imports in Columns 1 and 6, log share of imports in total intermediate inputs in Columns 2 and 7, log average GDP per capita across origin countries in Columns 3 and 8, log import unit value by origin country-product in Columns 4 and 9, and log import product quality by origin country-product in Columns 5 and 10. Quality is estimated as demand elasticity (set to 5) x unit value + quantity as described in the text. A product is HS 8-digit. All regressions for China include fixed effects for firm province, main SIC-3 industry, year, and ownership status. All regressions for the US include fixed effects for firm state and main NAICS-6 industry. Columns 4-5 and 9-10 include origin country-product pair fixed effects. All columns also include a full set of firm and noise controls as described in Table 1. Standard errors clustered by firm in Columns 1-5 and 9-10 and robust in Columns 6-8. US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 5. Assembly Complexity

	China			US		
Dep Variable:	Log # Origins	Log # Import Prod	Log # Origin-Prod	Log # Origins	Log # Import Prod	Log # Origin-Prod
	(1)	(2)	(3)	(4)	(5)	(6)
Management	0.168***	0.123*	0.145**	0.058***	0.079***	0.087***
	(4.24)	(1.82)	(2.09)	(7.41)	(6.81)	(6.97)
Log # Export Products	0.245***	0.387***	0.441***	0.426***	0.561***	0.632***
	(7.69)	(6.97)	(7.77)	(66.14)	(58.70)	(60.40)
Fixed Effects	Province, SIC-3 Industry, Own, Year			State, NAICS-6 Industry		
Noise Controls	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y
R-squared	0.61	0.64	0.67	0.56	0.51	0.53
# observations	1,566	1,566	1,566	10,000	10,000	10,000

This table examines the relationship between firms' management practices and imported input complexity. The dependent variable is firms' log number of origin countries in Columns 1 and 4, log number of imported products in Columns 2 and 5, and log number of origin country-product pairs in Columns 3 and 6. A product is HS 8-digit. All regressions for China include fixed effects for firm province, main SIC-3 industry, year, and ownership status. All regressions for the US include fixed effects for firm state and main NAICS-6 industry. All columns also include a full set of firm and noise controls as described in Table 1. Standard errors clustered by firm (China) and robust (US). US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 6. India RCT: Change in Management and Trade Activity (2008-2017)

Dep Variable:	Exporter Dummy	Log (1+ Exports)	Log Exports
	(1)	(2)	(3)
Panel A. Intention to Treat (Reduced Form)			
Treatment	0.189*	0.665**	0.416**
	(1.78)	(2.85)	(2.80)
Panel B. Management Impact (IV 2nd Stage)			
Management	0.899	3.16**	1.95**
	(1.67)	(2.45)	(2.71)
1st Stage (Management on Treatment) F-test	35.8	35.8	20.9
Data frequency	Yearly	Yearly	Yearly
Years	2008,11,14,17	2008,11,14,17	2008,11,14,17
Firms	17	17	12
Plants	31	31	22
# Observations	109	109	66

This table examines the relationship between firms' management practices and trade activity following a randomized control trial that provided management consulting to plants in the textile industry in India, 2008-2017. Results are at the plant-year level from the long-run follow-up in Bloom et al. (2017) collecting yearly data. The pre-treatment period is 2008, and the post-treatment period is 2011, 2014, and 2017. The sample includes 14 intervention plants in treated firms that received both initial diagnostics and management consulting, 6 non-intervention plants in treated firms that received only initial diagnostics, and 11 control plants that received neither. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level using the sample-size appropriate t-distribution tables.

Table 7. US Panel: Management and Trade Activity over Time

	Export Activity				Quality and Efficiency			Imported Input Quality and Assembly Complexity				
Dep Variable:	Exporter Dummy	Log Exports	Log # Dest-Prod	Log Avg Exports per Dest-Prod	Log Avg Export Quality	Log Avg Qual-Adj Export Price	Log Avg Export Price	Log Imports	Log Avg Origin Income	Log Avg Imp Input Price	Log Avg Imp Input Quality	Log # Origin-Prod
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A. Lags: Trade Activity 2011 and Management 2010												
Management	0.029***	0.395***	0.208***	0.187***	0.053***	-0.059***	-0.006	0.374***	0.038***	-0.003	0.045**	-0.048***
	(9.48)	(18.10)	(16.19)	(13.62)	(3.25)	(-4.19)	(-1.61)	(13.23)	(3.86)	(-0.81)	(2.21)	(-2.62)
Fixed Effects	State, NAICS-6 Industry											
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.29	0.39	0.33	0.32	0.97	0.96	0.98	0.33	0.21	0.97	0.93	0.91
# observations	31,000	13,000	13,000	13,000	13,000	13,000	13,000	10,000	10,000	10,000	10,000	10,000
Panel B. First Differences: Δ Trade Activity 2005→2010 and Δ Management 2005→2010												
Management	0.004***	0.055***	0.031***	0.025**	0.024**	-0.024**	0.001	0.050***	-0.018***	-0.001	0.057***	0.031***
	(3.19)	(4.12)	(4.28)	(2.53)	(2.25)	(-2.49)	(0.41)	(2.76)	(-2.88)	(-0.53)	(4.48)	(3.69)
Fixed Effects	State, NAICS-6 Industry											
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.10	0.06	0.07	0.06	0.042	0.04	0.08	0.09	0.09	0.07	0.07	0.08
# observations	31,000	13,000	13,000	13,000	13,000	13,000	13,000	10,000	10,000	10,000	10,000	10,000

This table examines the relationship between firms' management practices, export and import activity in the panel for US firms with matched data in 2010. All variables are defined in Tables 1-5. In Panel A, the dependent variable is for year 2011, while the management variable is for year 2010. In Panel B, both the dependent and management variables are within-firm changes from 2005 to 2010. All regressions include noise controls, fixed effects for firm state and main NAICS-6 industry, and a full set of 2010 firm controls as described in Table 1. Robust standard errors. Sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Figure 1A. US Management and Organizational Practices Survey: Examples

Example 1: Monitoring

2 In 2005 and 2010, how many key performance indicators were monitored at this establishment?

Examples: Metrics on production, cost, waste, quality, inventory, energy, absenteeism and deliveries on time.

Check one box for each year	2005	2010
1-2 key performance indicators	☐	☐
3-9 key performance indicators	☐	☐
10 or more key performance indicators	☐	☐
No key performance indicators (If no key performance indicators in both years, SKIP to **6**)	☐	☐

Example 2: Targets

8 In 2005 and 2010, who was aware of the production targets at this establishment? *Check one box for each year*

	2005	2010
Only senior managers	☐	☐
Most managers and some production workers	☐	☐
Most managers and most production workers	☐	☐
All managers and most production workers	☐	☐

Example 3: Incentives

14 In 2005 and 2010, what was the primary way **managers** were promoted at this establishment?

Check one box for each year	2005	2010
Promotions were based solely on performance and ability	☐	☐
Promotions were based partly on performance and ability, and partly on other factors (for example, tenure or family connections)	☐	☐
Promotions were based mainly on factors other than performance and ability (for example, tenure or family connections)	☐	☐
Managers are normally not promoted	☐	☐

This figure provides examples of the 16 questions in the MOPS survey for the US that span the management of physical capital resources (subdivided into monitoring production and setting targets) and of human capital resources (incentives design).

Figure 1B. China World Management Survey: Examples

Example 1: Monitoring: How is performance tracked?

Score	**(1): Measures tracked do not indicate directly if overall business objectives are being met. Certain processes aren't tracked at all**	**(3): Most key performance indicators are tracked formally. Tracking is overseen by senior management**	**(5): Performance is continuously tracked and communicated, both formally and informally, to all staff using a range of visual management tools**

Example 2: Targets: How are targets set?

Score	**(1): Goals are exclusively financial or operational**	**(3): Goals include non-financial targets, which form part of the performance appraisal of top management *only***	**(5): Goals are a balance of financial and non-financial targets. Senior managers believe the non-financial targets are often more inspiring and challenging than financials alone**

Example 3: Incentives: How does promotion work?

Score	**(1) People are promoted primarily upon the basis of tenure, irrespective of performance (ability & effort)**	**(3) People are promoted primarily upon the basis of performance**	**(5) We actively identify, develop and promote our top performers**

This figure provides examples of the 18 questions in the WMS survey for China that span the management of physical capital resources (subdivided into monitoring production and setting targets) and of human capital resources (incentives design).

Figure 2. Management Practices across Firms

Figure 2A. US MOPS

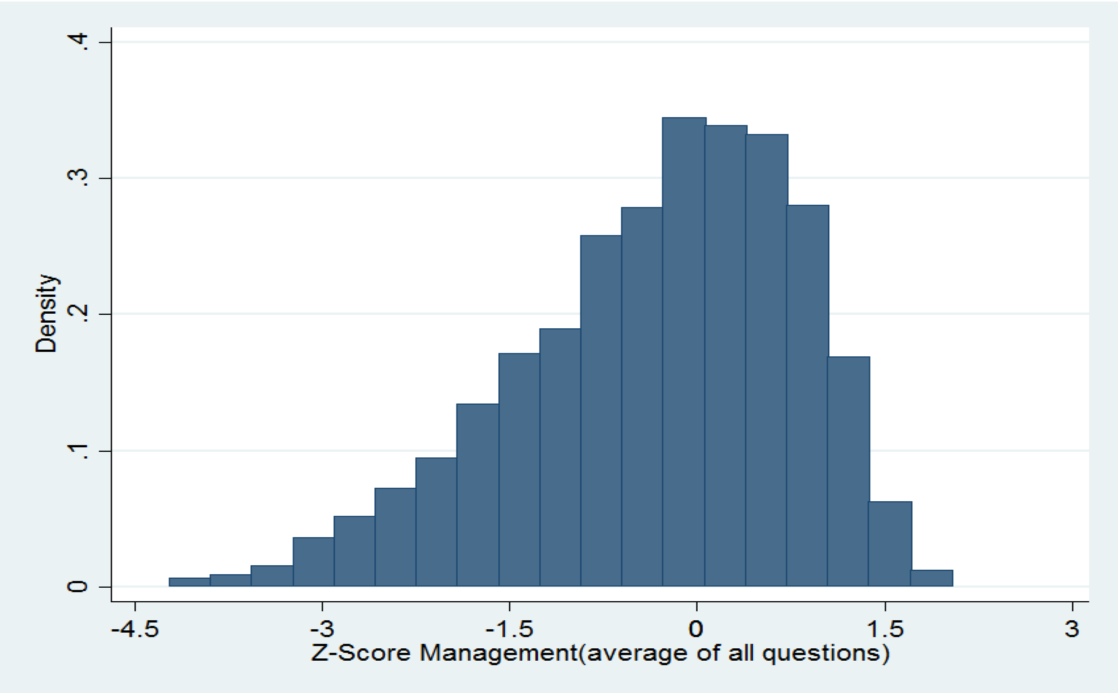
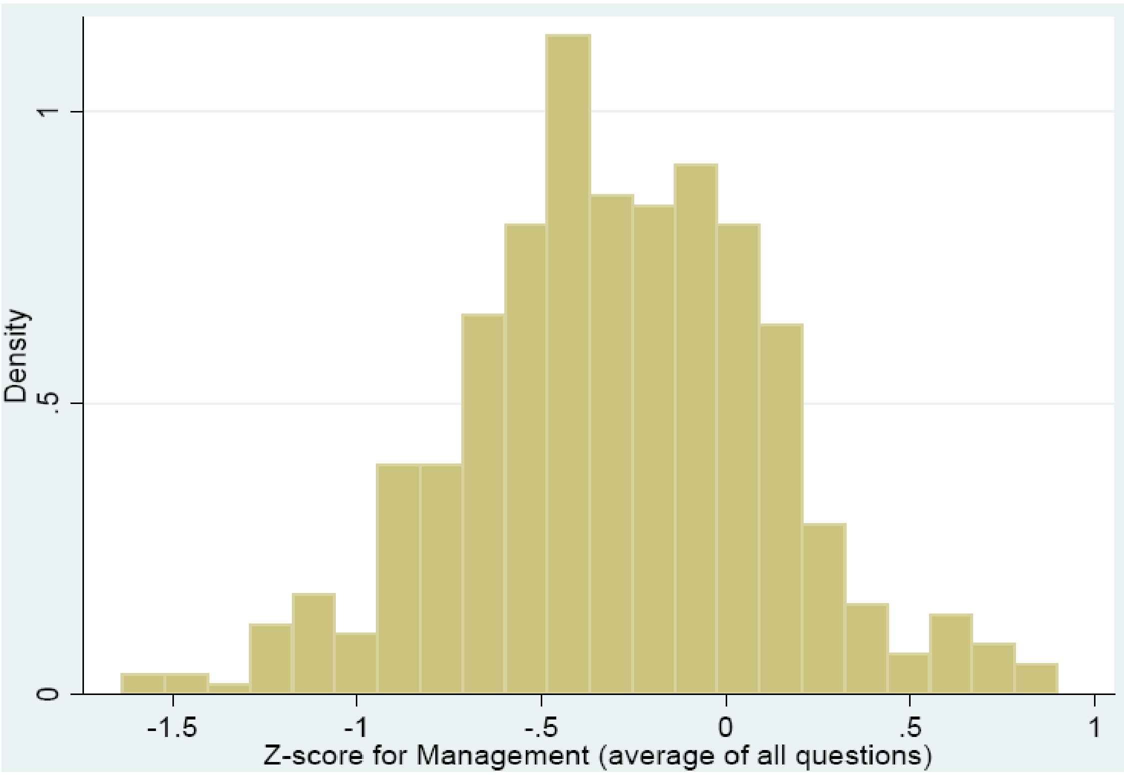
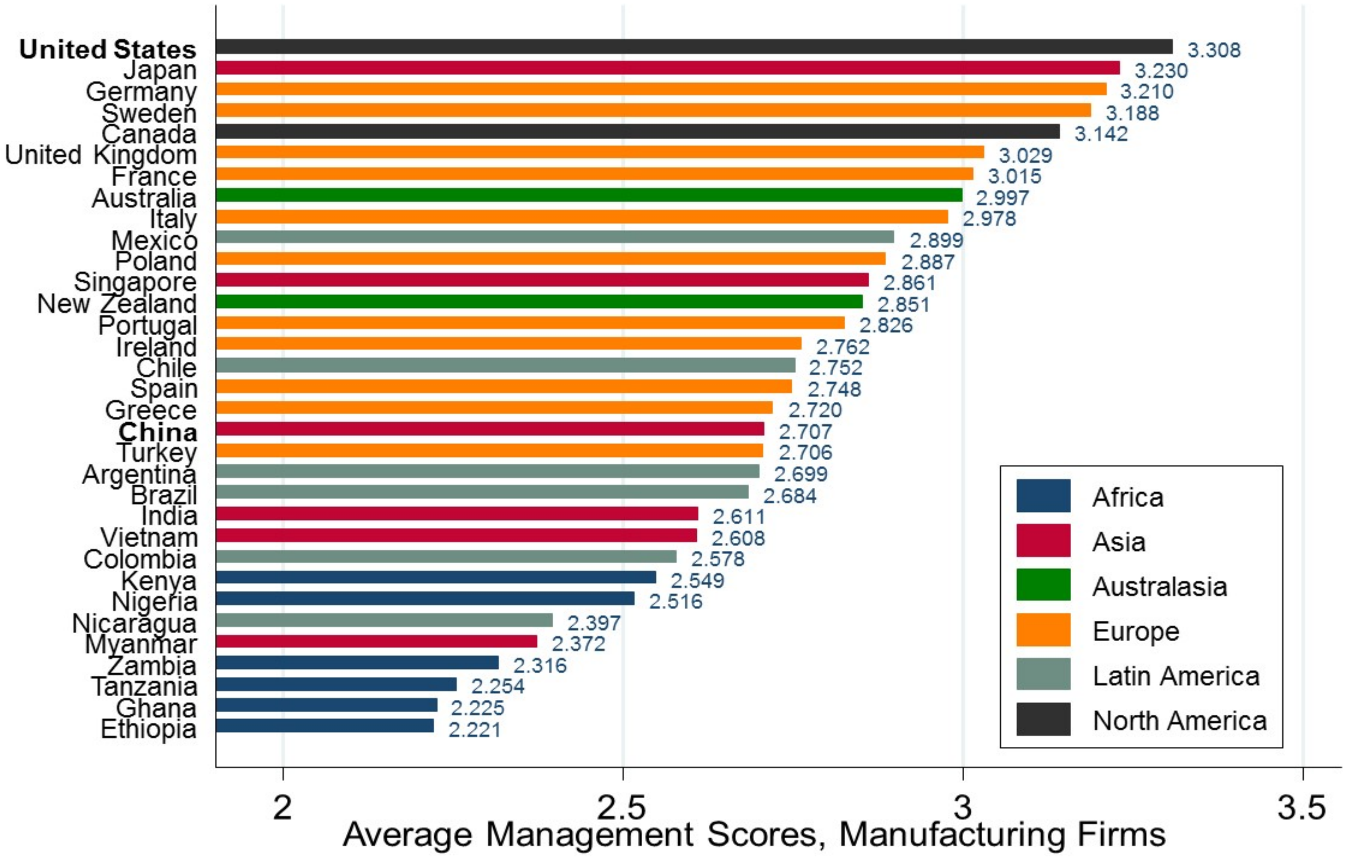


Figure 2B. China WMS



This figure plots the MOPS management score distribution for the US (top) and the WMS ma score distribution for China (bottom). The management scores are averaged across all questi being normalized for the regression analysis.

Figure 3. Average WMS Management Practices across Countries



This figure plots the WMS average management score across all firms in a country, averaged over all WMS waves from 2004 to 2014. Each firm is scored on 18 questions and each question is marked on a scale of 1 to 5, such that the overall firm and country scores have a range of 1 to 5.

Figure 4. India RCT: Change in TFP vs. Change in Management (2008-2011)

This figure displays the relationship between the improvement in firms' management practices and total factor productivity (in logs) following a randomized control trial that provided management consulting to plants in the textile industry in India, 2008-2011. It plots the firm-by-week change in log total factor productivity against the firm-by-week change in the management score, both relative to their pre-experiment average. See Bloom et al. (2013) for experiment details.

Figure 5. India RCT: Change in Quality Defects vs. Change in Management (2008-2011)

This figure displays the relationship between the improvement in firms' management practices and quality control in production following a randomized control trial that provided management consulting to plants in the textile industry in India, 2008-2011. It plots the firm-by-week change in the log quality defects index against the firm-by-week change in the management score, both relative to their pre-experiment average. The quality defects index measures the severity-weighted number of defects per roll of fabric. See Bloom et al. (2013) for experiment details.

Appendix Table 1. Summary Statistics

Panel A. Characteristics of exporters and non-exporters

	China		US	
	Exporters	Non-exporters	Exporters	Non-exporters
# Observations	1,875	1,358	14,000	18,000
Management	0.06	-0.09	0.12	-0.26
Log Gross Output	11.72	11.55	10.6	9.55
Log Employment	6.46	6.15	4.76	3.96
TFPR	4.86	4.77	4.3	4.07
Log Value Added / L	3.73	3.95	5.04	4.78

Panel B. Firms' management, export and import activity

	China		US	
	Mean	St Dev	Mean	St Dev
Management	0	1	0	1
# Export Observations	2,236		13,000	
Log Exports	14.80	2.31	13.79	2.77
# Export Products	8.65	11.58	18.94	47.50
# Export Destinations	12.85	14.99	12.95	16.72
# Import Observations	2,048		10,000	
Log Imports	13.87	2.97	13.93	2.96
# Import Products	33.45	51.43	19.67	43.09
# Import Origins	6.30	5.67	6.20	8.02

This tables provides summary statistics. China: all firms in the matched WMS-ASIE sample for 1999-2007 (Panel A) and all exporters in the matched WMS-CCTS sample for 2000-2008 (Panel B). US: all plants in the matched MOPS-ASM sample for 2010 (Panel A) and all exporting firms in the matched MOPS-LFTTD sample for 2010 (Panel B).

Appendix Table 2. (Export) Profits

	China			US		
Dep Variable:	Log Profits			Log Profits		
	(1)	(2)	(3)	(4)	(5)	(6)
Management	0.546***	0.387***	0.361***	0.431***	0.340***	0.111***
	(6.98)	(5.70)	(5.43)	(32.61)	(27.01)	(10.21)
Log Dom Sales			0.097***			0.671***
			(5.85)			(64.28)
Fixed Effects	Province, SIC-3 Industry, Own, Year			State, NAICS-6 Industry		
Noise Controls	Y	Y	Y	Y	Y	Y
Firm Controls	N	Y	Y	N	Y	Y
R-squared	0.45	0.55	0.57	0.71	0.75	0.85
# observations	2,520	2,438	2,438	13,000	13,000	13,000

This table examines the relationship between firms' management practices and profits. The dependent variable is firms' log profits. All regressions for China include noise controls and fixed effects for firm province, main SIC-3 industry, year, and ownership status. All regressions for the US include noise controls and fixed effects for firm state and main NAICS-6 industry. Columns 2-3 and 5-6 also include a full set of firm controls as described in Table 1. Standard errors clustered by firm (China) and robust (US). US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Appendix Table 3. Extensive and Intensive Margins of Exports: No Firm Controls

	China					US				
Dep Variable:	Log # Dest	Log # Prod	Log # Dest-Prod	Log Avg Exports per Dest-Prod	Log Exports Top Dest-Prod	Log # Dest	Log # Prod	Log # Dest-Prod	Log Avg Exports per Dest-Prod	Log Exports Top Dest-Prod
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Management	0.159**	0.152***	0.200***	0.062	0.226**	0.179***	0.213***	0.257***	0.231***	0.418***
	(2.51)	(3.06)	(2.72)	(0.75)	(2.11)	(17.44)	(19.67)	(19.76)	(16.62)	(20.8)
Fixed Effects	Province, SIC-3 Industry, Own, Year					State, NAICS-6 Industry				
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	N	N	N	N	N	N	N	N	N	N
R-squared	0.43	0.41	0.40	0.38	0.39	0.33	0.29	0.33	0.28	0.32
# observations	2,236	2,236	2,236	2,236	2,236	13,000	13,000	13,000	13,000	13,000

This table examines the relationship between firms' management practices and the extensive and intensive margins of their exports. All variables, fixed effects, and noise controls are as described in Table 2, but the regressions exclude firm controls. Standard errors clustered by firm (China) and robust (US). US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Appendix Table 4. Export vs. Domestic Activity

	China					US				
Dep Variable:	Log Dom Sales	Exporter Dummy	Log Exports	Log # Dest-Prod	Log Avg Exports per Dest-Prod	Log Dom Sales	Exporter Dummy	Log Exports	Log # Dest-Prod	Log Avg Exports per Dest-Prod
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Management	0.475***	0.058***	0.250*	0.219***	0.032	0.344***	0.022***	0.164***	0.072***	0.092***
	(2.97)	(3.32)	(1.96)	(2.96)	(0.37)	(29.43)	(6.92)	(7.35)	(5.54)	(6.46)
Log Dom Sales		-0.025***	-0.035	-0.007	-0.028		0.028***	0.605***	0.358***	0.247***
		(-7.33)	(-1.46)	(-0.43)	(-1.50)		(9.87)	(33.62)	(33.85)	(21.83)
Fixed Effects	Province, SIC-3 Industry, Own, Year					State, NAICS-6 Industry				
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.98	0.43	0.44	0.40	0.45	0.49	0.27	0.45	0.43	0.35
# observations	1,935	3,123	1,935	1,935	1,935	13,000	32,000	13,000	13,000	13,000

This table examines the relationship between firms' management practices, domestic and export activity. All dependent variables are defined in Tables 1-2. All regressions for China include fixed effects for firm province, main SIC-3 industry, year, and ownership status. All regressions for the US include fixed effects for firm state and main NAICS-6 industry. All columns also include a full set of firm and noise controls as described in Table 1. Standard errors clustered by firm (China) and robust (US). US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Appendix Table 5. Management vs. TFPR

Dep Variable:	TFPR	Exporter Dummy	Log Exports	Exporter Dummy	Log Exports	Log Export Quality	Log Qual-Adj Exp Price	Log Imp Input Quality
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. China								
Management	0.150***			0.053***	0.287**	0.520*	-0.363*	0.592***
	(3.48)			(2.93)	(2.34)	(1.89)	(-1.69)	(3.14)
TFPR		-0.006	0.274***					
		(-0.45)	(3.54)					
Non-Management TFPR				-0.006	0.246***	0.242**	-0.192**	0.411***
				(-0.49)	(3.28)	(2.30)	(-2.32)	(2.87)
Fixed Effects	Province, SIC-3 Industry, Own, Year							
Noise, Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y
Country-Product FE	--	--	--	--	--	Y	Y	Y
R-squared	0.49	0.42	0.44	0.43	0.46	0.90	0.89	0.78
# observations	2,800	2,802	1,880	2,800	1,880	54,565	54,565	70,270
Panel B. US								
Management	0.090***			0.026***	0.358***	0.041***	-0.045***	0.049**
	(10.10)			(8.66)	(16.37)	(2.96)	(-3.64)	(2.50)
TFPR		0.040***	0.307***					
		(11.49)	(12.09)					
Non-Management TFPR				0.037***	0.273***	0.025**	-0.024**	0.035***
				(10.50)	(11.12)	(2.30)	(-2.38)	(2.58)
Fixed Effects	State, NAICS-6 Industry							
Noise, Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y
Country-Product FE	--	--	--	--	--	Y	Y	Y
R-squared	0.83	0.28	0.38	0.28	0.41	0.97	0.96	0.93
# observations	32,000	32,000	13,000	32,000	13,000	290,000	290,000	140,000

This table examines the relationship between firms' management practices, total factor productivity, and trade activity. All dependent variables are defined in Tables 1, 3 and 4. *TFPR* is revenue-based TFP measured as in Levinsohn-Petrin. *Non-Management TFPR* is the residual from the regression of TFPR on management and no other controls or fixed effects. All regressions for China include fixed effects for firm province, main SIC-3 industry, year, and ownership status. All regressions for the US include fixed effects for firm state and main NAICS-6 industry. Columns 6-8 include country-product pair fixed effects. All columns also include a full set of firm and noise controls as described in Table 1. Standard errors clustered by firm, except for Columns 1-5 for the US where they are robust. US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Appendix Table 6. Production Efficiency and Product Quality: Robustness

Panel A. Sector-specific demand elasticity (Broda-Weinstein)

	China				US			
Dep Variable:	Log Export Quality	Log Qual-Adj Export Price	Log Export Price	Log Export Quantity	Log Export Quality	Log Qual-Adj Export Price	Log Export Price	Log Export Quantity
Structural parameter(s)	θ^{CH}	$-\delta^{CH}$	$\theta^{CH}-\delta^{CH}$		θ^{US}	$-\delta^{US}$	$\theta^{US}-\delta^{US}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Management	0.332*	-0.185	0.149**	-0.203	0.042***	-0.046***	0.003	0.034***
	(1.96)	(-1.48)	(2.16)	(-1.49)	(2.99)	(-3.68)	(0.68)	(2.83)
Fixed Effects	Province, Dest-Product, Own, Year				State, Dest-Product			
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.90	0.89	0.92	0.79	0.97	0.96	0.97	0.83
# observations	58,101	58,101	58,101	58,101	290,000	290,000	290,000	290,000

Panel B. Controlling for market power

	China				US			
Dep Variable:	Log Export Quality	Log Qual-Adj Export Price	Log Export Price	Log Export Quantity	Log Export Quality	Log Qual-Adj Export Price	Log Export Price	Log Export Quantity
Structural parameter(s)	θ^{CH}	$-\delta^{CH}$	$\theta^{CH}-\delta^{CH}$		θ^{US}	$-\delta^{US}$	$\theta^{US}-\delta^{US}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Management	0.531*	-0.385*	0.146**	-0.200	0.040**	-0.044***	-0.004	0.058***
	(1.95)	(-1.82)	(2.16)	(-1.49)	(2.36)	(-2.99)	(-1.01)	(4.69)
Market Share	0.001	-0.001	0.000	0.001	0.038*	-0.040*	-0.002*	0.048*
	(0.94)	(-1.01)	(0.28)	(1.43)	(1.78)	(-1.78)	(-1.72)	(1.78)
Fixed Effects	Province, Dest-Product, Own, Year				State, Dest-Product			
Noise Controls	Y	Y	Y	Y	Y	Y	Y	Y
Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.90	0.89	0.92	0.79	0.97	0.96	0.98	0.84
# observations	58,101	58,101	58,101	58,101	290,000	290,000	290,000	290,000

This table examines the robustness of the relationship between firms' management practices and the price, quality, quality-adjusted price and quantity of their exports. All variables, controls and fixed effects are as described in Table 3 with two exceptions. In Panel A, quality and quality-adjusted prices are constructed using industry-specific demand elasticities from Broda-Weinstein (2006). In Panel B, an additional control is added for a firm's market power: its share of total Chinese exports by destination-product-year (Columns 1-4) or of total US exports by destination-product (Columns 5-8). Standard errors clustered by firm. US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Appendix Table 7. Management Components

	Export Activity		Quality and Efficiency			Imported Input Quality and Assembly Complexity		
Dep Variable:	Exporter Dummy	Log Exports	Log Export Quality	Log Qual-Adj Export Price	Log Export Price	Log Avg Origin Income	Log Imp Input Quality	Log # Origin-Prod
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. China								
Monitoring & Targets	0.061***	0.012	0.558*	-0.378	0.180**	0.059**	0.353	0.373***
	(2.68)	(0.08)	(1.84)	(-1.58)	(2.54)	(2.19)	(1.64)	(3.89)
Incentives	-0.030	0.266*	-0.008	-0.024	-0.032	-0.013	0.289	-0.195**
	(-0.58)	(1.96)	(-0.03)	(-0.11)	(-0.52)	(-0.42)	(1.23)	(-2.09)
Fixed Effects	Province, SIC-3 Industry, Own, Year							
Noise, Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y
Country-Product FE	--	--	Y	Y	Y	--	Y	--
R-squared	0.43	0.43	0.9	0.89	0.92	0.38	0.78	0.61
# observations	3,123	1,935	58,101	58,101	58,101	1,778	76,626	1,778
Panel B. US								
Monitoring & Targets	0.022***	0.307***	0.050**	-0.050***	-0.005	0.045***	0.052**	0.101***
	(6.99)	(13.11)	(2.56)	(-3.88)	(-1.10)	(4.52)	(2.57)	(7.67)
Incentives	0.013***	0.141***	0.017	-0.006	0.001	-0.003	0.014	0.011
	(4.63)	(6.57)	(1.03)	(-0.057)	(0.16)	(-0.29)	(0.86)	(0.88)
Fixed Effects	State, NAICS-6 Industry							
Noise, Firm Controls	Y	Y	Y	Y	Y	Y	Y	Y
Country-Product FE	--	--	Y	Y	Y	--	Y	--
R-squared	0.27	0.39	0.96	0.96	0.97	0.21	0.93	0.53
# observations	32,000	13,000	290,000	290,000	290,000	10,000	140,000	10,000

This table examines the role of different components of firms' management practices as described in the text. All variables are defined in Tables 1-5. All regressions for China include fixed effects for firm province, main SIC-3 industry, year, and ownership status. All regressions for the US include fixed effects for firm state and main NAICS-6 industry. Columns 3-5 and 7 include country-product pair fixed effects. All columns also include a full set of firm and noise controls as described in Table 1. Standard errors clustered by firm, except for Columns 1, 2, 6 and 8 for the US where they are robust. US sample sizes rounded for disclosure reasons. T-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Managing Trade: Evidence from China and the US*

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Abstract

This appendix provides formal proofs for the baseline model in the paper and presents three theoretical extensions for endogenous choice of management practices, multiple components of firm ability, and endogenous choice of input and output quality.

1 Proofs for Baseline Model

1.1 Set Up

Product demand. The representative consumer in country j has CES utility

$$U_j = \left[\int_{i\in\Omega_j} (q_{ji}x_{ji})^{\alpha} di\right]^{\frac{1}{\alpha}} \tag{1.1}$$

*We thank Rui Zhang and Xincheng Qiu of Peking University for his excellent research assistance for this appendix.

where q_{ji} and x_{ji} are quality and quantity consumed by country j of variety i, and Ω_j is the set of goods available to j. The elasticity of substitution across products is $\sigma = 1/(1-\alpha) > 1$ with $0 < \alpha < 1$. If total expenditure in country j is R_j, j's demand for variety i is

$$x_{ji} = R_j P_j^{\sigma-1} q_{ji}^{\sigma-1} p_{ji}^{-\sigma}. \tag{1.2}$$

Proof. The utility maximization problem is

$$\max_{\{x_{ji}\}} U_j = \left[\int_{i\in\Omega_j} (q_{ji}x_{ji})^{\alpha} di\right]^{\frac{1}{\alpha}} \quad \text{s.t.} \quad \int_{i\in\Omega_j} (p_{ji}x_{ji})\, di = R_j. \tag{1.3}$$

where p_{ji} is the price of variety i in country j. Define the Lagrangian function as

$$L = \left[\int_{i\in\Omega_j} (q_{ji}x_{ji})^{\alpha} di\right]^{\frac{1}{\alpha}} + \lambda\left(R_j - \int_{i\in\Omega_j} (p_{ji}x_{ji})\, di\right). \tag{1.4}$$

The first order condition implies:

$$\frac{\partial L}{\partial x_{ji}} = \left[\int_{i\in\Omega_j} (q_{ji}x_{ji})^{\alpha} di\right]^{\frac{1-\alpha}{\alpha}} (q_{ji}x_{ji})^{\alpha-1} q_{ji} - \lambda p_{ji} = 0, \tag{1.5}$$

$$\implies x_{ji} = \frac{\left(\lambda\frac{p_{ji}}{q_{ji}}\right)^{\frac{1}{\alpha-1}} \left[\int_{i\in\Omega_j} (q_{ji}x_{ji})^{\alpha} di\right]^{\frac{1}{\alpha}}}{q_{ji}}. \tag{1.6}$$

Substituting for x_{ji} in the budget constraint and rearranging yields

$$\lambda = \left\{\frac{\left[\int_{i\in\Omega_j} (q_{ji}x_{ji})^{\alpha} di\right]^{\frac{1}{\alpha}} \int_{i\in\Omega_j} \left(\frac{p_{ji}}{q_{ji}}\right)^{1-\sigma} di}{R_j}\right\}^{1-\alpha} \quad \text{and} \tag{1.7}$$

$$x_{ji} = R_j P_j^{\sigma-1} q_{ji}^{\sigma-1} p_{ji}^{-\sigma}, \tag{1.8}$$

where we have used $\sigma = 1/(1-\alpha)$ and defined $P_j \equiv \left[\int_{i\in\Omega_j} \left(\frac{p_{ji}}{q_{ji}}\right)^{1-\sigma} di\right]^{\frac{1}{1-\sigma}}$ as a quality-adjusted ideal price index. ■

1.2 Profit Maximization

Optimal firm behavior. Individual producers separately maximize profits for each destination-product market by solving

$$\max_{p_{ji},x_{ji}} \pi_{ji} = p_{ji}x_{ji} - \tau_j x_{ji} (\varphi\lambda_i)^{\theta-\delta} - f_{pj} \tag{1.9}$$
$$\text{s.t. } x_{ji} = R_j P_j^{\sigma-1} q_{ji}^{\sigma-1} p_{ji}^{-\sigma}.$$

Product quality is exogenously determined by the quality production function as $q_{ji} = q_i = (\varphi\lambda_i)^{\theta}$. A producer with management competence φ and product expertise λ_i will therefore charge a constant mark-up $\frac{1}{\alpha}$ over marginal cost and have the following price, quantity, quality, quality-adjusted price, revenues and profits for product i in market j:

$$
\begin{aligned}
p_{ji}(\varphi,\lambda_i) &= \frac{\tau_j (\varphi\lambda_i)^{\theta-\delta}}{\alpha}, \qquad x_{ji}(\varphi,\lambda_i) = R_j P_j^{\sigma-1}\left(\frac{\alpha}{\tau_j}\right)^{\sigma}(\varphi\lambda_i)^{\delta\sigma-\theta}, &(1.10)\\
q_i(\varphi,\lambda_i) &= (\varphi\lambda_i)^{\theta}, \qquad p_{ji}(\varphi,\lambda_i)/q_i(\varphi,\lambda_i) = \frac{\tau_j(\varphi\lambda_i)^{-\delta}}{\alpha}, &(1.11)\\
r_{ji}(\varphi,\lambda_i) &= R_j\left(\frac{P_j\alpha}{\tau_j}\right)^{\sigma-1}(\varphi\lambda_i)^{\delta(\sigma-1)}, \qquad \pi_{ji}(\varphi,\lambda_i) = \frac{r_{ji}(\varphi,\lambda_i)}{\sigma} - f_{pj}. &(1.12)
\end{aligned}
$$

Proof. Define the Lagrangian function as

$$
L = p_{ji}x_{ji} - \tau_j x_{ji}(\varphi\lambda_i)^{\theta-\delta} - f_{pj} + \mu\left(R_j P_j^{\sigma-1}(\varphi\lambda_i)^{\theta(\sigma-1)} p_{ji}^{-\sigma} - x_{ji}\right). \tag{1.13}
$$

The first order conditions are:

$$
\begin{aligned}
\frac{\partial L}{\partial x_{ji}} &= p_{ji} - \tau_j(\varphi\lambda_i)^{\theta-\delta} - \mu = 0, &(1.14)\\
\frac{\partial L}{\partial p_{ji}} &= x_{ji} - \sigma\mu R_j P_j^{\sigma-1}(\varphi\lambda_i)^{\theta(\sigma-1)} p_{ji}^{-\sigma-1} = 0, &(1.15)\\
\frac{\partial L}{\partial \mu} &= R_j P_j^{\sigma-1}(\varphi\lambda_i)^{\theta(\sigma-1)} p_{ji}^{-\sigma} - x_{ji} = 0. &(1.16)
\end{aligned}
$$

Plugging the second condition into the third one, one obtains $p_{ji} = \sigma\mu$. Substituting into the first condition, it follows that $\mu = \tau_j(\varphi\lambda_i)^{\theta-\delta}/(\sigma-1)$. Using simple algebra and $\sigma = 1/(1-\alpha)$ delivers the following expressions for the outcomes of interest:

$$
\begin{aligned}
p_{ji}(\varphi,\lambda_i) &= \sigma\mu = \sigma\frac{\tau_j(\varphi\lambda_i)^{\theta-\delta}}{\sigma-1} = \frac{\tau_j(\varphi\lambda_i)^{\theta-\delta}}{\alpha}, &(1.17)\\
x_{ji}(\varphi,\lambda_i) &= R_j P_j^{\sigma-1}(\varphi\lambda_i)^{\theta(\sigma-1)} p_{ji}^{-\sigma} = R_j P_j^{\sigma-1}\left(\frac{\alpha}{\tau_j}\right)^{\sigma}(\varphi\lambda_i)^{\delta\sigma-\theta}, &(1.18)\\
\frac{p_{ji}(\varphi,\lambda_i)}{q_i(\varphi,\lambda_i)} &= \frac{\tau_j(\varphi\lambda_i)^{-\delta}}{\alpha}, &(1.19)\\
r_{ji}(\varphi,\lambda_i) &= p_{ji}x_{ji} = R_j\left(\frac{P_j\alpha}{\tau_j}\right)^{\sigma-1}(\varphi\lambda_i)^{\delta(\sigma-1)}, &(1.20)\\
\pi_{ji}(\varphi,\lambda_i) &= p_{ji}x_{ji} - \tau_j x_{ji}(\varphi\lambda_i)^{\theta-\delta} - f_{pj} = (1-\alpha)r_{ji} - f_{pj} = \frac{r_{ji}(\varphi,\lambda_i)}{\sigma} - f_{pj}. &(1.21)
\end{aligned}
$$

■

1.3 Selection into Products and Markets

Product expertise cut-off for production. Since profits $\pi_d(\varphi, \lambda_i)$ increase with product expertise λ_i, there is a zero-profit expertise level $\lambda^*(\varphi)$ for each management ability draw φ below which the firm will not produce i for the domestic market. This cut-off is defined by the zero-profit condition $\pi_d(\varphi, \lambda^*(\varphi)) = 0$ and is decreasing in φ, i.e. $\frac{d\lambda^*(\varphi)}{d\varphi} < 0$.

Proof. The definition of the product expertise cut-off $\lambda^*(\varphi)$ delivers a closed-form solution for it:

$$\pi_d(\varphi, \lambda^*(\varphi)) = 0 \Leftrightarrow r_d(\varphi, \lambda^*(\varphi)) = R_d (P_d\alpha)^{\sigma-1} (\varphi\lambda^*(\varphi))^{\delta(\sigma-1)} = \sigma f_p \tag{1.22}$$

$$\Longrightarrow \lambda^*(\varphi) = \frac{1}{\varphi}\left[\frac{\sigma f_p}{R_d (P_d\alpha)^{\sigma-1}}\right]^{\frac{1}{\delta(\sigma-1)}}. \tag{1.23}$$

Therefore $\frac{d\lambda^*(\varphi)}{d\varphi} < 0$. ∎

Product expertise cut-off for exporting. Similarly, export profits $\pi_{ji}(\varphi, \lambda_i)$ increase with product expertise λ_i, such that there is a cut-off expertise level $\lambda_j^*(\varphi)$ for each management ability draw φ below which the firm will not export product i to country j. This cut-off is defined by the zero-profit condition $\pi_{ji}\left(\varphi, \lambda_j^*(\varphi)\right) = 0$ and is decreasing in φ, i.e. $\frac{d\lambda_j^*(\varphi)}{d\varphi} < 0$.

Proof. The definition of the export product expertise cut-off $\lambda_j^*(\varphi)$ delivers a closed-form solution for it:

$$\pi_{ji}\left(\varphi, \lambda_j^*(\varphi)\right) = 0 \Leftrightarrow r_{ji}\left(\varphi, \lambda_j^*(\varphi)\right) = R_j \left(\frac{P_j\alpha}{\tau_j}\right)^{\sigma-1} \left(\varphi\lambda_j^*(\varphi)\right)^{\delta(\sigma-1)} = \sigma f_{pj} \tag{1.24}$$

$$\Longrightarrow \lambda_j^*(\varphi) = \frac{1}{\varphi}\left[\frac{\sigma f_{pj}}{R_j \left(\frac{P_j\alpha}{\tau_j}\right)^{\sigma-1}}\right]^{\frac{1}{\delta(\sigma-1)}}. \tag{1.25}$$

Therefore $\frac{d\lambda_j^*(\varphi)}{d\varphi} < 0$. ∎

Management ability cut-off for exporting. The export profits in country j of a firm with management competence φ are:

$$\pi_j(\varphi) = \int_{\lambda_j^*(\varphi)}^{\infty} \pi_{ji}(\varphi, \lambda)\, z(\lambda)\, d\lambda - f_{hj}. \tag{1.26}$$

Since export profits $\pi_j(\varphi)$ increase with management ability φ, only firms with management level above a cut-off φ_j^* will service destination j. This cut-off is defined by the zero-profit condition $\pi_j\left(\varphi_j^*\right) = 0$.

Proof. According to Leibniz's rule,

$$\frac{d\pi_j(\varphi)}{d\varphi} = \int_{\lambda_j^*(\varphi)}^{\infty} \frac{\partial \pi_{ji}(\varphi, \lambda)}{\partial \varphi} z(\lambda)\, d\lambda - \pi_{ji}\left(\varphi, \lambda_j^*(\varphi)\right) z\left(\lambda_j^*(\varphi)\right) \frac{d\lambda_j^*(\varphi)}{d\varphi}. \tag{1.27}$$

Since $r_{ji}(\varphi, \lambda_i) = R_j \left(\frac{P_j \alpha}{\tau_j}\right)^{\sigma-1} (\varphi\lambda_i)^{\delta(\sigma-1)}$ and $\pi_{ji}(\varphi, \lambda_i) = \frac{r_{ji}(\varphi,\lambda_i)}{\sigma} - f_{pj}$, it follows that

$$\frac{\partial \pi_{ji}(\varphi, \lambda)}{\partial \varphi} = \frac{1}{\sigma} \frac{\partial r_{ji}(\varphi, \lambda)}{\partial \varphi} = \frac{\delta(\sigma-1)}{\sigma} R_j \left(\frac{P_j \alpha}{\tau_j}\right)^{\sigma-1} (\varphi\lambda)^{\delta(\sigma-1)-1} \lambda > 0 \tag{1.28}$$

because $\delta > 0$ and $\sigma > 1$. We have already proved that $\frac{d\lambda_j^*(\varphi)}{d\varphi} < 0$. Therefore $\frac{d\pi_j(\varphi)}{d\varphi} > 0$, such that export profits in country j increase with management ability and only firms above a zero-profit management cut-off will export to j. ■

Management ability cut-off for production. Firm φ's global profits are given by

$$\pi(\varphi) = \pi_d(\varphi) + \sum\nolimits_j \pi_j(\varphi) = \int_{\lambda^*(\varphi)}^{\infty} \pi_d(\varphi, \lambda) z(\lambda)\, d\lambda + \sum\nolimits_j \left(\int_{\lambda_j^*(\varphi)}^{\infty} \pi_{ji}(\varphi, \lambda) z(\lambda)\, d\lambda - f_{hj} \right) - f_h \tag{1.29}$$

Since global profits $\pi(\varphi)$ increase with management ability φ, firms with management below a minimum level φ^* will be unable to break even and exit immediately upon learning their attributes. This cut-off is defined by the zero-profit condition $\pi(\varphi^*) = 0$.

Proof. According to Leibniz's rule,

$$\frac{d\pi(\varphi)}{d\varphi} = \int_{\lambda^*(\varphi)}^{\infty} \frac{\partial \pi_d(\varphi, \lambda)}{\partial \varphi} z(\lambda)\, d\lambda - \pi_d(\varphi, \lambda^*(\varphi)) z(\lambda^*(\varphi)) \frac{d\lambda^*(\varphi)}{d\varphi} + \sum\nolimits_j \frac{d\pi_j(\varphi)}{d\varphi}. \tag{1.30}$$

Since $r_d(\varphi, \lambda_i) = R_d (P_d \alpha)^{\sigma-1} (\varphi\lambda_i)^{\delta(\sigma-1)}$ and $\pi_d(\varphi, \lambda_i) = \frac{r_d(\varphi,\lambda_i)}{\sigma} - f_p$, it follows that

$$\frac{\partial \pi_d(\varphi, \lambda)}{\partial \varphi} = \frac{1}{\sigma} \frac{\partial r_d(\varphi, \lambda)}{\partial \varphi} = \frac{\delta(\sigma-1)}{\sigma} R_d (P_d \alpha)^{\sigma-1} (\varphi\lambda)^{\delta(\sigma-1)-1} \lambda > 0 \tag{1.31}$$

because $\delta > 0$ and $\sigma > 1$. We have already proved that $\frac{d\lambda^*(\varphi)}{d\varphi} < 0$ and $\frac{d\pi_j(\varphi)}{d\varphi} > 0$. Therefore $\frac{d\pi(\varphi)}{d\varphi} > 0$, such that global profits increase with management ability and only firms above a zero-profit management cut-off will commence production. ■

1.4 Empirical Predictions

Proposition 1. *Better managed firms are more likely to export.*

Proof. This proposition follows from the result that total export profits $\pi_X(\varphi) = \sum_j \pi_j(\varphi)$ increase with management ability φ. On the intensive margin, we have already established that bilateral export profits increase with management competence, $\frac{\partial \pi_j(\varphi)}{\partial \varphi} > 0$. On the extensive margin, only firms with ability $\varphi \geq \varphi_j^*$ will sell to destination j. For destinations $j = \{1, 2, ..., J\}$, denote

$$\varphi_X^* = \min\{\varphi_1^*, \varphi_2^*, ..., \varphi_J^*\} \tag{1.32}$$

Since firms with higher φ are more likely to have both $\varphi \geq \varphi_j^*$ for any j and $\varphi \geq \varphi_X^*$ overall, they have a higher propensity to export to any given destination j, as well as a higher propensity to be exporters, i.e. to export to at least one destination. The proof to the next proposition is closely related and provides detailed derivations for these claims. ■

Proposition 2. *Better managed firms export more products to more destination markets and earn higher export revenues and profits.*

Proof. First, denote the number of destinations a firm enters as $n(\varphi) = \sum_j I\left(\varphi \geq \varphi_j^*\right)$, where

$$I\left(\varphi \geq \varphi_j^*\right) = \begin{cases} 1, & \varphi \geq \varphi_j^* \\ 0, & \varphi < \varphi_j^* \end{cases} \tag{1.33}$$

A higher φ means that a larger number of destinations j satisfy $\varphi \geq \varphi_j^*$ because $\frac{\partial I\left(\varphi \geq \varphi_j^*\right)}{\partial \varphi} > 0$. Therefore $n(\varphi)$ is increasing in φ and better managed exporters enter more markets, i.e. $\frac{\partial n(\varphi)}{\partial \varphi} > 0$.

Second, for any given market j, we have already shown that bilateral export revenues and profits increase with management ability, $\frac{dr_j(\varphi)}{d\varphi} > 0$ and $\frac{d\pi_j(\varphi)}{d\varphi} > 0$. From the product expertise cut-off condition for exporting, we know that $\frac{d\lambda_j^*(\varphi)}{d\varphi} < 0$. This implies that a higher φ is associated with a bigger measure of products $N_j(\varphi) = 1 - Z\left(\lambda_j^*(\varphi)\right)$ exported to destination j:

$$\frac{dN_j(\varphi)}{d\varphi} = -\frac{dZ\left(\lambda_j^*(\varphi)\right)}{d\varphi} = -\frac{dZ\left(\lambda_j^*(\varphi)\right)}{d\lambda_j^*}\frac{d\lambda_j^*(\varphi)}{d\varphi} > 0. \tag{1.34}$$

Third, total export sales $r_X(\varphi)$, profits $\pi_X(\varphi)$ and number of products $N_X(\varphi)$ are:

$$r_X(\varphi) = \sum\nolimits_j r_j(\varphi)\, I\left(\varphi \geq \varphi_j^*\right), \quad \pi_X(\varphi) = \sum\nolimits_j \pi_j(\varphi)\, I\left(\varphi \geq \varphi_j^*\right), \quad N_X(\varphi) = 1 - Z\left(\lambda_X^*(\varphi)\right) \tag{1.35}$$

where $\lambda_X^*(\varphi) = \min\{\lambda_1^*(\varphi), \lambda_2^*(\varphi), ..., \lambda_J^*(\varphi)\}$ denotes the minimum product expertise cut-off for exporting $\lambda_j^*(\varphi)$ across countries j for a firm with given φ. Note that firms export a nested set of products i to different markets, which follows a strict pecking order based on λ_i.

Since $\frac{dr_j(\varphi)}{d\varphi} > 0$, $\frac{d\pi_j(\varphi)}{d\varphi} > 0$, $\frac{\partial I\left(\varphi \geq \varphi_j^*\right)}{\partial \varphi} > 0$ and $\frac{dN_j(\varphi)}{d\varphi} > 0$, it directly follows that:

$$\frac{dr_X(\varphi)}{d\varphi} = \sum_j \left[\frac{dr_j(\varphi)}{d\varphi} I\left(\varphi \geq \varphi_j^*\right) + \frac{dI\left(\varphi \geq \varphi_j^*\right)}{d\varphi} r_j(\varphi)\right] > 0, \tag{1.36}$$

$$\frac{d\pi_X(\varphi)}{d\varphi} = \sum_j \left[\frac{d\pi_j(\varphi)}{d\varphi} I\left(\varphi \geq \varphi_j^*\right) + \frac{dI\left(\varphi \geq \varphi_j^*\right)}{d\varphi} \pi_j(\varphi)\right] > 0, \tag{1.37}$$

$$\frac{dN_X(\varphi)}{d\varphi} = -\frac{dZ\left(\lambda_X^*(\varphi)\right)}{d\lambda_X^*} \frac{d\lambda_X^*(\varphi)}{d\varphi} > 0. \tag{1.38}$$

■

Proposition 3. *Better managed firms offer higher-quality products if $\theta > 0$, but quality is invariant across firms if $\theta = 0$. Better managed firms set lower quality-adjusted prices if $\delta > 0$, but quality-adjusted prices are invariant across firms if $\delta = 0$. Better managed firms charge higher prices if $\theta > \delta$ and lower prices if $\delta > \theta$, but prices are invariant across firms if $\theta = \delta$.*

Proof. This proposition can be established directly from the solution to the firm's profit-maximization problem above. Taking the partial derivative of firm's price, quality and quality-adjusted price with respect to management ability, we have:

$$p_{ji}(\varphi, \lambda_i) = \frac{\tau_j (\varphi\lambda_i)^{\theta-\delta}}{\alpha} \Longrightarrow \frac{\partial p_{ji}}{\partial \varphi} = \frac{(\theta-\delta)}{\alpha} \tau_j (\varphi\lambda_i)^{\theta-\delta-1} \lambda_i \tag{1.39}$$

$$q_{ji}(\varphi, \lambda_i) = (\varphi\lambda_i)^{\theta} \Longrightarrow \frac{\partial q_{ji}}{\partial \varphi} = \theta (\varphi\lambda_i)^{\theta-1} \lambda_i \tag{1.40}$$

$$\frac{p_{ji}(\varphi, \lambda_i)}{q_{ji}(\varphi, \lambda_i)} = \frac{\tau_j (\varphi\lambda_i)^{-\delta}}{\alpha} \Longrightarrow \frac{\partial (p_{ji}/q_{ji})}{\partial \varphi} = -\frac{\delta}{\alpha} \tau_j (\varphi\lambda_i)^{-\delta-1} \lambda_i \tag{1.41}$$

Recall that $\theta \geq 0$ and $\delta \geq 0$. It immediately follows that $\frac{\partial q_{ji}}{\partial \varphi} > 0$ if and only if $\theta > 0$ and $\frac{\partial (p_{ji}/q_{ji})}{\partial \varphi} < 0$ if and only if $\delta > 0$. Since the sign of $\frac{\partial p_{ji}}{\partial \varphi}$ depends on $(\theta - \delta)$, $\frac{\partial p_{ji}}{\partial \varphi} > 0$ if $\theta > \delta$, $\frac{\partial p_{ji}}{\partial \varphi} < 0$ if $\delta > \theta$, and $\frac{\partial p_{ji}}{\partial \varphi} = 0$ if $\theta = \delta$. ■

Proposition 4. *Better managed firms use more expensive inputs of higher quality and/or more expensive assembly of higher complexity if $\theta > 0$, but input quality and assembly complexity are invariant across firms if $\theta = 0$.*

Proof. From Proposition 3, we know that better managed firms produce goods of higher quality if and only if $\theta > 0$. While we do not explicitly model firms' endogenous choice of product quality in the baseline framework, we assume that producing goods of higher quality entails higher marginal production costs. The implicit micro-foundation for this quality production function is that manufacturing higher-quality products requires more expensive inputs of higher quality and/or more costly assembly technologies. See also Section 2.3 in this Appendix. ■

2 Model Extensions

2.1 Extension 1: Endogenous Management

Our baseline model assumes that management competence is an exogenous draw at the firm level. We now establish that Propositions 1-4 would continue to hold if an exogenous firm primitive endogenously determines the firm's choice of management practice, as long as implementing more effective management practices improves firm performance but is sufficiently more costly. Intuitively, adopting more sophisticated management practices can enhance existing firm capabilities and thereby stimulate market entry and firm revenues. Good management and intrinsic firm attributes may also be complementary, such that effective firm productivity may be supermodular in these two components. At the same time, superior management strategies arguably require higher sunk costs of adoption (e.g. hiring a manager, re-designing production facilities, training staff to use new data monitoring, etc.) and higher fixed costs of production (e.g. collecting data, analyzing peformance, communicating results to staff, etc.). As a result of such economies of scale, exogenously better firms that expect to be more competitive in the market and generate higher sales would endogenously choose better management practices, thereby further improving their performance. Propositions 1-4 would then hold both for the exogenous firm primitive and for the endogenous management quality. In particular, the Propositions would state causal effects for the firm primitive and conditional correlations for management, where the latter would constitute one mechanism through which the former operates.

To illustrate this insight tractably and transparently, we make minimal functional form assumptions for the impact of management choice on firm ability and for the cost of management adoption. The same insight would however apply more generally, as long as the benefit to management upgrading increases faster with management competence than the cost of management upgrading.

We assume that firm entrepreneurs receive an exogenous talent draw ϕ and choose to use management practice m at a convex fixed cost of f_m, where $df_m/dm > 0$ and $d^2 f_m/dm^2 > 0$. Firm ability $\varphi = \phi m(\phi)$ depends on the combination of talented entrepreneurs and management effectiveness. Given product expertise draws λ_i, firms can produce one unit of product i with quality $q_i = [\varphi\lambda_i]^{\theta} = [\phi m(\phi)\lambda_i]^{\theta}$ at a marginal cost of $[\varphi\lambda_i]^{\theta-\delta} = [\phi m(\phi)\lambda_i]^{\theta-\delta}$. In this environment, the proof below establishes that Propositions 1-4 continue to hold as conditional correlations for the endgenous management level in two steps: We first show that Propositions 1-4 apply for effective firm ability $\varphi = \phi m(\phi)$. We then demonstrate that effective firm ability and management are monotonically related, $d\varphi/dm > 0$. Together, these two results directly imply that Propositions 1-4 must also hold for management $m(\phi)$.

Proof. Step One

This extension of the model closely follows the solution concept in Sections 1.3 and 1.4 of this Appendix. Since the fixed cost of management adoption is independent of the firm's product scope, market penetration, and production scale, the firms' profit maximization problem can be solved in steps. The choice of management practice will be determined in the last of these steps. All preceding steps will remain in essense the same as in the baseline model, such that all key equations can be obtained simply by replacing φ with $\phi m(\phi)$.

First, note that entrepreneurial talent ϕ and management competence m always enter multiplicatively as firm ability $\varphi = \phi m(\phi)$ and fix product quality at $q_i = [\varphi\lambda_i]^{\theta} = [\phi m(\phi)\lambda_i]^{\theta}$. The firm will therefore begin by choosing the profit-maximizing price and quantity in each potential destination-product market, conditional on entry there. The optimal price, quantity, quality-adjusted price, revenues and profits for product i in country j will be given by equations (1.17). In particular, domestic profits $\pi_{di}(\phi, m, \lambda)$ from product i and export profits $\pi_{ji}(\phi, m, \lambda_i)$ from product i in country j will be given by the expressions below and increasing in management competence as before:

$$\pi_{di}(\phi, m, \lambda_i) = \frac{1}{\sigma} R_d (P_d \alpha)^{\sigma-1} (\phi m \lambda_i)^{\delta(\sigma-1)} - f_p \Longrightarrow \frac{\partial \pi_{di}(\phi, m, \lambda)}{\partial m} > 0 \tag{2.1}$$

$$\pi_{ji}(\phi, m, \lambda_i) = \frac{1}{\sigma} R_j \left(\frac{P_j \alpha}{\tau_j}\right)^{\sigma-1} (\phi m \lambda_i)^{\delta(\sigma-1)} - f_{pj} \Longrightarrow \frac{\partial \pi_{ji}(\phi, m, \lambda)}{\partial m} > 0 \tag{2.2}$$

Second, the firm will decide which products to produce and which products to export to destination j based on product expertise cut-offs for production and for exporting, $\lambda^*(\phi, m)$ and $\lambda_j^*(\phi, m)$. As before, these cut-offs are given by zero-profit conditions and defined by equations (1.23) and (1.25). However, these are no longer closed-form solutions that depend only on the exogenous firm attribute φ and model parameters, since firm ability $\varphi = \phi m(\phi)$ is now endogenous. Note also that these product expertise cut-offs are decreasing in both entrepreneurial talent and management capacity:

$$\lambda^*(\phi, m) = \frac{1}{\phi m}\left[\frac{\sigma f_p}{R_d (P_d \alpha)^{\sigma-1}}\right]^{\frac{1}{\delta(\sigma-1)}}, \frac{\partial \lambda^*(\phi, m)}{\partial m} = -\frac{\lambda^*}{m} < 0,\ \frac{\partial \lambda^*(\phi, m)}{\partial \phi} = -\frac{\lambda^*}{\phi} < 0 \tag{2.3}$$

$$\lambda_j^*(\phi, m) = \frac{1}{\phi m}\left[\frac{\sigma f_{pj}}{R_j \left(\frac{P_j \alpha}{\tau_j}\right)^{\sigma-1}}\right]^{\frac{1}{\delta(\sigma-1)}}, \frac{\partial \lambda_j^*(\phi, m)}{\partial m} = -\frac{\lambda_j^*}{m} < 0,\ \frac{\partial \lambda_j^*(\phi, m)}{\partial \phi} = -\frac{\lambda_j^*}{\phi} < 0 \tag{2.4}$$

Third, the firm will choose which export markets j to enter. This decision will be guided by firm ability cut-offs for exporting, φ_j^*, which are pinned down by the zero-profit condition $\pi_j\left(\varphi_j^*\right) = 0$ as earlier.

Together, the results above imply that Propositions 1-4 hold for effective firm ability $\varphi = \phi m(\phi)$.

Step Two

Given *Step One* above, Propositions 1-4 will atutomatically hold for management competence m if effective firm ability $\varphi = \phi m(\phi)$ is increasing in m. We now prove this monotonicity.

In the final stage of the firm's problem, the entrepreneur will decide whether to begin production upon learning his talent draw. It is at this point that the firm will also choose its optimal management practice m and thereby effective ability φ, in order to maximize global profits from domestic sales and any exports abroad. This profit maximization problem closely resembles equation (1.29) in the baseline model:

$$\max_{m} \pi(\phi, m) = \int_{\lambda^*(\phi,m)}^{\infty} \pi_{di}(\phi, m, \lambda) z(\lambda) d\lambda + \sum_j \left(\int_{\lambda_j^*(\phi,m)}^{\infty} \pi_{ji}(\phi, m, \lambda) z(\lambda) d\lambda - f_{hj} \right) - f_h - f_m. \tag{2.5}$$

The first order condition with respect to management practices m implies that:

$$\begin{aligned} \frac{\partial \pi(\phi, m)}{\partial m} &= \left(\int_{\lambda^*(\phi,m)}^{\infty} \frac{\partial \pi_{di}(\phi, m, \lambda)}{\partial m} z(\lambda) d\lambda - \pi_{di}(\phi, m, \lambda^*) z(\lambda^*) \frac{\partial \lambda^*(\phi, m)}{\partial m} \right) + \\ &+ \sum_j \left(\int_{\lambda_j^*(\phi,m)}^{\infty} \frac{\partial \pi_{ji}(\phi, m, \lambda)}{\partial m} z(\lambda) d\lambda - \pi_{ji}\left(\phi, m, \lambda_j^*\right) z\left(\lambda_j^*\right) \frac{\partial \lambda_j^*(\phi, m)}{\partial m} \right) - \frac{\partial f_m}{\partial m} = \\ &= \int_{\lambda^*(\phi,m)}^{\infty} A_d \delta(\sigma - 1) \frac{(\phi m \lambda)^{\delta(\sigma-1)}}{m} z(\lambda) d\lambda + \\ &+ \sum_j \left(\int_{\lambda_j^*(\phi,m)}^{\infty} A_j \delta(\sigma - 1) \frac{(\phi m \lambda)^{\delta(\sigma-1)}}{m} z(\lambda) d\lambda \right) - \frac{\partial f_m}{m} \\ &= 0. \end{aligned} \tag{2.6}$$

Note that by the definition of the zero-profit product expertise cut-offs $\lambda^*(\phi, m)$ and $\lambda_j^*(\phi, m)$, the terms involving $\pi_{di}(\phi, m, \lambda^*) = \pi_{ji}\left(\phi, m, \lambda_j^*\right) = 0$ drop out. For ease of notation, the exogenous terms characterizing aggregate expenditure, aggregate price indices, and bilateral trade costs have been collected in $A_d \triangleq \frac{1}{\sigma} R_d (P_d \alpha)^{\sigma-1}$ and $A_j \triangleq \frac{1}{\sigma} R_j \left(\frac{P_j \alpha}{\tau_j}\right)^{\sigma-1}$.

Using this first order condition, one can solve for the firm's optimal management competence level m as an implicit function of ϕ defined as $F(\phi, m)$:

$$\begin{aligned} F(\phi, m) &\equiv \int_{\lambda^*(\phi,m)}^{\infty} A_d \delta(\sigma - 1) \frac{(\phi m \lambda)^{\delta(\sigma-1)}}{m} z(\lambda) d\lambda + \\ &+ \sum_j \left(\int_{\lambda_j^*(\phi,m)}^{\infty} A_j \delta(\sigma - 1) \frac{(\phi m \lambda)^{\delta(\sigma-1)}}{m} z(\lambda) d\lambda \right) - \frac{\partial f_m}{m} \\ &\triangleq F_d(\phi, m) + \sum_j F_j(\phi, m) - \frac{\partial f_m}{m}. \end{aligned} \tag{2.7}$$

We want to prove that $\varphi = \phi m(\phi)$ is increasing in m. We therefore need to show that:

$$\frac{d(\phi m(\phi))}{dm} = \frac{d\phi}{dm} m + \phi = \phi \left(\frac{d\phi}{dm} \frac{m}{\phi} + 1 \right) > 0. \tag{2.8}$$

From the Implicit Function Theorem, it follows that:

$$\frac{d\phi}{dm} = -\frac{\partial F/\partial m}{\partial F/\partial \phi}. \tag{2.9}$$

Therefore, all we need is to prove that:

$$\frac{\partial F/\partial m}{\partial F/\partial \phi} < \frac{\phi}{m}. \tag{2.10}$$

We first show that the denominator $\partial F/\partial \phi$ is positive. Note that

$$\frac{\partial F}{\partial \phi} = F_{1d}(\phi, m) + \sum_j F_{1j}(\phi, m), \tag{2.11}$$

where for each country k in the set comprising the home economy d and all potential export destinations j, $k \in \{d\} \cup \{1, 2, \ldots, J\}$, $F_{1k}(\phi, m)$ is given by:

$$F_{1k}(\phi, m) = A_k \delta(\sigma - 1)(\phi m)^{\delta(\sigma-1)-1} \left[\delta(\sigma - 1) \int_{\lambda_k^*(\phi,m)}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda - \phi (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \frac{\partial \lambda_k^*(\phi, m)}{\partial \phi} \right]. \tag{2.12}$$

Since $\partial \lambda_k^*(\phi, m)/\partial \phi < 0$ as shown above, it follows that $\partial F/\partial \phi > 0$.

We next examine the numerator $\partial F/\partial m$:

$$\frac{\partial F}{\partial m} = F_{2d}(\phi, m) + \sum_j F_{2j}(\phi, m) - \frac{d^2 f_m}{dm^2}, \tag{2.13}$$

where for each country k, $F_{2k}(\phi, m)$ is given by:

$$F_{2k}(\phi, m) = A_k \delta(\sigma - 1)(\phi m)^{\delta(\sigma-1)} \frac{1}{m} \left[\frac{\delta(\sigma - 1) - 1}{m} \int_{\lambda_k^*}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda - (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \frac{\partial \lambda_k^*}{\partial m} \right]. \tag{2.14}$$

Since $\partial F/\partial \phi > 0$ and $d^2 f_m/dm^2 > 0$, we therefore know that:

$$\frac{\partial F/\partial m}{\partial F/\partial \phi} < \frac{F_{2d}(\phi, m) + \sum_j F_{2j}(\phi, m)}{F_{1d}(\phi, m) + \sum_j F_{1j}(\phi, m)}. \tag{2.15}$$

Recalling that $\partial \lambda_k^*/\partial \phi = -\lambda_k^*/\phi$ and $\partial \lambda_k^*/\partial m = -\lambda_k^*/m$ for all $k \in \{d\} \cup \{1, 2, \ldots, J\}$, one can show that $F_{2k}(\phi, m)/F_{1k}(\phi, m) < \phi/m$:

$$\frac{F_{2k}(\phi, m)}{F_{1k}(\phi, m)} = \frac{A_k \delta(\sigma - 1)(\phi m)^{\delta(\sigma-1)} \frac{1}{m} \left[\frac{\delta(\sigma-1)-1}{m} \int_{\lambda_k^*}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda - (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \frac{\partial \lambda_k^*}{\partial m} \right]}{A_k \delta(\sigma - 1)(\phi m)^{\delta(\sigma-1)-1} \left[\delta(\sigma - 1) \int_{\lambda_k^*}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda - \phi (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \frac{\partial \lambda_k^*}{\partial \phi} \right]} \tag{2.16}$$

$$= \frac{\phi \left[\frac{\delta(\sigma-1)-1}{m} \int_{\lambda_k^*}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda + (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \frac{\lambda_k^*}{m} \right]}{\left[\delta(\sigma - 1) \int_{\lambda_k^*}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda + \phi (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \frac{\lambda_k^*}{\phi} \right]}$$

$$= \frac{\phi}{m} \cdot \frac{(\delta(\sigma - 1) - 1) \int_{\lambda_k^*}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda + (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \lambda_k^*}{\delta(\sigma - 1) \int_{\lambda_k^*}^{\infty} \lambda^{\delta(\sigma-1)} z(\lambda)\, d\lambda + (\lambda_k^*)^{\delta(\sigma-1)} z(\lambda_k^*) \lambda_k^*}$$

$$< \frac{\phi}{m}.$$

Therefore,

$$\frac{\partial F/\partial m}{\partial F/\partial \phi} < \frac{F_{2d}(\phi, m) + \sum_j F_{2j}(\phi, m)}{F_{1d}(\phi, m) + \sum_j F_{1j}(\phi, m)} < \frac{\phi}{m}. \tag{2.17}$$

We have thus proven that effective firm ability $\varphi = \phi m(\phi)$ is increasing in management competence m. Since all comparative statics for φ hold as in the baseline model, it follows that all propositions also hold as conditional correlations for management quality m even when firms endogenously choose their management practices. ■

2.2 Extension 2: Multiple Ability Components

The theoretical predictions of our baseline model would continue to hold if management is one of multiple draws that jointly determine firm ability φ. For example, firm ability $\varphi = m \cdot \phi$ may depend on the entrepreneur's intrinsic talent ϕ and the manager's competence for implementing effective management practices m. If entrepreneurs and managers do not match perfectly assortatively due to labor market frictions, then $|corr(m, \phi)| \neq 1$. While all firm outcomes would now be pinned down by φ instead of m alone, management competence would have the same effects as in our baseline model *ceteris paribus*. Propositions 1-4 would now hold for φ unconditionally, for ϕ conditional on m, and for m conditional on ϕ. The last result is the conditional relationship that remains relevant for our empirical analysis.

2.3 Extension 3: Endogenous Quality

For expositional simplicity, we do not model firms's choice of product quality in the baseline model, and adopt instead a reduced-form quality production function. Endogenizing firms' choice of input and output quality in a richer framework would however preserve our theoretical predictions. What is sufficient for this to occur is that output quality - and by extension firm profits - is supermodular in firm ability and either the quality of inputs or the complexity of the assembly process. We illustrate this point here by incorporating endogenous quality choice as in Kugler and Verhoogen (2012) into our baseline framework. The same key insights would emerge with alternative microfoundations for the quality production function.

We assume that there is complementarity between firm ability and input quality in the production of output quality. In particular, using an input of quality c_{ji}, the firm can produce one unit of product i with output quality

$$q_{ji} = \left[\frac{1}{2}\left((\varphi\lambda_i)^b\right)^\rho + \frac{1}{2}\left(c_{ji}^2\right)^\rho\right]^{\frac{1}{\rho}} \tag{2.18}$$

at a marginal cost of c_{ji}. In this setting, the parameter b can be interpreted as the scope for quality differentiation, while the parameter ρ governs the degree of complementarity between input quality c_{ji} and firm-specific management φ (as well as firm-product specific expertise λ_i). The quadratic specification for c_{ji} is not crucial but adopted for tractability.

Given this quality production function, more capable firms will optimally use higher-quality inputs in order to produce higher-quality goods.

Proof. Now the firm's maximization problem becomes

$$\max_{p_{ji},x_{ji},c_{ji}} \pi(\varphi,\lambda_i) = p_{ji}x_{ji} - \tau_j x_{ji} c_{ji} - f_{pj}$$

$$\text{s.t. } x_{ji} = R_j P_j^{\sigma-1} q_{ji}^{\sigma-1} p_{ji}^{-\sigma}$$

Substituting the constraint into the objective function, this is equivalent to solving

$$\max_{p_{ji},c_{ji}} \pi_{ji}(\varphi,\lambda_i) = R_j P_j^{\sigma-1} \left[\frac{1}{2}(\varphi\lambda_i)^{b\rho} + \frac{1}{2}c_{ji}^{2\rho}\right]^{\frac{\sigma-1}{\rho}} p_{ji}^{-\sigma}(p_{ji} - \tau_j c_{ji}) - f_{pj}$$

The first order conditions with respect to p_{ji} and c_{ji} yield the following equations respectively:

$$p_{ji} = \frac{\sigma}{\sigma-1}\tau_j c_{ji} \tag{2.19}$$

$$(\sigma-1)\, c_{ji}^{2\rho-1}(p_{ji} - \tau_j c_{ji}) = \tau_j \left[\frac{1}{2}(\varphi\lambda_i)^{b\rho} + \frac{1}{2}c_{ji}^{2\rho}\right] \tag{2.20}$$

Substituting equation (2.19) into equation (2.20) and using equation (2.18) delivers the following endogenous input quality c_{ji} and output quality q_{ji} as a function of firm management ability φ and product expertise λ_i:

$$c_{ji} = c_i = (\varphi\lambda_i)^{\frac{b}{2}}, \quad q_{ji} = q_i = (\varphi\lambda_i)^{b}. \tag{2.21}$$

This expression immediately implies that better managed firms will endogenously choose to source higher-quality inputs in order to produce higher-quality goods, i.e. $\frac{\partial c_i(\varphi,\lambda_i)}{\partial\varphi} > 0$ and $\frac{\partial q_i(\varphi,\lambda_i)}{\partial\varphi} > 0$. While we have allowed firms to freely vary input and output quality across markets j, the quality production function we have considered guarantees that firms optimally select a single quality level for each product i in their portfolio. Intuitively, better managed firms would endogenously produce higher-quality goods for any given market under alternative formulations that allow for quality customization across markets.

Finally, note that when $\theta = b$ and $\delta = \frac{b}{2}$, the solution in equation (2.21) corresponds exactly to the reduced-form formulation of the quality production function in our baseline model: Firms then produce one unit of product i with quality $q_i = (\varphi\lambda_i)^{\theta}$ at a marginal cost of $c_i = (\varphi\lambda_i)^{\theta-\delta}$. ■