Entry Costs Rise with Development

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Abstract

A potential benefit of a large market (GDP) is a large number of locally-produced varieties. We attempt to quantify the number of varieties produced in a market by counting the number of firms and plants. Looking at manufacturing industries across countries and over time, we find that variety increases strongly with the number of workers and modestly with output per worker. In many models of firm dynamics, trade and growth, these facts imply that the cost of creating a new variety increase sharply with productivity. This increase in entry costs can be due to rising labor costs with development as well as intrinsically higher costs of using more sophisticated technologies. As a result, the welfare impact of productivity-enhancing policies appears to be only modestly amplified through variety expansion.

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1. Introduction

Do richer countries create more firms and establishments per worker? If the number of enterprises is a good proxy for the number of specialized goods available, then having more enterprises translates into variety gains for consumers and firms. Policies that raise productivity can induce more entry depending on the entry technology. Suppose new varieties are created with a fixed amount of output. Then endogenous expansion of product variety can amplify the welfare gains from policies that boost productivity. This is analogous to the multiplier effect of higher productivity on output through physical capital accumulation in the neoclassical growth model. Now suppose instead that entry requires a fixed amount of labor. Then policies boosting productivity are not amplified through variety expansion because entry costs rise with the price of labor.

Widely used models of firm dynamics, growth, and trade make different assumptions about entry costs.[1] Some models assume that entry costs are stable with development (e.g. a fixed output cost to invent a new product). Examples include Hopenhayn (1992), Romer (1994), and Foster et al. (2008). Other models assume that entry costs rise with development, say because entry requires a fixed amount of labor and labor becomes more expensive with development. See, for example, Grossman and Helpman (1991), Melitz (2003), Klette and Kortum (2004), Luttmer (2007), and Acemoglu et al. (2013). Other studies emphasize how entry costs matter for the welfare impact of policies; see Rivera-Batiz and Romer (1991), Atkeson and Burstein (2010), and the survey by Costinot and Rodríguez-Clare (2013).

Existing evidence is limited on how entry costs change with development. This is why models are mixed or agnostic on the question. The evidence is mostly confined to estimates of the regulatory barriers to entry, to the exclusion of the technological costs of innovating and setting up operations. Djankov et al. (2002) document higher statutory costs of entry (relative to GDP per capita)

[1] By "entry costs" we have in mind all non-production costs over a firm's life cycle, so not only upfront innovation and setup costs but also overhead costs and R&D of incumbents.

in poor countries. Their pioneering effort spawned the influential Doing Business Surveys conducted by the World Bank. Luttmer (2007, 2010) reports that the U.S. firm size distribution appears stationary over time. He shows that entry costs being proportional to the level of development is a necessary condition for the existence of a stationary firm size distribution in various growth models.

In this paper, we provide systematic evidence on how the number of firms and establishments varies with the level of labor productivity. We look across countries (2006 UNIDO data), over time in the U.S. (1982–2007 quinquennial Census data), and across states within the U.S. (2007 Census data). We look mostly within manufacturing industries, but present some evidence for all U.S. industries. As a corollary, we document how revenue per business varies with the number of workers and labor productivity. We argue that these simple empirical elasticities discipline the nature of entry costs in widely used models.

We find that the number of enterprises increases strongly with the level of employment across countries, states, and time. The number of enterprises increases much more modestly with output per worker. Put differently, average enterprise revenue increases strongly with labor productivity across time and space. These results are robust to looking only across OECD countries, for which data are better and more comparable. The U.S. cross-state and over-time evidence comes entirely from the U.S. Census, for which measurement should also be more consistent. These facts suggest that entry costs increase sharply with the level of development. Enterprises evidently need to be larger to satisfy the free entry condition in rich countries. If higher revenue is associated with higher operating profits, then upfront costs of entry must be bigger for the zero profit condition to hold.[2]

Entry costs could rise with development because entry is labor-intensive, and labor is expensive in productive economies. This would explain why entry increases steeply with employment but not with output per worker. Entry costs

[2]We consider other possibilities, such as falling markups or rising exit, discount or firm growth rates with development. We will argue that these forces are too weak to explain the massive variation in revenue per business.

could also rise with development because entrants must be more technologically sophisticated to succeed in more advanced economies. Our evidence is relevant for total entry costs, i.e. the sum of technological and regulatory barriers. If, as seen in the Doing Business surveys, regulatory entry costs do *not* increase sharply with development, then technological entry costs must be the dominant force pushing up entry costs with development.

Our findings have several implications for modeling and policy. First, if the choice is between fixed entry costs in terms of labor or output, our evidence favors denominating entry costs in terms of labor. More generally, one needs entry costs to be rising with the level of technology, directly or indirectly. Second, our evidence validates the assumption of rising entry costs with technological progress, as is often assumed to obtain balanced growth in theory.[3] Third, productivity-enhancing policies have muted effects on variety. Fourth, higher population goes along with horizontal innovation (more variety), whereas higher income is more strongly associated with vertical innovation (e.g. quality ladders).[4] An important caveat to these conclusions is that we are using firms and establishments as empirical proxies for variety.

The rest of the paper proceeds as follows. Section 2 describes a very simple model illustrating how the welfare effect of changes in productivity hinges on the nature of entry costs. Section 3 presents evidence on how the number of businesses varies with development across time and space. Section 4 discusses potential interpretation of the empirical patterns, focusing on entry costs but also considering alternative interpretations. Section 5 concludes.

2. A Simple Model

Here we use a simple model to motivate why we care about how entry costs vary with development. Consider a one-shot and closed economy version of the

[3] E.g. Romer (1990), Aghion and Howitt (1992), and chapters 13 and 14 of Acemoglu (2011).
[4] Models with these properties appear in Luttmer (2007), Young (1998), and Howitt (1999).

Melitz (2003) model. The economy has a representative household endowed with L units of labor. Consumption per capita, which is equal to the real wage w, is a measure of welfare in the economy.

Consumption goods are produced by a perfectly competitive sector that uses intermediate goods as inputs and a CES production technology. Profit maximization yields a downward sloping demand curve for each intermediate good.

The intermediate goods sector is monopolistically competitive. Without loss of generality we assume all firms in this sector have the same production function, which is linear in labor inputs with technology level A_y.[5] Each intermediate goods firm takes demand for its product as given and chooses output or price to maximize profit. This yields the familiar relationship between the wage bill, revenue, and profit in each firm:

$$wl = \frac{\sigma - 1}{\sigma} py = (\sigma - 1)\pi \propto w^{1-\sigma} Y A_y^{\sigma-1} \tag{1}$$

Also, by symmetry of the intermediate goods production function, aggregate output in the economy is

$$Y = A_y L_y M^{\frac{1}{\sigma-1}} \tag{2}$$

where L_y is the total amount of labor devoted to producing intermediate goods.

One unit of an entry good is required to create a variety, i.e., set up an intermediate goods firm. We generalize the production technology of the entry good in Melitz (2003) to allow final goods to be an input into creating a new variety. In particular, we assume that the entry technology has the Cobb-Douglas form

$$M = A_e Y_e^{\lambda} L_e^{1-\lambda} \tag{3}$$

where M is the number of varieties created, and L_e and Y_e are the amount of labor and final output, respectively, used in creating varieties.

Perfect competition in the CRS sector producing entry goods implies that

[5] We could generalize to allow post-entry heterogeneity in firm technology and define $A := (\mathbb{E}A^{\sigma-1})^{\frac{1}{\sigma-1}}$.

the cost of creating a variety in term of consumption goods is

$$p_e \propto \frac{w^{1-\lambda}}{A_e}. \tag{4}$$

And the labor share of revenue from entry goods production is

$$wL_e = (1-\lambda)p_e M. \tag{5}$$

Free entry with positive entry at the equilibrium implies

$$\pi = p_e \tag{6}$$

which equates profit per variety (LHS) with the entry cost (RHS).

Thus, the one-shot equilibrium given (L, A_y, A_e) consists of prices (w, p_e) and allocations (C, M, Y, L_e, L_y) such that $C = wL$, (1), (2), (3), (4), and (6) hold, and the following labor and goods market clearing conditions are satisfied:

$$L = L_y + L_e, \quad Y = C + Y_e. \tag{7}$$

We now consider how the welfare impact of a change in A_y depends on the specification of the entry technology. In equilibrium, welfare (the real wage) is

$$w = A_y M^{\frac{1}{\sigma-1}} \tag{8}$$

so

$$\frac{\partial \ln w}{\partial \ln A_y} = 1 + \frac{1}{\sigma - 1}\frac{\partial \ln M}{\partial \ln A_y}.$$

An increase in A_y not only improves welfare directly, but also has the potential to improve welfare indirectly through variety expansion.

One can show that equilibrium variety satisfies

$$M \propto \frac{wL}{p_e} \tag{9}$$

so that the number of varieties depends on the value of labor relative to the entry cost. Combining this with equation (6) relating the real wage to p_e, we get

$$\frac{\partial \ln M}{\partial \ln A_y} \;=\; \lambda \, \frac{\partial \ln w}{\partial \ln A_y}$$

That is, the elasticity of variety with respect to A_y is larger when the share of output used in producing varieties (λ) is bigger. Higher A_y means more output, and some of this output is devoted to producing more varieties if the final good is used in entry ($\lambda > 0$). Repeated substitution will show that the compounding impact of A_y on welfare is

$$\frac{\partial \ln w}{\partial \ln A_y} \;=\; 1 + \frac{\lambda}{\sigma - 1 - \lambda}$$

with the second term capturing the amplification of the welfare impact of A_y through variety expansion. A higher output share leads to bigger amplification.

The amplification of an increase in productivity depends on σ, the degree of substitutability of intermediate goods, because varieties are more valuable when substitutability is low. To illustrate the potential importance of variety expansion, consider the Broda and Weinstein (2006) estimates of $\sigma \approx 4$ at the 3-digit to 4-digit level. For this value of σ, the amplification effect can range from 50% when $\lambda = 1$ to 0% when $\lambda = 0$. Thus, for reasonable calibration of σ, how entry costs vary with A_y has economically significant ramifications for the welfare impact of changes in technology.

Other than amplifying technology changes, how entry costs vary with development can be important for understanding the welfare impact of policies affecting allocative efficiency. Take trade liberalization, which in the current model can be described as an increase in the population. As in Melitz (2003), increasing the population is like an extreme trade liberalization going from autarky to frictionless trade between countries. In this case, the overall welfare effect is

$$\frac{\partial \ln w}{\partial \ln L} = \frac{1}{\sigma - 1}\left(1 + \frac{\lambda}{\sigma - 1 - \lambda}\right)$$

At $\sigma = 4$, again, the amplification through variety expansion is 50% when $\lambda = 1$ and 0% when $\lambda = 0$.

To recap, this simple model illustrates how the nature of entry costs matters for welfare analysis.

2.1. Welfare effect when A_e changes with A_y

It is plausible that different production technologies have intrinsically different setup costs. Suppose that, in the previous model, entry technology is related to production technology by

$$\ln A_e = -\mu \ln A_y + \epsilon$$

where ϵ is a component unrelated to A_y and μ represents how fast entry costs rise with production technology (for a given cost of labor).

Now consider the impact of a change in A_y on welfare in this setting. We still have

$$\frac{\partial \ln w}{\partial \ln A_y} = 1 + \frac{1}{\sigma - 1}\frac{\partial \ln M}{\partial \ln A_y}.$$

But now

$$\frac{\partial \ln M}{\partial \ln A_y} = \lambda \frac{\partial \ln w}{\partial \ln A_y} + \frac{\partial \ln A_e}{\partial \ln A_y} = \lambda \frac{\partial \ln w}{\partial \ln A_y} - \mu.$$

The overall welfare impact becomes

$$\frac{\partial \ln w}{\partial \ln A_y} = 1 + \frac{\lambda - \mu}{\sigma - 1 - \lambda}.$$

Our previous welfare analysis is the special case of when $\mu = 0$. More generally, when entry costs rise with productivity, either through higher labor costs (small λ) or more costly setup (large positive μ), the impact of A_y on variety and welfare is dampened.

3. Empirical Patterns

Having motivated why we care about how entry costs vary with development, we now attempt to provide evidence on the question. In this section, we present results for OLS regressions of the form:

$$\ln M_i = \beta_0 + \beta_1 \ln \frac{Y_i}{L_i} + \beta_2 \ln L_i + \beta_3 Firm\_Dummy_i + \beta_4 Industry\_Dummy_i + \epsilon_i. \quad (10)$$

$$\ln \frac{Y_i}{M_i} = \beta_0 + \beta_1 \ln \frac{Y_i}{L_i} + \beta_2 Firm\_Dummy_i + \beta_3 Industry\_Dummy_i + \epsilon_i \quad (11)$$

where M is the number of establishments or firms (depending on data availability), Y is value added, and L is the number of workers. We put in a $Firm\_Dummy$ to take into account that firms are bigger than establishments when we pool firm and establishment data. We also control for industry fixed effects.[6] Subscript i is a country or a country-industry pair in 2006 in the first subsection below. In the second subsection, i is a year or year-industry pair within the U.S. In the third subsection, i is a state-sector pair within the U.S. in 2007.

The first equation uses the number of firms or establishments as a proxy for the number of varieties and looks at how variety varies with productivity and population. The second regression equation is motivated by the free entry condition. For example, in the model described in the previous section, the CES production function implies that average revenue per firm is proportional to profit per firm, which is in turn proportional to the entry cost by the zero profit condition. More precisely, the real wage w and the real price of entry p_e are related to the observable output, employment, and number of firms (Y, L

[6] β_3 and $Industry\_Dummy_i$ are vectors.

and M) by

$$p_e = \frac{1}{\sigma}\frac{Y}{M} \tag{12}$$

$$w = \frac{\sigma - 1}{\sigma}\frac{Y}{L}\frac{L}{L_y} = \frac{1 - \lambda + \sigma - 1}{\sigma}\frac{Y}{L}. \tag{13}$$

Thus regressing Y/M on Y/L is akin to regressing entry costs (p_e) on the real wage, in this simple model.

We show regression results with and without industry controls, as well as restricting samples to data on establishments (which might be closer to varieties than firms are). We will discuss possible interpretations of our regression results in more detail in the next section.

3.1. Cross-country evidence

Our cross-country dataset is the United Nations Industrial Development Organization (UNIDO) Industrial Statistics Database at the 4-digit level of ISIC Code Revision 3 (INDSTAT4 2012 ISIC Rev.3) for manufacturing.[7] We use the 2006 data because it has the largest number of countries. The data is from the OECD for OECD member nations, and from national statistical offices for non-OECD countries. We use series on the number of employees, number of enterprises (firms), number of establishments and value added. Not all countries report both the number of establishments so we use the number of enterprises when establishment counts are not available. We keep only countries with data on the number of employees, value added and the number of enterprises or establishments. This selection process leaves us with 72 countries, of which 33 have establishment data. To compare value added across countries, we use the U.S. dollar values from UNIDO, which are converted from national currencies at IMF market/official exchange rates.[8]

[7] There are 127 4-digit ISICs with data for at least one country in 2006.

[8] Deviations from PPP are much more important for nontradables than for tradables, and within manufacturing may owe to nontradable local distribution rather differences in manufacturing prices. See Hsieh and Klenow (2007).

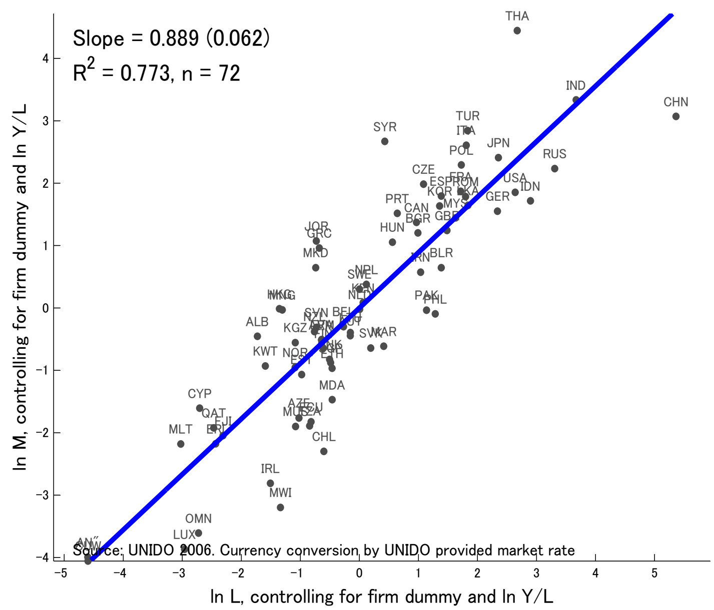

Figure 1: Cross-country variation in number of establishments (or firms) with the number of workers, conditional on revenue per worker

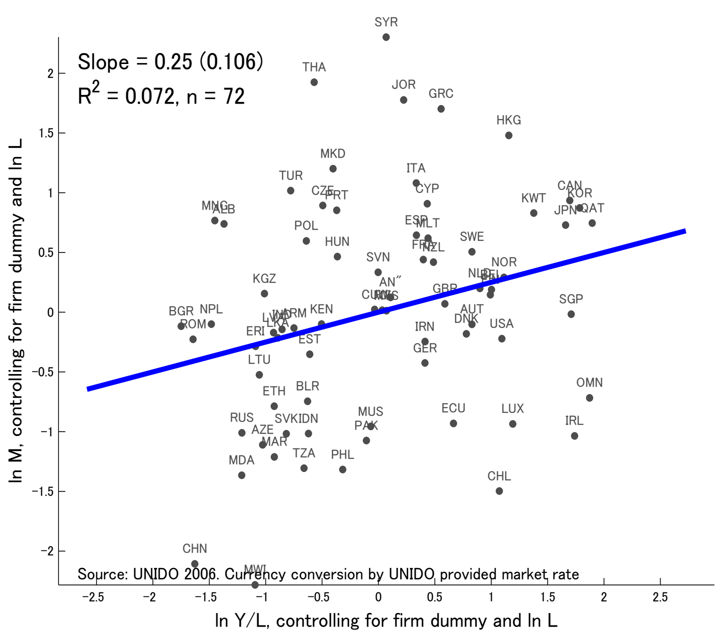

Figure 2: Cross-country variation in number of establishments (or firms) with revenue per worker, conditional on number of workers

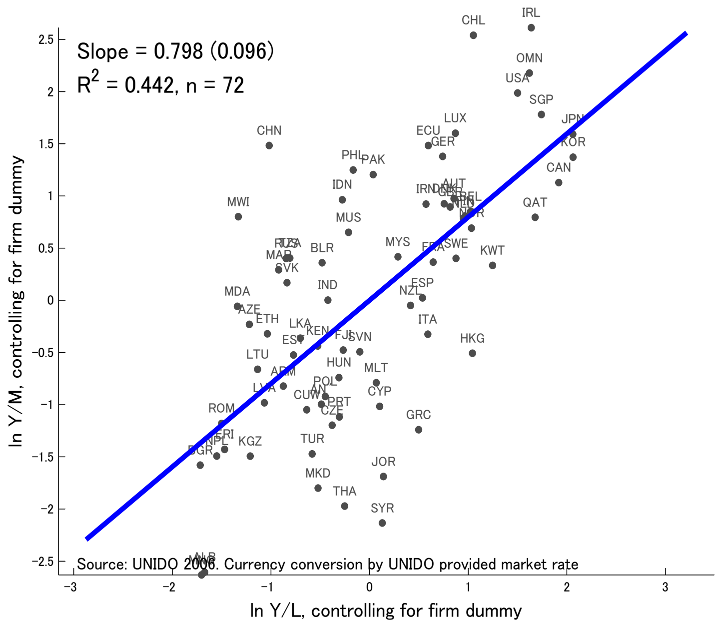

Figure 3: Cross-country variation in revenue per establishment (or firm) with revenue per worker

Figures 1 to 3 display the cross-country data. The first two figures illustrate that the number of firms or establishments increases much more strongly with the number of employees than with revenue per worker. Figure 3 shows that average revenue increases strongly with average revenue per worker. Figures 4 to 6 are counterparts of Figures 1 to 3 that control for industry fixed effects at the ISIC 4-digit level. They show that the results in Figures 1 to 3 continue to hold when looking across countries within 4-digit industries, so they are not coming from differences in industry composition across countries.

Table 1 provides the results of regressing the number of varieties on the number of workers and revenue per worker (all in natural logs). These are analogous to the figures, except for two additional specifications. First, we add a specification that uses only data from OECD nations to address the concern that the series might be inconsistently or poorly measured outside the OECD. e.g. the UNIDO data presumably misses the informal sector in developing coun-

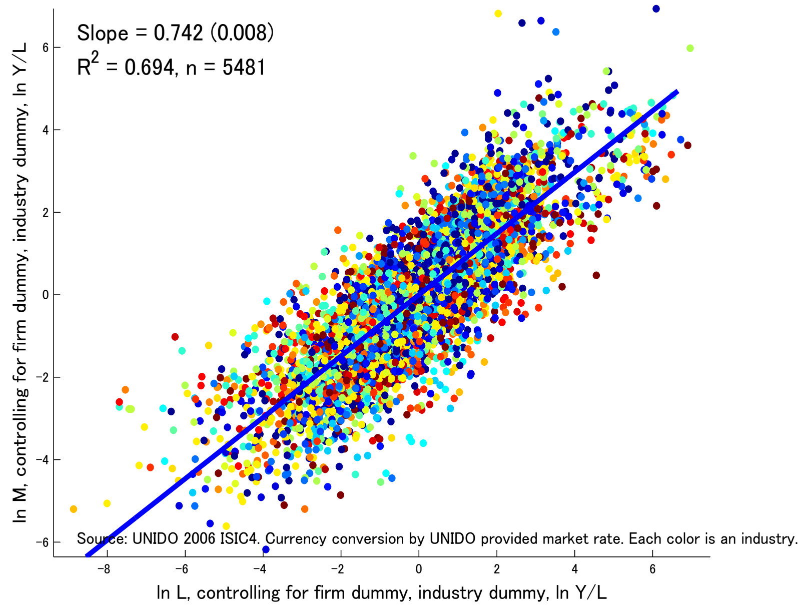

Figure 4: Cross-country variation in number of establishments (or firms) with number of workers, conditional on revenue per worker and industry (ISIC4)

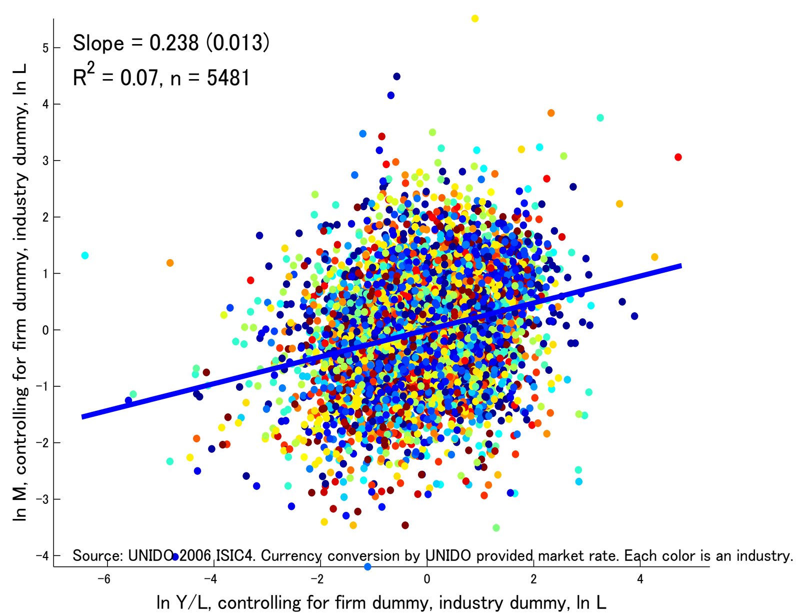

Figure 5: Cross-country variation in number of establishments (or firms) with revenue per worker, conditional on number of workers and industry (ISIC4)

Table 1: Cross country OLS regression of number of firms/establishments on number of workers and revenue per worker

Dep Var: $\ln M$	(1)	(2)	(3)	(4)	(5)	(6)
Countries:	All	All	OECD	OECD	ALL	ALL
Firm or estab:	Pooled	Pooled	Pooled	Pooled	Esta	Esta
Firm dummy:	Yes	Yes	Yes	Yes	-	-
Industry fixed effects:	-	ISIC 4	-	ISIC 4	-	ISIC 4
$\ln L$	0.889	0.743	1.041	0.742	0.938	0.804
	(0.062)	(0.008)	(0.105)	(0.015)	(0.101)	(0.014)
$\ln Y/L$	0.250	0.238	-0.331	-0.050	0.326	0.196
	(0.106)	(0.013)	(0.261)	(0.031)	(0.140)	(0.021)
R^2	0.820	0.795	0.850	0.805	0.769	0.786
Sample size	72	5481	27	2728	33	2037

Standard errors are heteroscedasticity-robust.

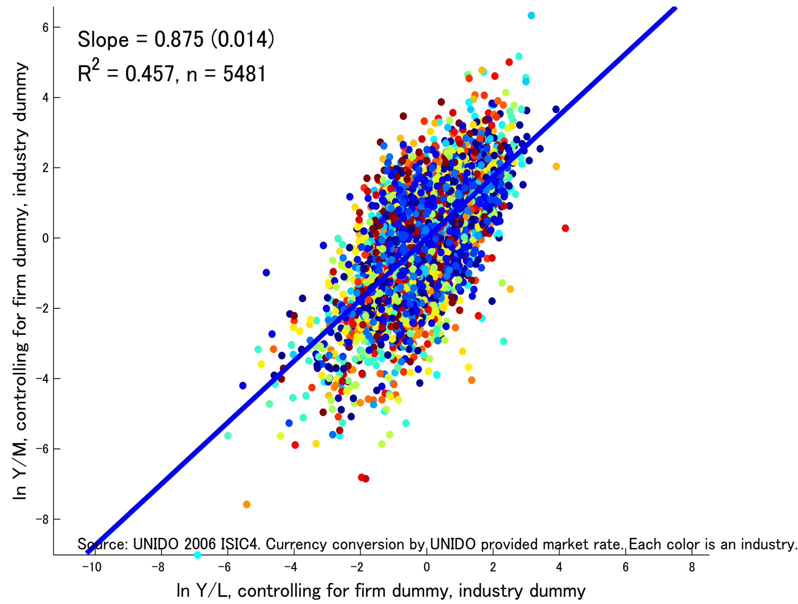

Figure 6: Cross-country variation in revenue per establishment (or firm) with revenue per worker, conditional on industry (ISIC4)

tries, which might be quite large outside the OECD even in manufacturing. See Tybout (2000) and Hsieh and Klenow (2012). We also add a specification that restricts the countries to those with establishment counts (rather than pooling firm and establishment data). In all specifications, varieties increase much more with workforce size than with revenue per worker. The elasticity of variety with respect to employment is around 0.8, whereas that with respect to value added per worker is closer to 0.25.

3.2. Over time in the U.S.

We next look at the U.S. over time. The U.S. Census data has several advantages over the cross-country data. First, the data is likely to be measured in a more consistent fashion. Second, the data covers all establishments with employees, rather than being a mix of establishment/enterprise data and missing the smallest employers. Third, we can control for industry composition at the 6-digit NAICS level starting in 1997.[9] Fourth, there is data for all sectors in more recent years, not just manufacturing. For brevity and because there is not much growth in employment over time, we focus on trends in revenue per establishment vs. revenue per worker.

Figure 7 plots the six Census years (1982, 1987, ..., 2007) with publicly-available data for all of manufacturing. Value added is deflated by the U.S. Bureau of Economic Analysis manufacturing value added deflator. As shown, value added per establishment and value added per worker rise in tandem. As real labor productivity has grown, plants have gotten larger in terms of real output, with an elasticity of around 0.8.

Figure 8 pools 6-digit manufacturing NAICS data from 1997, 2002, and 2007. Industries are color-coded, and industry dummies have been removed. Value added is deflated by the manufacturing-wide deflator in all years, on the grounds that entry costs might be denominated in manufacturing-wide output as opposed to the output of each manufacturing industry. The figure shows that industries with rapid growth in value added per worker also exhibit rapid growth in value added per plant, with an elasticity around 0.7. This is consistent across many industries.

Figure 9 looks at all sectors, not just manufacturing. The data is for 53 2-digit NAICS sectors in 1997, 2002, and 2007. Here the available output measure is receipts rather than value added. Sector fixed effects have been removed, and series are deflated by the BEA's GDP deflator. The positive relationship between growth in output per plant and growth in output per worker in the U.S. extends beyond manufacturing to all sectors, though it is not as precisely estimated outside manufacturing.

[9]There are 471 6-digit manufacturing NAICS, as opposed to only 127 4-digit manufacturing ISICs across countries.

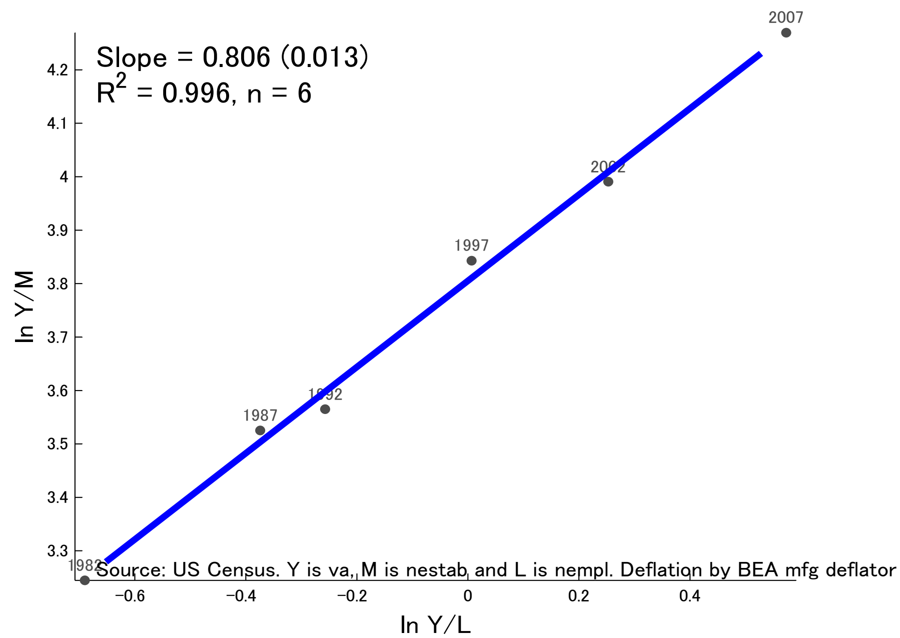

Figure 7: Variation over time revenue per establishment with revenue per worker, U.S. manufacturing overall

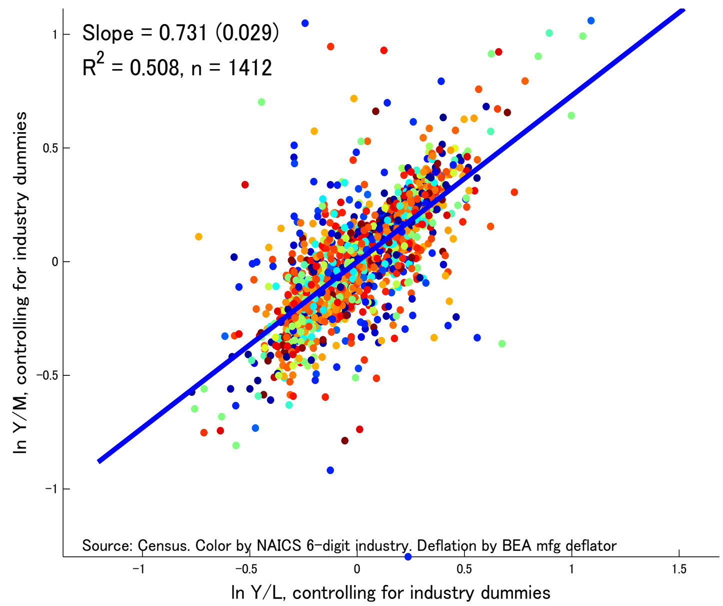

Figure 8: Variation over 1997, 2002, 2007 in revenue per establishment with revenue per worker, within U.S. manufacturing industries

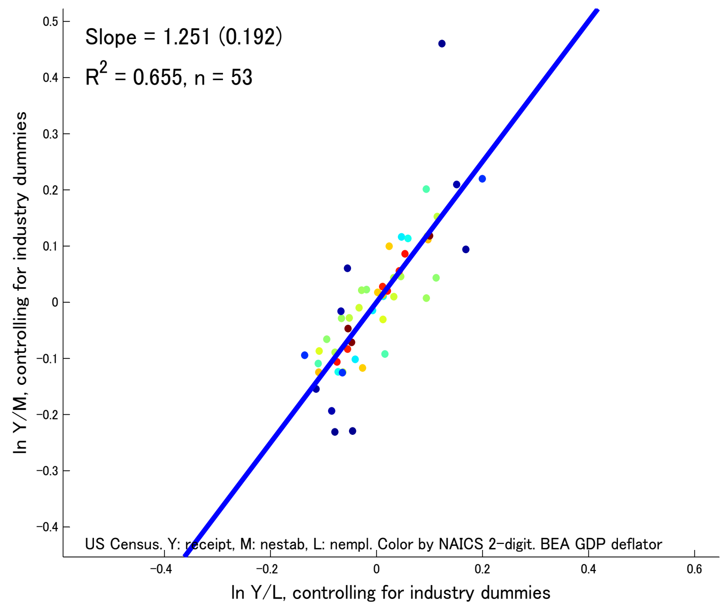

Figure 9: Variation 1997, 2002, 2007 in revenue per establishment with revenue per worker, all U.S. sectors using receipt data

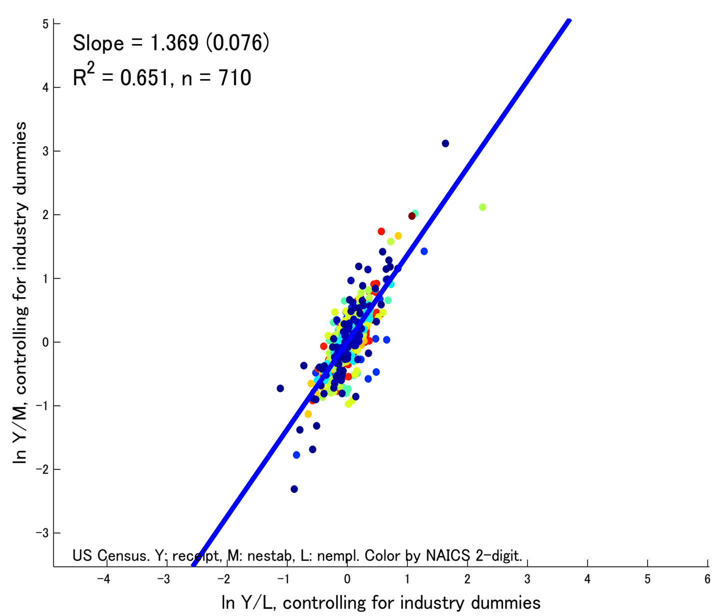

Figure 10: U.S. across states variation in average revenue per establishment with average revenue per worker for all sectors using receipt data

3.3. Across states in the U.S.

Just as we can look across countries, we can look across U.S. states. We have Census data for each state at the 2-digit NAICS level in 2007. Again, the measure of output is receipts. Figure 10 plots the log of output per plant against the log of value added per plant, after removing sector fixed effects. Even within sectors, there are large differences in labor productivity and these are strongly associated with plant size.

4. Competing explanations

4.1. Entry costs

Suppose the zero profit condition holds for entrants as a whole. Then average firm revenue can proxy for entry costs. Thus, one interpretation of our regression results is that entry costs rise sharply with development, and variety expands almost in proportion to the population but only somewhat with productivity. For the model in Section 2, assuming $A_e = A_y^{-\mu} e^{\epsilon}$ and using $\ln Y/M$ to proxy for entry costs, the following relationship holds between observables

$$\ln M = constant + \frac{(\lambda - \mu)(\sigma - 1)}{\sigma - 1 - \mu} \ln \frac{Y}{L} + \frac{\sigma - 1}{\sigma - 1 - \mu} \ln L + \frac{\sigma - 1}{\sigma - 1 - \mu} \epsilon. \quad (14)$$

This is the regression equation 10 we ran in Section 3.

Note that Y/L is endogenous to ϵ — countries with higher idiosyncratic entry costs should have lower variety and hence lower labor productivity. As a result, the coefficients we obtained in the previous section's OLS regressions using (14) should not generate consistent estimates even in this simple model. One can deal with the endogeneity issue by assuming more structure. To this end, suppose that $\epsilon \perp \ln A_y$ and $\epsilon \perp \ln L$. i.e., suppose that idiosyncratic entry costs are orthogonal to both the production technology and population in a country. We impose $\lambda \in [0, 1]$ so that the share of goods and labor in entry are nonnegative.

Table 2: Estimating μ and λ using cross country data

Identifying restrictions	$\hat{\lambda}$	$\hat{\mu}$	$\hat{\lambda} - \hat{\mu}$ (amplification)
$\epsilon \perp \ln A_y, \epsilon \perp \ln L$	0	0.041	-0.041
$\epsilon \perp \ln A_y, \epsilon \perp \ln L, \mu = 0$	0	0	0
$\epsilon \perp \ln A_y, \mu = 0$	0.016	0	0.016
	(0.144)		
$\epsilon \perp \ln A_y, \epsilon \perp \ln L, \lambda = 1$	1	0.706	0.294
		(0.125)	
$\epsilon \perp \ln A_y, \lambda = 1$	1	0.779	0.221
		(0.117)	

Note: standard errors are heteroskedasticity robust. Estimates of λ without standard errors are cases when the estimate is at its lower bound of 0.

Table 2 displays the results of GMM estimation using these moment restrictions. The first row shows that $\lambda \geq 0$ is binding, and we obtain a small point estimate for μ when we impose $\lambda = 0$. The implication is that entry requires labor, so that entry costs increase with the real wage but not directly because of the production technology.

If we impose $\mu = 0$, we find that λ continues to be at the zero lower bound. With a single parameter to estimate, we can also relax one of the moment restrictions. When we no longer assume employment is orthogonal to idiosyncratic entry costs, we get a small positive λ. We still get $\lambda - \mu \approx 0$, which implies little variety expansion in response to better production technology.

We can alternatively impose $\lambda = 1$. We then estimate a μ between 0.7 and

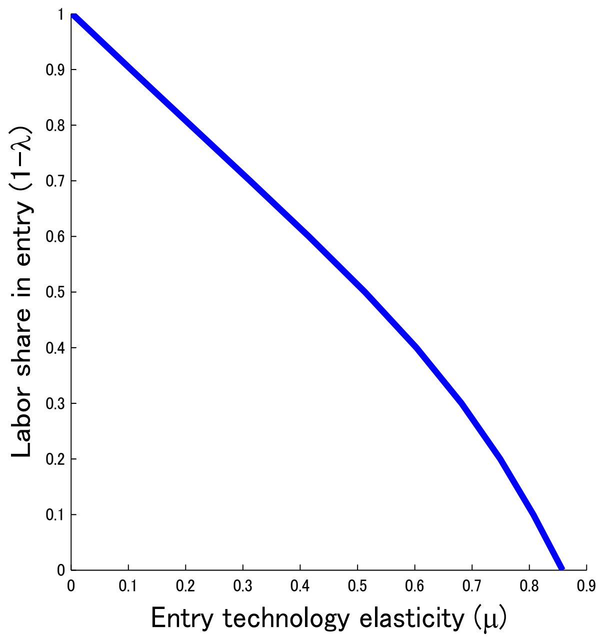

Figure 11: Combinations of $(1-\lambda, \mu)$ from GMM estimation.

0.8, depending on whether we impose both moment restrictions or only one. If entry uses output rather than labor ($\lambda = 1$), better technology must be more costly to set up ($\mu \gg 0$). In this case $\lambda - \mu$ is more positive at around 0.25. Still, there is much less amplification than one would get with a fixed level of entry costs denominated in goods (i.e., with $\lambda - \mu = 1$).

We also carried out estimation using only establishment data across countries, since establishments might better proxy for variety. This has little impact on the estimates.

Figure 11 reinforces the point by showing the tradeoff between the labor share in entry costs $(1-\lambda)$ and μ. To fit the cross-country data, we need entry costs to rise with production technology through some combination of requiring more expensive labor ($\lambda < 1$) or requiring more goods ($\mu > 0$) to enter.

Table 3: Required markup variation

Country	Required markup when $\lambda = 1, \mu = 0$ and U.S. markup is 1.33
India	∞
China	∞
France	1.97
Germany	1.84
UK	1.75
Japan	1.19

4.2. Markups

Suppose entry costs are the same across countries but the price/cost markup varies. In the model of Section 2,

$$\frac{Y}{M}_{rich} - \frac{Y}{M}_{poor} = (\sigma_{rich} - \sigma_{poor})p_e.$$

Richer economies could have larger firms because of lower markups rather than higher entry costs. Bresnahan and Reiss (1991) famously found that firms are bigger in more densely populated areas in the U.S., and and argued it was because markups dropped with the number of competitors. Melitz and Ottaviano (2008) and Edmond et al. (2012) make a similar argument in trade models.

It is unlikely, however, that markup variation is large enough to explain our regression results. Under the assumption that entry costs are uniform across countries, we have

$$\frac{Y}{M}_{US} \Big/ \frac{Y}{M}_{j} = \sigma_{US} / \sigma_j \, .$$

Using $\sigma_{US} = 4$ from Broda and Weinstein (2006) we can compute the markup $\sigma/(\sigma - 1)$ that is required to explain average value added per firm in each country. Table 3 displays the computed markup for selected countries. Markups would have to be infinite in places like China and India, where value added per firm is much smaller than the U.S. If entry costs were the same in China and India as in the U.S., then essentially all of output would have to be devoted to covering entry costs for firms to make zero profits. This would leave no resources left for consumption and investment. De Loecker et al. (2012) estimate much more modest markups in India – a median markup of 1.04 and mean markup of 1.67. Even in other rich countries, such as France, Germany and U.K., the Table shows that markups would have to be more than double the level in the U.S.

4.3. Discount rates

In a dynamic model, entry costs should equal the present discounted value of profits. So an alternative explanation is that firms in richer countries have higher discount rates. Higher discount rates would require firms to have larger profits and value added, since the profit flow is discounted more heavily.

We do not, however, see significantly higher interest rates with development. For example, Caselli and Feyrer (2007) report an average return to capital of 8.4% for rich countries and 6.9% for poor countries. Based on levels of financial development, the more common assumption is that firms are more financially constrained in developing countries, not developed ones.

4.4. Exit rates

Similar to discounting, a higher exit rate in richer countries is another candidate explanation for our regression results. Firms need to earn bigger profits while they are operating if they exit at a higher rate. Table 4 displays the exit rate required for selected countries to match the cross country evidence if entry costs do not differ across countries and the U.S. exit rate is 10%. The exit rate would have to be one-half the U.S. level in France, Germany and the U.K., and even lower in places like China and India. Japan would need a 50% higher exit rate than the U.S. to explain why Japanese firms are so big.

Table 4: Required exit rate variation

Country	Required exit rate when $\lambda = 1, \mu = 0$, U.S. exit rate = 10%
India	2%
China	1%
Portugal	2%
France	5%
Germany	5%
UK	6%
Japan	15%

There is no evidence to corroborate these predictions. Scarpetta et al. (2002) constructed comparable firm-level data for a subset of OECD countries and concluded that the average annual turnover rate over 1989–1994 did not differ much between U.S. and Europe. Hsieh and Klenow (2012) report a similar exit rate for India and the U.S. And Japanese exit rates are actually one-half as large as the U.S.

4.5. Growth rates

If incumbent firms grow more quickly in rich countries, then the average firm would need to be bigger in rich economies. The more profits are back-loaded, the lower their discounted value, so recovering the same entry costs would require firms to be bigger. Hsieh and Klenow (2012) find incumbents do grow much faster in the U.S. than in India and Mexico. But the U.S. seems to be an outlier in this regard, judging from evidence on other countries in Scarpetta et al. (2002) and for four more countries documented by Hsieh and Klenow (2012).

4.6. Measurement error in output

The strong positive relationship we find between value added per plant and value added per worker across time and space could be an artefact of measurement error in value added. In Section 3 we showed that the results extend to looking only at OECD countries, over time in the U.S., and across states. Measurement error should be less of a concern in these samples.

4.7. Labor share in goods production

Production uses capital, not just labor, so value added per worker may not be a good proxy for the real wage and the cost of labor used for entry. We could be overestimating the elasticity of entry costs with the real wage because the real wage does not vary in proportion to value added. Rich countries would need to have higher labor shares. We entertained this possibility by controlling for labor share using the values from Caselli and Feyrer (2007). We find that our slope estimates are robust to this.

5. Conclusion

In manufacturing, output per plant (or firm) increases sharply with output per worker. This is true across countries inside and outside the OECD, over time in the U.S., and across states in the U.S. It is true within industries, not just across them. Richer places have more plants (and firms) per worker, but the number of businesses is more closely tied to the number of workers.

These facts can be explained by a model in which entry costs rise with labor productivity. Higher ex ante entry costs require higher ex post profits for the zero profit condition to hold. Higher revenue per firm raises profits per firm, for given markups. Entry costs can rise with productivity for multiple reasons. First, if entry is labor-intensive than higher wages that go along with higher labor productivity raise the cost of entry. Second, the costs of setting up operations could be increasing with the level of technology, worker skill, or physical capital per worker. We leave it for future research to try to distinguish between these explanations.

If entry costs rise with development, then policies boosting productivity need not increase the number of firms or plants. The number of such businesses may in turn be connected to the number of specialized varieties available to local producers and consumers. If so, then our results that productivity-enhancing policies do not provide an indirect boost to welfare through variety.

We draw out several implications for growth and trade models. First, if the choice is between denominating entry costs in terms of labor or output, the empirically realistic choice is fixed entry costs in terms of labor. Labor costs rise with real wages, which in turn increase with labor productivity. Second, we empirically corroborate the common assumption in endogenous growth modeling that the cost of innovation rises with the level of technology attained. Third, growth appears more associated with climbing quality ladders than with expanding varieties.

We add an important qualifier to these conclusions: varieties per firm or per establishment may vary with the level of development. This would be useful to explore empirically, perhaps more easily within countries over time than across countries.

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