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Informal institutions, transaction risk, and firm productivity in Myanmar

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Abstract: In many low-income transition countries, where formal institutions such as courts do not function effectively, informal institutions are often used by firms to minimize transaction risks. We examine the role of informal institutions, in the forms of relational contracting and social networks, in determining the risks that firms are willing to bear in their transactions with their suppliers and customers, and whether firms that bear such risks have higher firm productivity. Our country context is Myanmar, a country which is making a transition from a socialist to market-oriented economy. Using an unique dataset of 2,496 micro, small, and medium firms, we find that firms that engage in risk taking are significantly more productive than firms that do not, and such firms are more likely to utilize informal institutions, such as acquiring information from informal interaction with customers, and social networks, including information received from business networks by firms, talking to other suppliers of customers, and being a member of a business association. Our findings suggest that informal institutions can be effective substitutes for formal institutions that are often absent or not effective in low-income transition economies.

Key words: firm productivity, informal institutions, Myanmar, relational contracting, social networks, transition economies

JEL classification: O12, O43, P26

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1 Introduction

What explains the productivity of firms in developing countries? Several studies have examined the role of factors internal to the firm such as technology, human capital, research and development investment, and managerial practices, as well as external factors such as trade reforms, competition, and foreign direct investment (Syverson 2011). The new institutional economics literature has also highlighted the role of institutions in explaining firm productivity. As this literature argues, well-specified and enforced property rights and efficient contracting institutions formed the institutional architecture that are the bedrock of productivity and living standard gains (North 1994b). An emerging literature has highlighted the role of formal institutions such as formal property rights, simplified business registration processes, and well-functioning courts and credit bureaus in determining firm productivity in developing countries (Bloom et al. 2014; Dethier et al. 2011; Dollar et al. 2005; Subramanian et al. 2005; World Bank 2020).

While such formal institutions are expected to exist and function to some extent in middle-income countries, they are less likely to be observed in low-income countries. This would particularly be the case in low-income transition economies which are emerging from a prolonged period of isolation from the outside world and from socialistic practices which forbid the existence of private enterprise towards a market-oriented economics. Since the laws of contracts are often inadequate, informal institutions can substitute for formal institutions in allowing firms in these economies to undertake crucial economic exchanges that are necessary for their survival and growth (Grief 2006; McMillan 1997; McMillan and Woodruff 1999). In such economies, firms depend on the goodwill of other firms and of their customers for their business. Social networks that provide information to the firm about the reliability of their suppliers and their customers are a key set of informal institutions for maintaining business trust (Steer and Sen 2010). Relational contracts that take the form of repeated, ongoing relationships between firms, suppliers, and customers provide a means of informal enforcement in the absence of courts and formal dispute resolution mechanisms (Fafchamps 2016).

However, relatively little is known about the role of informal institutions, such as social networks and relational contracting, in determining firm productivity in low- income country contexts where formal institutions either do not exist or function poorly. One important reason for the paucity of studies in this area is the lack of reliable data that can provide robust measures of firm productivity for micro and small firms in low-income countries. In addition, measures of informal institutions, such as social networks and relational contracts, are often difficult to obtain and questions about the functioning of informal institutions are not conventionally included in firm surveys undertaken by national statistical agencies.

In this paper, we examine the role of informal institutions in determining firm productivity in a low-income country which has made the move recently from a socialist economy to a market-based economy. The country we study is Myanmar, a low-income country in South East Asia, which is re-integrating with the world economy after several decades of economic isolation and centralized socialistic controls on private enterprises. Economic reforms have been underway in Myanmar since 2011, and laws have been passed to encourage the growth of the private sector. However, even though the Myanmar government has simplified business registration in recent years and does well in the ease of doing business (Myanmar does better than the regional average in the World Bank's Doing Business indicators), it has weak creditor rights and does poorly in contract enforcement. Therefore, for private firms in Myanmar, formal contracting institutions are weak, and firms need to rely on informal institutions when engaging in transactions with their suppliers and customers. We assess whether informal institutions, such as relational contracts and

social networks, allow firms to take on a degree of risk in their transactions and whether firms that take on such risk are more likely to be productive than firms that do not.

A strength of our paper is that we have a survey of 2,496 micro, small, medium, and large firms in Myanmar which provides detailed information on firms' sales and the inputs they purchase, allowing us to construct robust measures of firm productivity. Unusually for firm surveys in low-income countries, the questionnaire asks firms about their reliance on family and friends, the strength of their informal ties with their customers, and the social networks they rely on for their everyday business. Finally, the survey also asks firms whether they have made a specific investment in equipment or trained workers, specifically to supply a particular customer, which we use as a measure of the assumed risk of firms.

The paper uses the stochastic frontier analysis approach to investigate the impact of the assumed risk of firms—the risk that firms willingly bear in transactions with their customers—on firm productivity in Myanmar. Secondly, we examine the role of informal institutions in explaining the assumed risk of firms. The findings reveal that the assumed risk of firms significantly increases firm productivity in Myanmar. Firms that engage in risk taking are significantly more productive than firms that do not. Firms that utilize informal institutions, such as acquiring information from informal interaction with customers and social networks, including information received from business networks by firms, talking to other suppliers of customers, and being a member of business association, have a higher propensity to take larger assumed risk with respect to transactions with their customers.

The remainder of the paper proceeds as follows. Section 2 presents an overview of the reform process in Myanmar. The conceptual framework for the paper is discussed in Section 3. Section 4 contains the methodological approach. Section 5 discusses the source of the data used for this paper and presents some descriptive statistics. Section 6 provides the empirical results and discussion. Section 7 presents the concluding remarks and policy implications.

2 Myanmar's reform process

In 1962, the Revolutionary Council (RC) led by General Ne Win overthrew the parliamentary government of the time and introduced a centrally planned system. The RC was openly hostile to business, banning private enterprise in 1963 (Turnell 2009). It nationalized much of the private sector, including agricultural and industry, wholesale and retail trade, and banking (Tin 2006). Private imports were banned in 1963 and exports in 1964 (Tin 2006). The introduction of socialism in Myanmar led to 'the end of institutions serving the functioning of the market system, such as the laws of property, and of contract, the legal system of courts and lawyers, and the monetary and banking institutions that provided the financial framework of the market system' (Khin et al. 2000: 189).

By the mid-1980s, socialism had led to economic stagnation (Bissinger 2014). The economic crisis culminated in protests in 1988, leading to the resignation of General Ne Win and the coming to power of a military junta—the State Law and Order Restoration Council (SLORC). The junta took steps to move the economy away from central planning by legalizing the role of markets in the economy. The SLORC focused on the development of local firms that were in the nascent stage after three decades of socialism and encouraged both domestic and foreign investment in the private sector while privatizing a number of state-owned enterprises (OECD 2015). However, the state maintained a controlling role in the managed transition to a market-oriented economy through state-owned enterprises and widespread economic controls (Tin 2006).

The reform process intensified in 2011 under the leadership of Thein Sein with the move to a managed floating exchange rate in 2012 and the extension of international banking licences to a range of private banks, thereby reducing the role of state-owned banks in the domestic financial system. The government also reduced barriers to trade, removing import and export licensing requirements for selected goods. Further, in 2012, the government passed a new Foreign Investment Law (FIL) to attract foreign direct investment, which included enhanced tax incentives, new arbitration mechanisms, and greater clarity on the structure of investment partnerships (Bissinger 2014). In 2013, the government passed a revised Citizen Investment Law, which extended the benefits of the FIL to local investors.

However, notwithstanding the new set of reforms initiated since 2011, the basic legal and regulatory framework for business is still provided by the colonial era Companies Act (1914) and associated rules (1940) and regulations (1957) (UNESCAP 2015). A number of line ministries plus various local municipal authorities are involved in the licensing of individual businesses and supervision of different industries. As a consequence, Myanmar's regulatory and policy framework remains fragmented and less transparent, with businesses having to deal with a number of parallel line ministries that often fail to adequately coordinate activities between themselves (OECD 2013).

The mixed record of the reform process in promoting an enabling environment for private domestic firms to grow is apparent in the World Bank's Doing Business Report 2020 (World Bank 2020). As Table 1 indicates, Myanmar does well in the time taken to start a business or to obtain a construction permit (seven days to start a business or 88 days to obtain a construction permit in Myanmar, compared to the regional averages of 25.6 and 132.2 days respectively). However, when it comes to creditor rights and the enforcement of contracts, Myanmar does badly. With respect to legal rights and credit registry coverage, its strength of legal rights is 2, compared to 7.1 for East Asia and the Pacific (EAP), its credit registry coverage is zero, compared to 16.6 per cent for EAP. With respect to the enforcement of contracts, it takes 1,160 days to enforce a contract in Myanmar, compared to the EAP average of 581.1 days, and its quality of judicial processes is 4.0, compared to the EAP coverage of 8.1. This suggests that the functioning of formal institutions is very weak in Myanmar, which could be a huge impediment for firms to engage in market transactions.

Table 1: Doing business indicator, Myanmar and East Asia and the Pacific

Doing business indicator	Time taken to start a business, men (days)	Time taken to obtain a construction permit (days)	Strength of legal rights (index, 0–12)	Credit registry coverage (% of adults)	Enforcing contracts (days)	Quality of judicial processes (index, 0–18)
Myanmar	7	88	2	0	1,160	4.0
East Asia and the Pacific	25.6	132.3	7.1	16.6	581.1	8.1

Source: World Bank (2020). Licensed under CC BY 3.0 IGO.

3 The conceptual framework

In this section, we sketch out a conceptual framework to understand the relationships between informal institutions, assumed risk, and productivity. Our argument in the paper is based on two propositions. The first proposition is that firms that are more willing to assume risk are likely to be more productive. The second proposition is that, in the absence of well-functioning formal institutions, informal institutions play a key role in mitigating risk faced by firms. We discuss the rationale for each of these two propositions in turn.

3.1 The relationship between assumed risk and firm productivity

Firms face two specific types of risk in their economic exchanges. The first is in the transactions that they have with their suppliers where they lack information about the reliability of their suppliers in delivering the inputs in time. In addition, they face uncertainty about the quality of inputs that they purchase from these suppliers. The second is in the risk that firms face when they sell their products to their customers, in the proper settlement of the dues that they may have to incur in the act of sales (Steer and Sen 2010). There is also a risk associated with the monitoring and enforcement of agreements that firms may have with their customers in the production of certain goods.

While an earlier literature took the transaction risks that firms face in their exchanges with suppliers and customers as exogenous (Boerner and Macher 2001), a more recent literature treats these risks as endogenous as they involve a degree of choice by the firm, and depend on the firm's ability to assume these risks (Steer and Sen 2010). This may be termed as 'assumed risk'—the risk that firms willingly bear in the transactions with their customers and their suppliers. A commonly used measure of assumed risk is asset specificity—the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value (Williamson 1996). Asset specificity can take several forms:

> '… site specificity, where successive stations are located in a cheek by jowl relation to each other so as to economize on inventory and transportation expenses; physical asset specificity, such as specialized dyes that are required to produce a component; human asset specificity, that arises in a learning by doing fashion; and dedicated assets, which are discrete investments in general purpose plant that are made at the behest of a particular customer' (Williamson 1996: 59–60).

A large literature on the determinants of firm productivity has found that asset- or relationship-specific investments, such as those that firms make in training their workers and in specialized machinery and equipment, are associated with higher productivity of the firm (Bloom et al. 2014; McKenzie and Woodruff 2014; Syverson 2011). For example, on-the-job training for workers leading to learning by doing allows producers to identify opportunities for process improvements (Syverson 2011). Investment in specialized machinery and equipment that embodies the most advanced technological knowledge leads to large spillover effects and has been shown to be associated with higher productivity growth (De Long and Summers 1991, 1992).

3.2 The determinants of assumed risk

The new institutional economics literature posits that the institutional architecture of the economy will determine whether firms are willing to bear a higher degree of assumed risk. As North (1994a: 3) notes, 'in order to realize the gains from the productive potential associated with a technology of increasing returns, one has to invest enormous amounts in transacting'. Transaction costs can be both 'the costs of acquiring information on the multiple dimensions of what is being exchanged (and) also the costs of enforcing contracts and making credible commitments across time and space' (North 1994a: 3). Where a well-functioning legal system exists, ongoing relationships between firms can supplement formal contracts for economic exchange to occur smoothly (McMillan and Woodruff 1999). Better enforcement of contracts ex post is likely to lead to less under-investment in relationship-specific investments ex ante, making the firm more productive (Nunn 2007). However, where the legal system is inadequate, informal institutions of information acquisition and relational contracting can substitute for formal institutions for transactions to occur. We discuss three sets of informal institutions that can mitigate transaction risks for firms, especially in low-income country settings.

Mechanisms of information acquisition

When formal mechanisms of information acquisition do not exist, firms use informal means such as frequent visits and communication with their suppliers and customers. Long-term relationships that firms have with other firms and customers are also important ways to learn about their partners' reliability over time (Steer and Sen 2010). These long-term relationships that are repeated over time can be termed as 'relational contracts' and have two main advantages: they economize on the costs of finding new matches and enable agents to deal in a more trusting manner (Fafchamps 2016). The threat of losing this valuable relationship deters firms from breaching the informal contract between the firm and its supplier or customer. We hypothesize that firms that have a means of acquiring information or are embedded in long-term relationships will be more willing to bear a degree of assumed risk.

Social networks

Social networks can be of two types: informal interactions with family and friends and membership of business associations. These networks provide information on customers' reliability as well as mechanisms of social sanctions on customers or suppliers who renege (McMillan and Woodruff 1999). For example, the threat of no further trade if debts are not paid has additional impact if it comes not just from the firm but also from other agents in the network (Kandori 1992). Information shared by members of a social network allows for community sanctions against errant firms and provides a 'private order contract enforcement mechanism' in the absence of formal dispute resolution procedures (Grief 2006). We hypothesize that firms that have access to social networks will be more willing to bear a degree of assumed risk.

Locked-in behaviour

If few alternative suppliers are available, for example, due to high search costs or high transportation costs, a customer can be locked in a relationship (Steer and Sen 2010). If the customer is locked in, the firm can threaten to cut off further economic exchange if debts are not paid. Lock-ins make relational contracts workable (McMillan and Woodruff 1999). We hypothesize that greater competition will decrease the possibility of lock-ins for a firm and make them more willing to bear a degree of assumed risk.

4 Methodology

In this section, we first present the methodology used in computing firm productivity and discuss the empirical strategy in the analysis of the correlates of firm productivity. We then describe the empirical specification we estimate to examine the relationship between assumed risk and institutions.

4.1 Estimation of firm efficiency and relationship between firm efficiency and assumed risk

The empirical approach used to estimate firm efficiency and the impact of assumed risk of firms on firm efficiency is the parametric stochastic frontier analysis (Aigner et al. 1977; Kumbhakar and Lovell 2000). To do this, we design and estimate five different stochastic frontier models in order to compute 'accurate' efficiency estimates of firms in Myanmar. We start with a baseline homoscedastic model, followed by four modified versions of heteroscedastic stochastic frontier models. The heteroscedastic stochastic frontier models are important to this exercise because ignoring the heterogeneity in the stochastic frontier production model may cause biased estimates of the frontier function parameters as well as estimates of inefficiency (see Greene 2004; Hadri et al. 2003; Kumbhakar and Lovell 2000; Wang and Schmidt 2002).

The baseline model is a standard cross-sectional stochastic frontier model:

$$y_i = \beta' x_i + v_i - u_i, \quad ui=|U| \tag{1}$$

$$v_i \sim N[0,\sigma_v^2]$$

$$U \sim N^+[0, \sigma_u^2],$$

where y_i is the output of the firm (log total sales), β' is parameters to be estimated, x_i represents a set of production inputs (log labour force, log capital stock), and type of technology—hand tools, only power, and both power and manually driven. $\beta' x_i + v_i$ is the optimal, frontier goal (in this case maximal production output) pursued by firms, $\beta' x_i$ is the deterministic part of the frontier, and v_i embodies measurement errors, any statistical noise, and random variations of the frontier across firms (the stochastic part). The deterministic and stochastic part put together constitute the 'stochastic frontier'. $-u_i$ is the measure of the shortfall of output from the frontier for each observed firm in the sample. In this analysis, $-u_i$ is technical inefficiency and is assumed to be normal half normal while v_i is assumed to be normally distributed. As firms may use different technologies, in this case of Myanmar, estimating a common frontier function encompassing every sample observation may not be appropriate because the estimated technology is not likely to represent the true technology. If these unobserved technological differences are not taken into account during estimation of the frontier function, the effects of these omitted unobserved technological differences may be inappropriately labelled as inefficiency (see Parmeter and Kumbhakar 2014). As a result, an important feature of our specification in equation (1) is the inclusion of heterogeneous technologies for firms based on the type of technology used by the firm as part of the production inputs x_i.

In building the heteroscedastic models we introduce significant firm-level characteristics (h_i - location in an industrial zone and access to electricity from the grid) that may affect the production process in Myanmar. The first heteroscedastic stochastic frontier model introduces h_i in the frontier function itself. The stochastic frontier function can be specified as:

$$y_i = \beta' x_i + \alpha' h_i + v_i - u_i, \quad ui=|U| \tag{2}$$

$$v_i \sim N[0,\sigma_v^2]$$

$$U \sim N[0, \sigma_u^2].$$

In the second heteroscedastic frontier model, we introduce heterogeneity in the mean of the underlying distribution of u_i (the truncation model). This is specified as:

$$y_i = \beta' x_i + v_i - u_i, \quad \text{ui}=|\text{U}| \tag{3}$$

$v_i \sim \ \text{N}[0,\sigma_v^2]$

$U \sim \text{N}\ [\alpha' h_i\ , \sigma_u^2]$.

The third and fourth heteroscedastic models allow observable variation h_i in the variance of u_i (σ_u^2) and v_i (σ_v^2) respectively (see Hadri et al. 2003). In this case, given a frontier model as shown in equation (3), the variance functions of u_i and v_i can be specified as Var $[u|h_i]= \sigma_u^2 \exp(\Omega' h_i)$ and Var $[v|h_i]= \sigma_v^2 \exp(\delta' h_i)$ respectively. Therefore, the heterogeneity in variance of u_i model can be specified as:

$$y_i = \beta' x_i + v_i - u_i, \quad \text{ui}=|\text{U}| \tag{4}$$

$\text{v}_\text{i} \sim \ \text{N}[0,\sigma_v^2]$

$U \sim \text{N}\ [0, \sigma_u^2 \exp(\Omega' h_i)]$.

The heterogeneity in variance of v_i model can also be written as:

$$y_i = \beta' x_i + v_i - u_i, \quad \text{ui}=|\text{U}| \tag{5}$$

$v_i \sim \ \text{N}\ [0, \sigma_v^2 \exp(\delta' h_i)]$

$U \sim \text{N}\ [0, \sigma_u^2]$.

An important issue with regard to the estimation of the stochastic frontier equations is the functional form of the production frontier. As a result of the questions raised over the suitability of the Cobb–Douglas functional form and the inclination for the Translog stochastic frontier specification (see Danquah and Ouattara 2015; Duffy and Papageorgiou 2000; Kneller and Stevens 2003), we apply the Translog specification to characterize the production frontier (see also Table 3 for a test of Cobb–Douglas against the Translog using a likelihood-ratio (LR) test). We find support for the Translog production function. Using the Translog production function and including sector and an urban dummy, we fit the baseline and heteroscedastic stochastic frontier models using maximum likelihood and estimate the inefficiency terms in the stochastic frontier, u_i by observation. The Jondrow et al. (1982) estimator $\hat{E}[u_i|\varepsilon_i]$ is the standard estimator for inefficiency u_i. This is:

$$\hat{E}[u_i|\varepsilon_i] = \left[\frac{\sigma\lambda}{1+\lambda^2}\right]\left[\frac{\phi(w)}{1-\Phi(w)} - w\right], \ \varepsilon_i = v_i - u_i, \ w = \frac{S\lambda\varepsilon_i}{\sigma} \tag{6}$$

$$\sigma = \sqrt{\sigma_v^2+\sigma_u^2}\ , \ \lambda = \frac{\sigma_u}{\sigma_v}$$

The properties of the estimated inefficiencies are examined to determine the preferred model as well as estimates of firm efficiency.

Subsequently, we proceed to examine the effect of assumed risk by firms on firm efficiency. As explained in the seminal review by Parmeter and Kumbhakar (2014), many studies have used a simpler, two-step analysis to model the influence of specific covariates on firm-level inefficiency. With this approach, authors construct estimates of inefficiency using the Jondrow et al. (1982) conditional mean in the first step, and then regress these inefficiency estimates on the exogenous

variables in a second step (notably, these authors include Ali and Flinn 1989; Bravo-Ureta and Rieger 1991; Kalirajan 1990; Pitt and Lee 1981; Wollni and Brümmer 2012, among many others). 'This method has no statistical merit and duplication of this approach should be avoided' (Parmeter and Kumbhakar 2014: 52).[1]

In our case we employ a single-step stage approach proposed by Greene (2004, 2018).[2] This approach estimates the parameters of the relationship between efficiency and the explanatory variables, together with all the other parameters of the frontier model via maximum likelihood. In essence, this approach computes the marginal/partial effects of the explanatory variables (say z).

Following from equation (6), efficiency can be expressed as:

$$Efficiency_i = exp\{-\hat{E}[u_i|\varepsilon_i]\}$$

The expression for the normal half normal model is a function of $w(\varepsilon_i)$ that is specific to the model. This can be written as:

$$Efficiency_i = exp\{-\tau_m A[w_m(\varepsilon_i)]\}$$

where m represents half normal, $\tau_m = \frac{\sigma\lambda}{1+\lambda^2}$ and w_m is defined earlier in equation (6). Suppose that

$$\varepsilon_i = y_i - \beta' x_i + \delta' z_i \ ,$$

x are inputs and z are the explanatory variables. We require the derivatives with respect to z.

For convenience, we let $W = -w$ and exploit the symmetry of the normal density. Then, $A[w_m(\varepsilon_i)] = \left[\frac{\phi(W)}{\Phi(W)} + W\right]$. The derivative is

$$\partial Efficiency/\partial z = Efficiency \times -\tau_m \times \frac{dA(W)}{dW} \times -1 \times \partial w_m/\partial\varepsilon \times -\delta$$

The two terms that we need to complete the derivation for the half normal model are $\partial w_m/\partial\varepsilon = S\lambda/\sigma$ and

$$\frac{dA(W)}{dW} = \left[1 - \frac{W\phi(W)}{\Phi(W)} - \left(\frac{\phi(W)}{\Phi(W)}\right)^2\right] = D(W)$$

Collecting terms:

$$\frac{\partial Efficiency}{\partial z} = Efficiency \times D(W) \times (\lambda^2/(1+\lambda^2) \times (1) \times (-\delta) \qquad (7)$$

The Jondrow et al. (1982) estimator is used to estimate the partial effects of the z variables on efficiency. We recast our preferred model for estimating firm efficiency to include our z

[1] See Parmeter and Kumbhakar (2014) for detailed discussions on the biases that arise at various stages of this two-step procedure.

[2] The approach by Greene (2018) follows the half normal heteroscedastic model earlier proposed by Caudill and Ford (1993), Caudill et al. (1995), and Hadri et al. (2003).

variables[3]—that is, assumed risk of firm and some control variables which capture firm and owner characteristics that can affect firm productivity and examine how it impacts on firm efficiency. Following from the literature, the control variables include age of the firm, firm size, formal registration, percentage of sales for export, educational attainment of owner/manager, and an urban dummy.

Age-related effects on firm productivity can be largely explained by a range of factors, including scale economies gained as young firms grow over time and the likelihood of young firms employing new and improved technology or equipment. Younger firms therefore tend to be more productive and grow faster than older firms (Colacelli and Hong 2019; Lopez-Garcia and Puente 2012; Navaretti et al. 2014). With respect to firm size, larger firms may have a higher productivity due to economies of scale resulting from a greater allocative efficiency and the presence of fixed costs (see Bartelsman et al. 2013; Tybout 2000). The opposite case of diminishing productivity with firm size is also possible due to decreasing returns to scale. Several empirical studies have examined this relationship in detail (see Alvarez and Crespi 2003; De and Nagaraj 2014; Diaz and Sánchez 2008). Formal registration by firms may lead to access to public goods and services such as public infrastructure, bank support and credit, and better enforcement of property rights and contracts. Some studies have shown that formal registration leads to an increase in firm profit and productivity (Rand and Torm 2012; Sharma 2014; De Vries 2010). Also, firms that export may be exposed to knowledge flows from international buyers and competitors and to more intense competition in international markets which may lead to larger opportunities and incentives to improve productivity (see Alvarez and Lopez, 2005; Eliasson et al. 2012). The educational attainment of the manager relates to the quality of management of a firm, and this has been found to impact firm productivity (Bloom and Van Reenen 2007; Syverson 2011). Urban areas can also offer agglomeration benefits, including larger markets, better infrastructure to access markets, and operating a larger pool of workers, among others. These benefits are likely to affect firm productivity positively (see Rand et al. 2019; Rosenthal and Strange 2004).

4.2 Estimating the relationship between assumed risk and institutions

Adopting the specification by Steer and Sen (2010), we estimate the following probit model using assumed risk as the endogenous variable:

$$AR_i = \alpha INF_i + \beta FML_i + \gamma LKI_i + \delta CTR_i + \mu_i \quad (8)$$

AR is assumed risk of firm *i* in its relationship with customers. In this study we use asset specificity to measure assumed or transaction risk. We measure assumed or transaction risk as investments that firms make in physical or human assets to meet the needs of a specific customer. Thus, we measure *AR* with respect to risk taken by firms in their relationship with customers by whether or not a firm has made any specific investments in equipment or trained their workers specifically to supply a particular customer. These measures of assumed or transaction risk have been used extensively in the empirical transaction cost literature (see Boerner and Macher 2001; Hendley and Murrell 2003; Richman and Macher 2006; Steer and Sen 2010).

INF represents informal institutions and captures mechanisms of information acquisition available to firms on customers as well as bilateral and multilateral networks. The variables used here include

[3] Greene (2018: 32), shows that 'partial effects of variables in the stochastic frontier efficiency models may be computed with respect to any variable in any model, regardless of where those variables appear in the model'. This may include input variables in the original frontier model, exogenous variables in the means of the truncated regression formats and also in the variances of the heteroscedasticity models.

own information from informal interaction with customer; whether customer is foreign; whether first information about customer is from family and friends and or business network; whether firm talks to other suppliers about customers; and whether firm is a member of a business association. *FML* is formal institutions and is measured as the percentage of total sales based on formal written contracts with customers; *LKI* measures the degree of lock-in. As indicated by Steer and Sen (2010), a customer can be locked in a relationship with a firm if few alternative suppliers of that particular product are available. This could be due to high search or transportation costs and therefore in this case bilateral relationships and networks become more effective. In capturing *LKI*, we use the variable 'approximately how many competitors do the firm currently have?'. *CTR* is a vector controlling for sector, location (state/region) and firm characteristics (such as size), and μ_i is the error term.

5 Data

In this section, we discuss the sources of the data and present some descriptive statistics.

5.1 Source of data

We use data from the Myanmar Enterprise Monitoring Survey (MEMS) project by the United Nations University World Institute for Development Economics Research (UNU-WIDER) and the Central Statistical Organization (CSO) of the Ministry of Planning and Finance of Myanmar. The survey is a nationally representative enterprise survey, conducted in 2017, which focuses on and provides a unique dataset on small and medium enterprises (SMEs) in the manufacturing sector (CSO and UNU-WIDER 2018). The data was collected in 2017 in 35 townships in all 15 regions and states of the country, including the Nay Pyi Taw Union Council. The sample comprises 2,496 enterprises and 6,722 employees and is statistically representative of more than 71,000 manufacturing firms in Myanmar. A stratified sampling approach was used to select enterprises. The main questionnaire was administered to enterprise owners or managers. It included information on enterprise characteristics and practices, such as number and structure of workforce, technology and innovation, investment, regulatory framework, revenues and costs, customers, owner characteristics, and perceptions about the constraints and potentials of the business environment.[4]

5.2 Characteristics of surveyed firms

Out of the 2,496 firms surveyed, 84 per cent of firms, including rice mills, are formally licensed by and/or registered with government authorities responsible for businesses in Myanmar, the rest being informal firms. The number of workers of the surveyed firms ranges from 1 to 540 workers, with an average of 13 workers. The annual total sales averaged about 1,290 million kyats in 2017 while the mean value of total assets is around 236 million kyats. The enterprises manufacture a variety of products. Many of the enterprises produce food products (40 per cent), followed by textiles (11 per cent), wood and wood products (8 per cent), non-metallic mineral products, and machinery and equipment (6 per cent). Informal firms[5] also operate mainly in the food and textiles industry. The mean age of a firm is 15 years. Yangon has the largest number of firms (14.4 per cent) followed by Mandalay (13.6 per cent) and Sagaing (10.1 per cent). Chin has the smallest

[4] More detailed information about sampling is available in CSO and UNU-WIDER (2018).

[5] An enterprise is considered to be informal when it is not licensed by and/or registered with any government authority responsible for businesses in Myanmar.

number of firms (0.52 per cent). The majority of the firms (83 per cent) are found in urban areas. With respect to legal ownership, about 68 per cent of firms are family-owned businesses, while 30 per cent are private firms. Only 0.8 per cent of firms are limited liability companies. About 74 per cent of firms are micro, 20 per cent are small, and 5 per cent are medium. Roughly 0.5 per cent of the firms that produce mainly wearing apparel and food are large. Many of the firms (45 per cent) use both manual and power-driven technology. With regards to infrastructure, 90 per cent of firms have access to paved roads while 87 per cent have access to the electricity grid. Within our sample of surveyed firms, 524 firms (21 per cent) with a mean firm size of 33 workers and producing mainly food, machinery and equipment, and wearing apparel are located within industrial zones. The average education level of enterprise owners tends to be low, with most of the owners having completed primary and middle school as their highest education level. About 1.8 per cent of firms export all their products, while about 0.9 per cent of firms export some of their products. The descriptive statistics of the data are provided in Appendix Table A1.

Using the asset specificity measure of transaction risk to examine whether firms in Myanmar take on risk in their market transactions, our survey data shows that about 20 per cent of firms invest in specific equipment for their customers. About 20 per cent of micro and small firms and 16 per cent of medium and large firms in our sample invest in specific equipment and machinery for their customers, respectively (see Table 2). Firms in Myanmar rely on different types of informal risk management strategies or governance mechanisms to manage transaction risk. The survey data indicate the sources of information about the customer or supplier through personal, social, or business networks. About 68 per cent of all firms obtain information from informal interaction with customers. The percentage of medium and large firms (77 per cent) that obtain information from customers frequently and informally is larger than that of micro and small firms (66 per cent). The source of information about customers and suppliers through personal contacts is 39 per cent, while information through business networks is 9 per cent. The proportion of micro and small firms that obtain information about customers from personal contacts (39 per cent) from the sample is higher than that of medium and large firms. Twelve per cent of medium and large firms obtain information from their business network compared to 8 per cent for micro and small firms. A number of firms (13 per cent) also talk to other suppliers of customers about the business environment. About 10 per cent of firms in the survey are members of a business association. The percentage of medium and large firms that are members of a business association (30 per cent) is higher than the firm average. With respect to the percentage of sales based on written contracts to mitigate transaction risk, about 7 per cent of firms have sales based on written contracts. A higher fraction of medium and large firms (30 per cent) in our survey have their sales based on written contracts in contrast to 5 per cent for micro and small firms. Approximately 82 per cent of firms face different degrees of competition from other firms, while 18 per cent have no competition at all. The average numbers of competitors for firms is four. About 69 per cent of medium and large firms can be found in Yangon.

Table 2: Variable means of determinants of assumed risk

	All firms	≤ 50 employees (micro/small firms)	≥ 50 employees (medium/large firms)
No. of observations	2,496	2,361	135
% of firms that made specific investments to supply a customer	20%	20%	16%
Information from informal interaction /visits to customers	68%	66%	77%
% of customers that are foreign	3%	2.6%	10%
Information from personal contacts	39%	39%	36%
Information from business network	9%	8%	12%
Manager talks to other suppliers of customer	13%	13%	13%
Member of business association	10%	9%	30%
% of total sales based on written contracts	7%	5%	30%
Avg. number of competitors for firms that have competitors	4	4	3
Log number of workers	1.6	1.4	4.6
Firms located in Yangon	14%	11%	69%

Source: CSO and UNU-WIDER (2018).

6 Empirical results

In this section, we first present the productivity estimates for firms in Myanmar obtained from the stochastic frontier analysis. We then examine the relationship between firm productivity and assumed risk. Finally, we analyse the institutional determinants of assumed risk.

6.1 Stochastic frontier models: results and analysis

In this section we discuss the properties of the estimated inefficiencies for models (1)–(5) and settle on a preferred model. The firm efficiency estimates by size of firm are also discussed. Table 3 summarizes the relevant diagnostic tests to ensure validity of the econometric approach adopted in this study. Following from the generalized LR-test statistic, the null hypothesis of no inefficiency is rejected, while the Translog production function is suitable at the 5 per cent significance level. The rejection of the null of no inefficiency effects provides support for the stochastic frontier model specification. Table 4 presents the estimated stochastic production frontier function for all specifications discussed in Section 4.1.

Table 3: Generalized likelihood-ratio (LR) tests

Null hypothesis (H_0)	LR-test statistics	Critical value (α=0.05)	Decision
No efficiency effects	119	2.706	Reject H_0
A Cobb–Douglas function is adequate	53	7.814	Reject H_0

Note: the critical values are at 5 per cent level of significance and are obtained from Table 1 of Kodde and Palm (1986).

Source: authors' calculations.

Table 4: Estimated stochastic frontier models (with sector dummies)

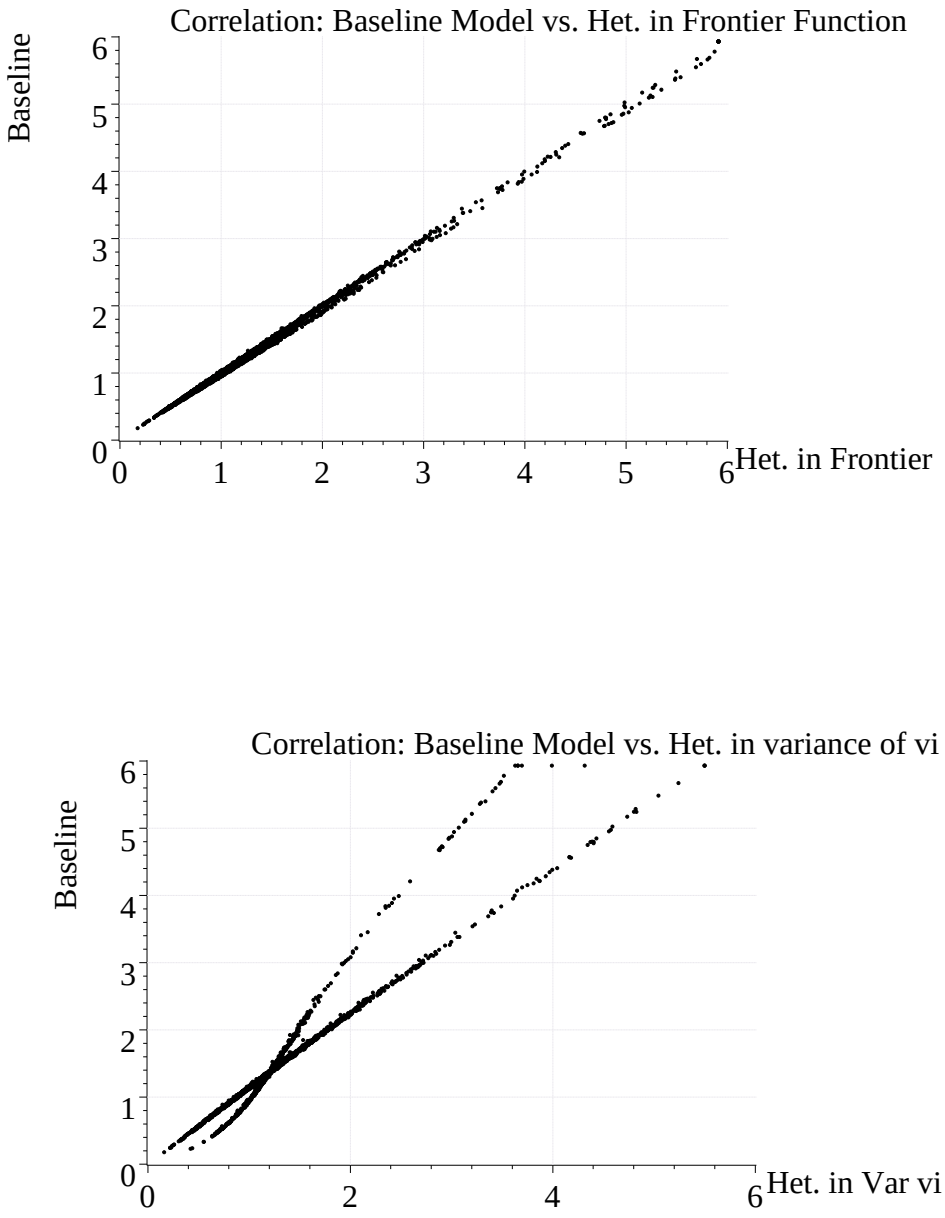
Parameters	Baseline	Het. in frontier	Het. in mean in the truncation	Het. in variance of u_i	Het. in variance of v_i
Constant	17.298*** (.450)	17.280*** (.455)	16.996*** (.428)	17.086*** (.446)	16.978*** (.463)
Ln capital stock (K)	-.205*** (.046)	-.198*** (.046)	-.245*** (.041)	-.231*** (.043)	-.186*** (.043)
Ln labour (L)	.755*** (.133)	.762*** (.133)	.758*** (.125)	.776*** (.137)	.814*** (.147)
K^2	.013*** (.002)	.012*** (.002)	.014*** (.001)	.013*** (.002)	.012*** (.002)
L^2	.005 (.016)	.002 (.016)	.003 (.015)	.009 (.016)	.001 (.017)
K×L	-.002 (.007)	-.003 (.007)	-.001 (.007)	-.001 (.007)	-.005 (.008)
Technology1	-.257** (.109)	-.234** (.109)	-.293*** (.101)	-.202* (.108)	-.243** (.104)
Technology2	.414*** (.101)	.418*** (.101)	.407*** (.100)	.534*** (.109)	.426*** (.106)
Technology3	.314*** (.087)	.314*** (.087)	.341*** (.085)	.461*** (.089)	.303*** (.089)
Urban dummy	-.009 (.085)	-.034 (.087)	.053 (.086)	.033 (.096)	-.030 (.088)
Ind. zone	-	.185** (.085)	-	-	-
Access to elect.	-	-.031 (.098)	-	-	-
Sector dummies	Yes	Yes	Yes	Yes	Yes
Parameters in mean of u / in variance of u and v					
Constant	-	-	-335.540 (1,817.091)	.981*** (.141)	.285*** (.081)
Ind. Zone	-	-	85.192 (449.599)	.602*** (.066)	.913*** (.066)
Access to elect.	-	-	26.345 (280.057)	.054 (.126)	-.049 (.082)
Variance parameters for compound error					
λ	1.543*** (.058)	1.565*** (.0.59)	14.557 (76.733)	1.524	1.222
σ	2.165*** (.001)	2.171*** (.001)	17.286 (90.869)	2.168	2.041
σ_u	1.817	1.830	17.245	1.812	1.579
σ_v	1.177	1.169	1.184	1.189	1.292

Notes: Technology1, Technology2 and Technology3 are dummies for firms using hand tools, only power, and both power and manually driven machines, respectively. ***, ** and * denote significance at 1%, 5% and 10%, respectively. Estimated standard errors in parentheses.

Source: authors' calculations.

The inefficiency estimates of all five specifications are highly correlated, around 90 per cent, indicating that the models are consistent. The pattern of the correlation plots also shows that the baseline model is very similar to the heteroscedastic model which introduces h_i in the frontier function itself. In fact, the correlation between the baseline model and the heteroscedastic models show that the baseline model is highly correlated with the heterogeneity in frontier model, followed by variance in u_i and the truncated normal model. The correlation is smaller between the baseline model and the heteroscedastic variance in v_i model (see Figure 1).

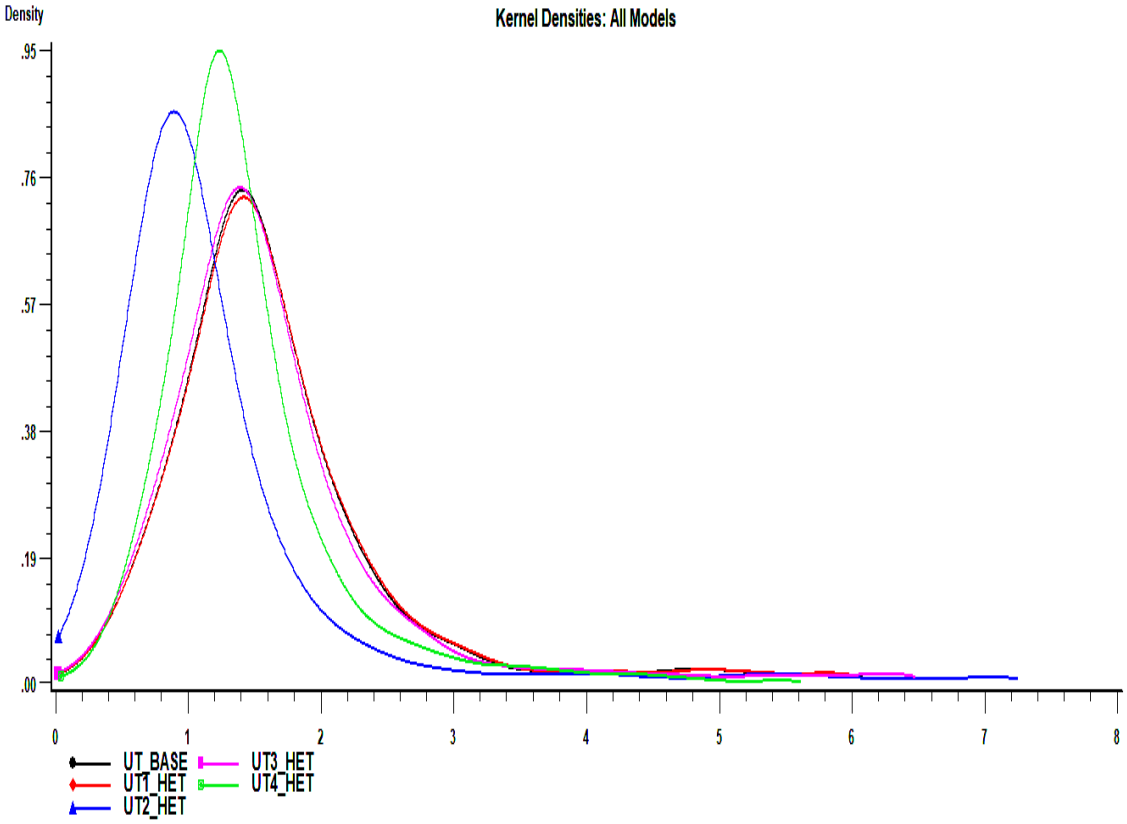
Figure 1: Correlation of inefficiency estimates between baseline homoscedastic and heteroscedastic models



Source: authors' illustration.

However, the mean and variation of the distribution for the estimated inefficiencies show some more differences. The kernel densities show that the mean and distribution of the baseline model are fairly large (see Figure 2). The mean and deviation of the heteroscedastic model which control for heterogeneity in the frontier function and in the variance of u_i are also very similar to the baseline. The mean of the heteroscedastic model which accounts for heterogeneity in the mean of the underlying distribution of u_i is somewhat smaller but relatively more dispersed than the others. The mean of the model which treats heterogeneity in the variance of v_i is also relatively small but, more importantly, much tighter than all the others.

Figure 2: Kernel densities for inefficiency: all models



Source: authors' illustration.

The unreasonable and extremely large estimates and standard errors of variance parameters for compound errors (λ and σ) as well as the distribution of σ_u and σ_v in the truncated model (see column 4, Table 4), do show that there is something wrong with this model. The heteroscedastic model, which allows for observable variation in σ_v^2, seems more preferable. Compared to the baseline homoscedastic model, the analysis above shows that the heteroscedastic model which treats heterogeneity in the variance of *vi* undoubtedly illustrates the influence of heterogeneity (see Figure 2).[6] The descriptive statistics for firm efficiency using the above models are presented in Table 5.

Table 5: Firm efficiency estimates

Model	Mean	Std. dev.	Min	Max	Obs.
Baseline	.2949	.1406	.0024	.8198	2,496
Het. in frontier	.2932	.1415	.0026	.8235	2,496
Het. in mean in the truncation	.4214	.1583	.0006	.8182	2,496
Het. in variance of u_i	.3031	.1411	.0015	.8223	2,496
Het. in variance of v_i	.3346	.1321	.0040	.8408	2,496

Source: authors' calculations.

[6] This observation from our study is consistent with the findings by studies that examine the consequences of ignoring heteroscedasticity in the stochastic frontier, particularly ignoring heteroscedasticity of v_i. (see Greene 2004; Kumbhakar and Lovell 2000; Parmeter and Kumbhakar 2014; Wang and Schmidt 2002).

Using the preferred model (Het. in variance of v_i), the average efficiency of a firm in Myanmar is around 34 per cent. In Table 6 we examine firm efficiency by size of firm using the heterogeneity in variance of v_i model.

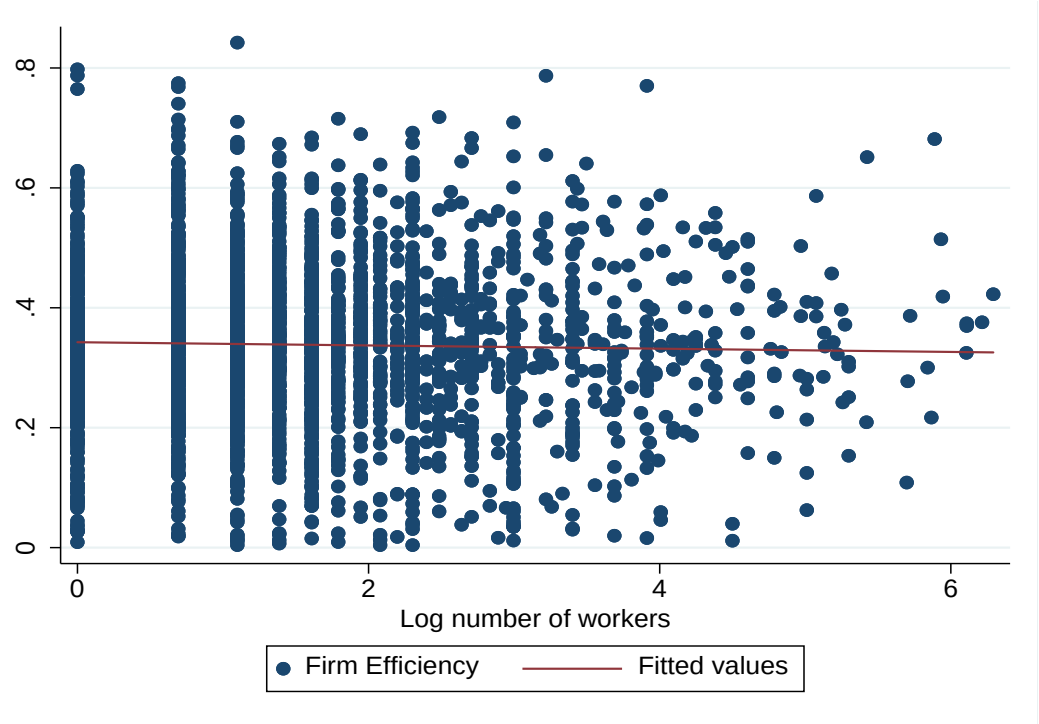
The mean efficiency estimates for large firms, around 37 per cent, is higher than the average for micro, small, and medium firms. Although, micro enterprises dominate, the few large firms are somewhat more efficient (see Table 6). The minimum average efficiency for large firms is 21 per cent on average. However, overall, there seems to be no significant relationship between firm efficiency and size of the firm (see Figure 3)

Table 6: Firm efficiency by size of firm

Size of firm	Mean	Std. dev.	Min	Max	Cases
Micro	.3374	.1296	.0040	.8408	1,851
Small	.3255	.1402	.0040	.7918	510
Medium	.3257	.1340	.0081	.7543	123
Large	.3732	.1230	.2077	.6507	12

Source: authors' calculations.

Figure 3: Firm efficiency and size of firm



Source: authors' illustration.

6.2 Assumed risk and firm efficiency

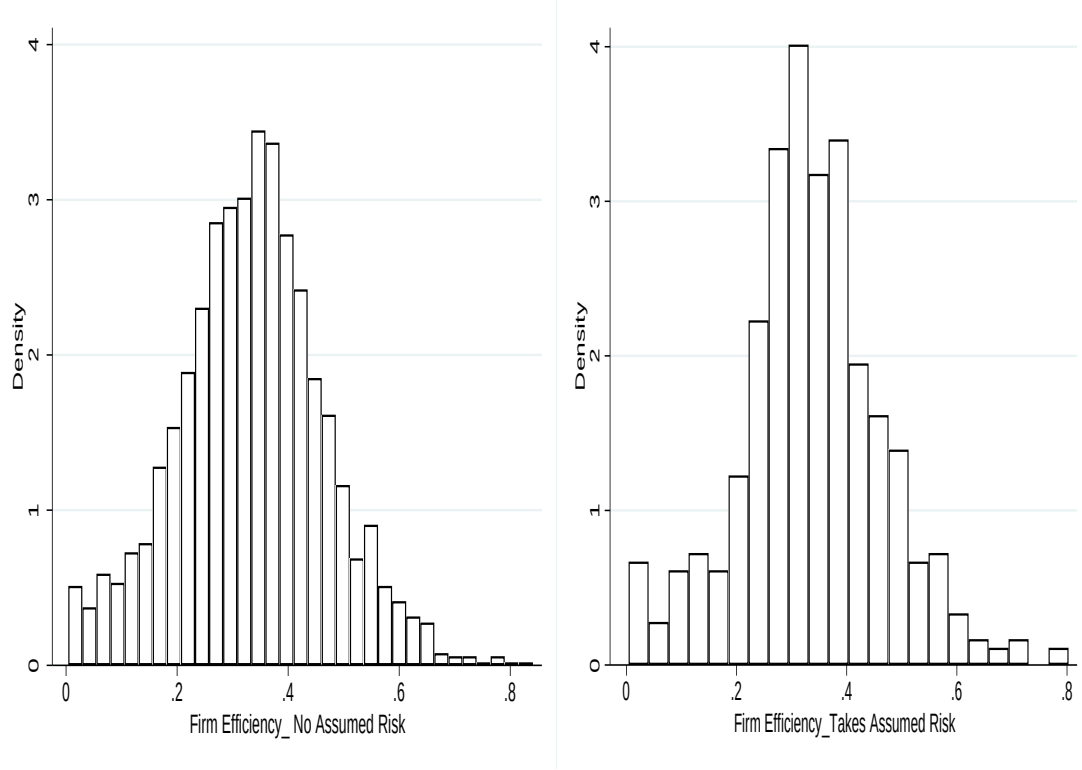
In this section we discuss the exogenous impact of firms that take risk on firm efficiency. First, we look at the efficiency levels for firms that take risk versus firms that do not take risk, across firm size. For all firms, there is no significant difference in average efficiency and the distribution between firms that take risk and firms that do not take risk (see Table 7 and Figure 4). With respect to size of the firm, the mean efficiency levels of firms that take risk are not different from firms that do not take risk (see Table 7 and Figure 5). The very large firms do not take risk.

Table 7: Efficiency of risk taking vs. non-risk taking for size of firms

	Mean	Std. dev.	Min	Max	Cases
All firms					
Takes assumed risk	.3365	.1298	.0039	.8028	494
No assumed risk	.3341	.1327	.0039	.8408	2,002
Micro firms					
Takes assumed risk	.3449	.1271	.0039	.8028	337
No assumed risk	.3357	.1302	.0039	.8408	1,514
Small firms					
Takes assumed risk	.3187	.1379	.0105	.6960	136
No assumed risk	.3279	.1412	.0039	.7918	374
Medium firms					
Takes assumed risk	.3214	.1117	.0381	.5644	20
No assumed risk	.3266	.1384	.0081	.7543	103

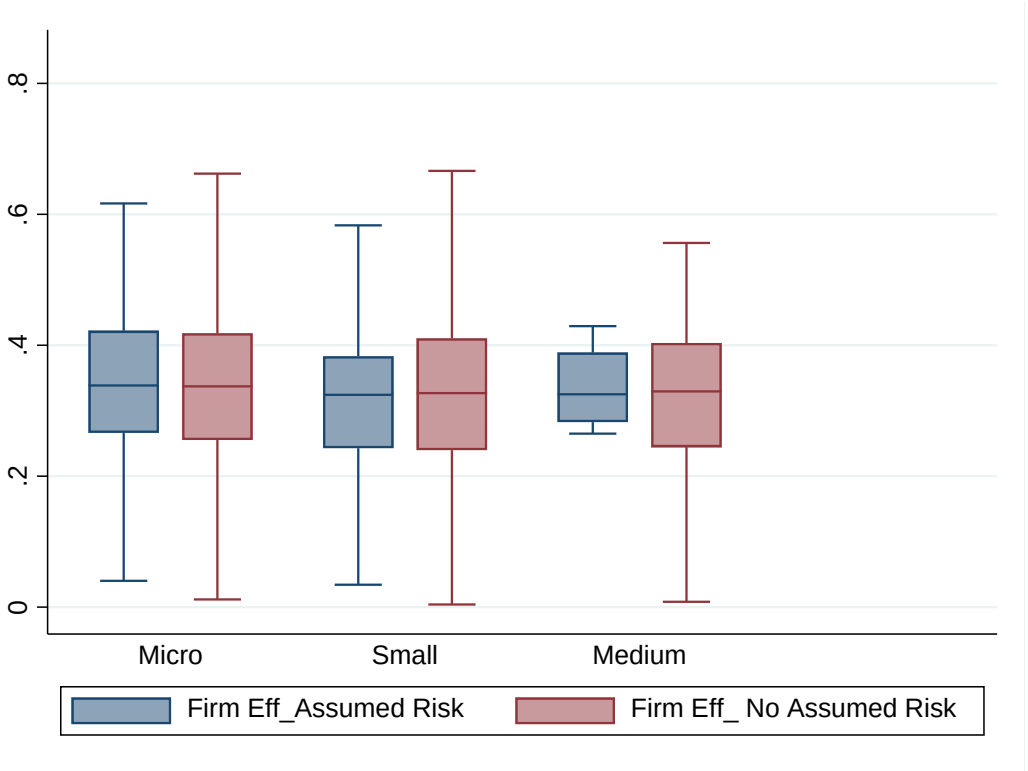
Source: authors' calculations.

Figure 4: Distribution of efficiency: risk taking firms vs. non-risk-taking firms



Source: authors' illustration.

Figure 5: Efficiency of risk taking vs. non-risk taking by size of firms



Source: authors' illustration.

Impact of assumed risk on firm productivity

Turning our focus to the impact of assumed risk by firms on firm productivity, we recast the heterogeneity in variance of v_i model in equation (5) to include our z variables: assumed risk of firms and the control variables—age of the firm, firm size, formal registration, percentage of sales for export, and educational attainment of owner/manager. In this case our z variables appear in the variance of *vi* in our heteroscedastic model. The model is estimated using maximum likelihood. We then discuss the partial effects for the Jondrow et al. (1982) estimator in the stochastic frontier model. Table 8 presents partial effects of assumed risk on firm efficiency.

Table 8: Partial effects for Het. in variance of *vi* Stochastic Frontier model

Variables	Coeff.	Standard error	|t stat|
Assumed risk	.00503	.00190	2.65
Log age of firm	-.00728	.00111	6.57
Formal registered	.00028	.00194	.14
% of sales for export	-.00006	.00006	.96
Log no. of workers	-.08547	.01486	5.75
Level of education (base: no education)			
Primary	.01591	.00502	3.17
Secondary	.00087	.00403	.22
Vocational/diploma	-.00877	.00627	1.40
Tertiary	.00432	.00418	1.03
Urban dummy	.00441	.00784	.56
No. of observations	2,496		

Note: parameters of the Translog stochastic frontier production function are omitted for the sake of brevity.

Source: authors' calculations.

The results show that the assumed risk of firms has a positive and statistically significant effect on firm productivity. Firms that engage in risk taking increase their productivity by 0.4 per cent more on average than firms that do not. Assumed risk by firms is therefore productivity enhancing in Myanmar. In effect, risk taken by firms in their relationships with customers, with respect to any firm-specific investments in equipment or training of workers specifically to supply a particular customer, significantly influences the efficiency and performance of the firm. This finding thus lends support to those researchers who argue that specific investments, particularly in training workers and in specialized equipment, influence productivity growth (see Bloom et al. 2014; McKenzie and Woodruff 2014). With respect to the control variables, the age of the firm and the number of workers have a significantly negative impact on firm productivity. In this case, younger firms are significantly more productive, as shown in the literature (see Lopez-Garcia and Puente 2012; Navaretti et al. 2014). As the firm size increases, firm productivity declines by 8.8 per cent in Myanmar. With respect to the educational attainment of a firm owner or manager, having primary education significantly impacts firm productivity positively, while the effect of having tertiary education is also positive but insignificant. Therefore, more formal education does not seem to induce firm productivity in Myanmar. This surprising finding, however, requires further research. Formal firm registration and the firm being located in an urban area are also positively associated with firm productivity, albeit not statistically significant.

6.3 Assumed risk and informal institutions

Table 9 presents the determinants of the risk assumed by firms. To ensure robustness of our regression estimates, we first run our model without the control variables (column 1), and then in column 2 we include our control variables but use the location of Yangon instead of state dummies. In column 3, we introduce state dummies as part of the control variables. The ensuing discussion focuses on the role of informal institutions in determining whether firms engage in risky transactions.

Beginning with information exchange and firms' interaction with customers, we find that information from informal interaction with customers significantly influences the risk assumed by firms positively, while the percentage of customers that are foreign does not have any effect on firms' propensity to take risk. Firms that receive information from informal interaction with customers have a 6.4 percentage points higher probability of making specific investment than firms that do not.

With respect to social and business networks, information received by firms from business networks, talking to other suppliers of customers, and being a member of a business association significantly affect the likelihood of a firm taking larger risk. The probability of making specific investment if firms receive information from business networks is raised by 8.1 percentage points. If firms talk to other suppliers of their customer, the predicted probability of investing increases significantly by 15.5 percentage points. Firms that are members of a business association have a 9.8 percentage point higher propensity of taking risk than non-members. Information from personal contacts does not determine the willingness of a firm to bear a degree of assumed risk in Myanmar.

In relation to formal institutions, firms are found to be willing to take significantly larger risk (by 0.2 percentage points) as the percentage of their sales based on written contracts increases. This small magnitude in terms of response by firms may be due largely to the weak enforcement of contracts and the prevailing quality of judicial processes. With respect to the locked-in behaviour by firms, the number of competitors does not seem to significantly affect firms' propensity to take larger risk.

With respect to the controls, a 100 per cent increase in the number of workers increases the probability of firms making specific investment by 2.5 percentage points, while location in Yangon decreases the propensity of a firm to bear assumed risk by 15.3 percentage points.

Table 9: Marginal effects of formal and informal institutions on assumed risk

	Specific investment		
	(1)	(2)	(3)
Information from visits/interaction with customer			
Information from informal interaction (d)	.064 (.016)***	.064 (.016)***	.058 (.017)***
% of customers that are foreign (c)	-.001 (.001)	-.001 (.001)	-.001 (.001)
Networks			
Information from personal contacts (d)	-.013 (.017)	.020 (.017)	.027 (.017)
Information from business network (d)	.069 (.032)**	.083 (.032)**	.081 (.032)**
Talk to other suppliers of customer (d)	.135 (.028)***	.136 (.028)***	.155 (.029)***
Member of business association (d)	.126 (.031)***	.089 (.029)***	.098 (.030)***
Contracts			
% of total sales based on written contracts (c)	.002 (.001)***	.002 (.001)***	.002 (.001)***
Competition or locked-in			
Number of competitors (c)	.003 (.002)*	.002 (.002)	.001 (.002)
Controls			
Log of number of workers (c)		.025 (.008)***	.020 (.008)**
Located in Yangon (d)		-.153 (.017)***	
State/region dummies	No	No	Yes
Sector dummies	No	Yes	Yes
Number of obs.	2,434	2,434	2,421
Prob > chi2	0.000	0.000	0.000
Pseudo R2	0.043	0.073	0.149

Notes: ***, ** and * denote significance at 1%, 5% and 10%, respectively. Estimated standard errors in parentheses.

Source: authors' calculations.

We continue the analysis further to examine the role of informal institutions on assumed risk based on the size of the firm, that is, firms that employ less than 50 workers (small) and firms that employ more than 50 employees (medium). Table 10 presents the results. Informal institutions play a significant role in the propensity of small firms to take larger risk, but this is not the case for medium and large firms in Myanmar. All sets of informal institutions, except for percentage of foreign customers and information from personal contacts, have a positive and statistically significant influence on small firms' likelihood to take risk. It is worth noting that the signs for the percentage of foreign customers and for information from personal contacts in the full sample are negative but are positive, albeit not significant, for small firms. For medium/large firms, the only informal institution that significantly influences the propensity to take risk is where firms talk to other suppliers of customers, which increases the predicted probability of specific investment by medium firms by 45 percentage points. With respect to written contracts as a risk management mechanism, both small and medium firms are more likely to invest in specific assets as the

percentage of their sales based on written contracts increases. The locked-in behaviour of both small and medium firms does not seem to significantly influence the willingness of small and medium firms to make specific investment. It is interesting to note that a 100 per cent increase in the number of workers increases the probability of small firms engaging in larger risk by 3.2 percentage points. The relationship for medium firms is positive but is not significant.

Table 10: Marginal effects of formal and informal institutions on assumed risk based on firm size

	Specific investment	
	≤ 50 employees (micro/small)	≥ 50 employees (medium/large)
Information from visits/interaction with customer	(1)	(2)
Information from informal interaction (d)	.056 (.018)***	.073 (.047)
% of customers that are foreign (c)	.004 (.004)	.0003 (.001)
Networks		
Information from personal contacts (d)	.016 (.018)	.049 (.076)
Information from business network (d)	.099 (.036)***	-.007 (.075)
Talk to other suppliers of customer (d)	.131 (.029)***	.452 (.239)*
Member of business association (d)	.105 (.034)***	.096 (.091)
Contracts		
% of total sales based on written contracts (c)	.002 (.001)***	.0012 (.0007)*
Competition or locked-in		
Number of competitors (c)	-.0001 (.002)	.004 (.013)
Controls		
Log of number of workers (c)	.032 (.010)***	.024 (.050)
State/Region dummies	Yes	Yes
Sector dummies	Yes	Yes
Number of obs.	2,290	106
Prob > chi2	0.000	0.000
Pseudo R2	0.130	0.423

Notes: ***, ** and * denote significance at 1%, 5% and 10%, respectively. Estimated standard errors in parentheses.

Source: authors' calculations.

7 Conclusion and policy implications

A feature of developing countries is the existence of a large number of unproductive firms, which leads to a low level of overall productivity for the economy (Bloom et al. 2014). Understanding what explains this low productivity among many firms in developing countries is of fundamental importance in understanding what drives economic growth in the developing country context and finding ways to reduce the gap in living standards between rich and poor countries. In this paper, we examine the institutional factors that may explain low productivity in a low-income transition economy—Myanmar—with a specific focus on informal institutions.

Using a rich firm-level dataset that spans micro, small, and large firms, and using stochastic frontier analysis to estimate firm-level productivity, we find that firms which assume higher transactions risks have higher levels of productivity. Further, we find that informal institutions, such as relational contracting and social networks, contribute to greater risk taking by firms, even in a context where formal institutions do not work well. This finding is consistent with the new institutional economics literature, which highlights the role that informal institutions can play when formal institutions are either missing or do not function well. Our findings suggest that relational contracting and social networks can be efficiency enhancing in low-income country contexts where courts and formal dispute resolution procedures may take time to develop.

Though we find in the Myanmar context that informal institutions have been effective in allowing firms to engage in more complex transactions, we also find that the use of written contracts is associated with greater risk taking by firms. This suggests that informal and formal institutions are not substitutes in the process of economic development, and the role of policy is to find synergies between these two sets of institutions so that they can be complements to each other in the process of economic development. For a low-income transition economy like Myanmar, while the presence of informal institutions has allowed firms to take risks with their investment, it is also important from a policy point of view that formal institutions of contracting and dispute resolution are strengthened over time.

References

Aigner, D., C.K. Lovell, and P. Schmidt (1977). 'Formulation and Estimation of Stochastic Frontier Production Function Models'. *Journal of Econometrics*, 6(1): 21–37. https://doi.org/10.1016/0304-4076(77)90052-5

Ali, M., and J.C. Flinn (1989). 'Profit Efficiency Among Basmati Rice Producers in Pakistan Punjab'. *American Journal of Agricultural Economics*, 71(2): 303–10. https://doi.org/10.2307/1241587

Alvarez, R., and G. Crespi (2003). 'Determinants of Technical Efficiency in Small Firms'. *Small Business Economics*, 20(3): 233–44. https://doi.org/0.1023/A:1022804419183

Alvarez, R., and R.A. Lopez (2005). 'Exporting and Performance: Evidence from Chilean Plants'. *Canadian Journal of Economics/Revue canadienne d'économique*, 38(4): 1384–400. https://doi.org/10.1111/j.0008-4085.2005.00329.x

Bartelsman, E., J. Haltiwanger, and S. Scarpetta (2013). 'Cross-country Differences in Productivity: The Role of Allocation and Selection'. *American Economic Review*, 103(1): 305–34. https://doi.org/10.1257/aer.103.1.305

Bissinger, J. (2014). 'Myanmar's Economic Institutions in Transition'. *Journal of Southeast Asian Economies*, 241–55. https://doi.org/10.1355/ae31-2f

Bloom, N., R. Lemos, R. Sadun, D. Scur, and J. Van Reenen (2014). 'JEEA-FBBVA Lecture 2013: "The New Empirical Economics of Management"'. *Journal of the European Economic Association*, 12(4): 835–76.

Bloom, N., and J. Van Reenen (2007). 'Measuring and Explaining Management Practices Across Firms and Countries'. *The Quarterly Journal of Economics*, 122(4): 1351–408.

Boerner, C.S., and J.T. Macher (2001). 'Transaction Cost Economics: An Assessment of Empirical Research in the Social Sciences'. Unpublished manuscript, Georgetown University.

Bravo-Ureta, B.E., and L. Rieger (1991). 'Dairy Farm Efficiency Measurement Using Stochastic Frontiers and Neoclassical Duality'. *American Journal of Agricultural Economics*, 73(2): 421–28. https://doi.org/10.2307/1242726

Caudill, S.B., and J.M. Ford (1993). 'Biases in Frontier Estimation Due to Heteroscedasticity'. *Economics Letters*, 41(1): 17–20. https://doi.org/10.1016/0165-1765(93)90104-K

Caudill, S.B., J.M. Ford, and D.M. Gropper (1995). 'Frontier Estimation and Firm-specific Inefficiency Measures in the Presence of Heteroscedasticity'. *Journal of Business & Economic Statistics*, 13(1): 105–11.

Colacelli, M., and M.G.H. Hong (2019). *Productivity Drag from Small and Medium-Sized Enterprises in Japan*. Washington, DC: International Monetary Fund.

CSO and UNU-WIDER (2018). *Myanmar Enterprise Monitoring Survey (MEMS) Dataset*. Nay Pyi Taw: Central Statistical Organization and Helsinki: UNU-WIDER.

Danquah, M., and B. Ouattara (2015). 'What Drives National Efficiency in Sub-Saharan Africa'. *Economic Modelling*, 44: 171–79. https://doi.org/10.1016/j.econmod.2014.10.019

De, P.K., and P. Nagaraj (2014). 'Productivity and Firm Size in India'. *Small Business Economics*, 42(4): 891–907.

De Long, J.B., and L.H. Summers (1991). 'Equipment Investment and Economic Growth'. *The Quarterly Journal of Economics*, 106(2): 445–502. https://doi.org/10.2307/2937944

De Long, J.B., and L.H. Summers (1992). 'Equipment Investment and Economic Growth: How Strong is the Nexus?'. *Brookings Papers on Economic Activity*, 157–99.

De Vries, G.J. (2010). 'Small Retailers in Brazil: Are Formal Firms Really More Productive?'. *The Journal of Development Studies*, 46(8): 1345–66.

Dethier, J.J., M. Hirn, and S. Straub (2011). 'Explaining Enterprise Performance in Developing Countries with Business Climate Survey Data'. *The World Bank Research Observer*, 26(2), 258–309. https://doi.org/10.1093/wbro/lkq007

Diaz, M.A., and R. Sánchez (2008). 'Firm Size and Productivity in Spain: A Stochastic Frontier Analysis'. *Small Business Economics*, 30(3): 315–23. https://doi.org/10.1007/s11187-007-9058-x

Dollar, D., M. Hallward-Driemeier, and T. Mengistae. (2005). 'Investment Climate and Firm Performance in Developing Economies'. *Economic Development and Cultural Change*, 54(1): 1–31. https://doi.org/10.1086/431262

Duffy, J., and C. Papageorgiou (2000). 'A Cross-country Empirical Investigation of the Aggregate Production Function Specification'. *Journal of Economic Growth*, 5(1): 87–120. https://doi.org/10.1023/A:1009830421147.

Eliasson, K., P. Hansson, and M. Lindvert (2012). 'Do Firms Learn by Exporting or Learn to Export? Evidence from Small and Medium-sized Enterprises'. *Small Business Economics*, 39(2): 453–72. https://doi.org/10.1007/s11187-010-9314-3.

Fafchamps, M. (2016). 'Formal and Informal Market Institutions: Embeddedness Revisited'. Stanford University Working Paper. Stanford, CA: Stanford University.

Greene, W. (2004). 'Distinguishing Between Heterogeneity and Inefficiency: Stochastic Frontier Analysis of the World Health Organization's Panel Data on National Health Care Systems'. *Health Economics*, 13(10): 959–80. https://doi.org/10.1002/hec.938

Greene, W.H. (2018). *Econometric Analysis/LimDep Users Manual.*

Grief, A. (2006). *Institutions and the Path to the Modern Economy*. Cambridge: Cambridge University Press.

Hadri, K., C. Guermat, and J. Whittaker (2003). 'Estimation of Technical Inefficiency Effects Using Panel Data and Doubly Heteroscedastic Stochastic Production Frontiers'. *Empirical Economics*, 28(1): 203–22. http://dx.doi.org/10.1007/s001810100127

Hendley, K., and P. Murrell (2003). 'Which Mechanisms Support the Fulfillment of Sales Agreements? Asking Decision-makers in Firms'. *Economics Letters*, 78(1): 49–54.

Johnson, S., J. McMillan, and C. Woodruff (2002). 'Courts and Relational Contracts'. *Journal of Law, Economics, and Organization*, 18(1): 221–77.

Jondrow, J., C.K. Lovell, I.S. Materov, and P. Schmidt (1982). 'On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model'. *Journal of Econometrics*, 19(2–3): 233–38.

Kalirajan, K.P. (1990). 'On Measuring Economic Efficiency'. *Journal of Applied Econometrics*, 5(1): 75–85. https://doi.org/10.1002/jae.3950050106

Kandori, M. (1992). 'Social Norms and Community Enforcement'. *The Review of Economic Studies*, 59(1): 63–80

Khin, M.K., R. Findlay, R.M. Sundram, M. Mya, N. Myo, and O. Zaw (2000). *Economic Development of Burma: A Vision and a Strategy*. Stockholm: Olof Palme International Center.

Kneller, R., and P.A. Stevens (2003). 'The Specification of the Aggregate Production Function in the Presence of Inefficiency'. *Economics Letters*, 81(2): 223–26.

Kodde, D.A., and F.C. Palm (1986). 'Wald Criteria for Jointly Testing Equality and Inequality Restrictions'. *Econometrica: Journal of the Econometric Society*, 1243–48. http://dx.doi.org/10.2307/1912331

Kumbhakar, S.L., and K. Lovell (2000). *Stochastic Frontier Analysis*. Cambridge: Cambridge University Press.

Lopez-Garcia, P., and S. Puente (2012). 'What Makes a High-growth Firm? a Dynamic Probit Analysis Using Spanish Firm-level Data'. *Small Business Economics*, 39(4), 1029–41.

McKenzie, D., and C. Woodruff (2014). 'What Are we Learning from Business Training and Entrepreneurship Evaluations Around the Developing World?'. *The World Bank Research Observer*, *29*(1): 48-82.

McMillan, J., and C. Woodruff (1999). 'Interfirm Relationships and Informal Credit in Vietnam'. *The Quarterly Journal of Economics*, 114(4): 1285–320.

McMillan, J. (1997). '"A Study of Economic Reform: The Case of New Zealand" Review by Brian Silverstone, Alan Bollard, and Ralph Lattimore'. *Journal of Economic Literature*, 35(4): 2094–95.

Navaretti, G.B., D. Castellani, and F. Pieri (2014). 'Age and Firm Growth: Evidence from Three European Countries'. *Small Business Economics*, 43(4): 823–37. https://doi.org/10.1007/s11187-014-9564-6

North, D.C. (1994a). 'Economic Performance Through Time'. *The American Economic Review*, 84(3): 359–68.

North, D.C., (1994b). *Institutions and Productivity in History,* Economic History 9411003. Munich: University Library of Munich.

Nunn, N. (2007). 'Relationship-specificity, Incomplete Contracts, and the Pattern of Trade'. *The Quarterly Journal of Economics*, 122(2): 569–600. https://doi.org/10.1162/qjec.122.2.569

OECD (2015). *Multi-Dimensional Review of Myanmar—An Initial Assessment*. Paris: Organisation for Economic Co-operation and Development.

Parmeter, C.F., and S.C. Kumbhakar (2014). 'Efficiency Analysis: A Primer on Recent Advances'. *Foundations and Trends in Econometrics*, 7(3–4): 191–385. http://dx.doi.org/10.1561/0800000023

Pitt, M.M., and L.F. Lee (1981). 'The Measurement and Sources of Technical Inefficiency in the Indonesian Weaving Industry'. *Journal of Development Economics*, 9(1): 43–64. https://doi.org/10.1016/0304-3878(81)90004-3

Rand, J., F. Tarp, N. Trifković, and H. Zille (2019). 'Industrial Agglomeration in Myanmar'. WIDER Working Paper 2019/3. Helsinki: UNU-WIDER.

Rand, J., and N. Torm (2012). 'The Benefits of Formalization: Evidence from Vietnamese Manufacturing Smes'. *World Development*, 40(5): 983–98.

Richman, B.M.J., and J. Macher (2006). 'Transaction Cost Economics: An Assessment of Empirical Research in the Social Sciences'. Duke Law School Legal Studies Paper 115. Durham, NC: Duke University School of Law, mimeo.

Rosenthal, S.S., and C.W. Strange (2004). 'Evidence on the Nature and Sources of Agglomeration Economies'. *Handbook of Regional and Urban Economics*, 4: 2119–71.

Sharma, S. (2014). 'Benefits of a Registration Policy for Microenterprise Performance in India'. *Small Business Economics*, 42(1): 153–64. https://doi.org/10.1007/s11187-013-9475-y

Steer, L., and K. Sen (2010). 'Formal and Informal Institutions in a Transition Economy: The Case of Vietnam'. *World Development*, 38(11): 1603–15. https://doi.org/10.1016/j.worlddev.2010.03.006

Subramanian, U., W.P. Anderson, and K. Lee (2005). *Measuring the Impact of the Investment Climate on Total Factor Productivity: The Cases of China and Brazil*. Washington, DC: The World Bank.

Syverson, C. (2011). 'What Determines Productivity?'. *Journal of Economic Literature*, 49(2): 326–65. https://doi.org/10.1257/jel.49.2.326

Tin, M.M.T. (2006). *State Dominance in Myanmar: The Political Economy of Industrialization*. Singapore: Institute of South East Asian Studies.

Turnell, S. (2009). *Fiery Dragons: Banks, Finance and Money Lenders in Burma*. Copenhagen: NIAS Press.

Tybout, J.R. (2000). 'Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?'. *Journal of Economic Literature*, 38(1): 11–44. https://doi.org/10.1257/jel.38.1.11

UNESCAP (2015). *Myanmar Business Survey*. Bangkok: United Nations Economic and Social Commission for Asia and the Pacific.

Wang, H.J., and P. Schmidt (2002). 'One-step and Two-step Estimation of the Effects of Exogenous Variables on Technical Efficiency Levels'. *Journal of Productivity Analysis*, 18(2): 129–44.

Williamson, O.E. (1996). *The Mechanisms of Governance*. Oxford: Oxford University Press.

Wollni, M., and B. Brümmer (2012). 'Productive Efficiency of Specialty and Conventional Coffee Farmers in Costa Rica: Accounting for Technological Heterogeneity and Self-selection'. *Food Policy*, 37(1): 67–76. https://doi.org/10.1016/j.foodpol.2011.11.004

World Bank (2020). *Doing Business Report 2020*. Washington, DC: The World Bank. https://doi.org/10.1596/978-1-4648-1440-2

Appendix

Table A1: Descriptive statistics

Variables	Mean	Std. Dev.	Min	Max
Production frontier				
Log total sales	17.216	2.034	7.600	28.303
Log (1+ capital stock)	17.247	2.817	0.00	24.568
Log labour (no. of workers)	1.604	1.174	0.00	6.291
Hand tools	.149	.356	0.00	1.00
Power technology	.202	.402	0.00	1.00
Both power and manual	.449	.497	0.00	1.00
Urban dummy	.826	.379	0.00	1.00
Location in industrial zone	.209	.407	0.00	1.00
Access to electricity grid	.866	.340	0.00	1.00
Firm productivity and assumed risk				
Assumed risk	.198	.398	0.00	1.00
Log age of the firm	2.294	.969	0.00	4.634
% of sales for export	2.328	14.500	0.00	100
Formally registered	.847	.359	0.00	1.00
Primary	.239	.426	0.00	1.00
Secondary	.406	.491	0.00	1.00
Vocational/diploma	.013	.115	0.00	1.00
Tertiary	.304	.460	0.00	1.00
Determinants of assumed risk				
Information from informal interaction	.676	.467	0.00	1.00
Information from personal contacts	.392	.488	0.00	1.00
Information from business network	.084	.278	0.00	1.00
Talk to other suppliers of customer	.127	.333	0.00	1.00
Member of business association	.103	.304	0.00	1.00
% of total sales based on written contracts	3.025	16.003	0.00	100
Number of competitors	3.636	4.621	0.00	40

Source: CSO and UNU-WIDER (2018).