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Firm Size Evolution and Outsourcing

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Abstract

This paper sheds new light on forces shaping the outsourcing decision by linking the decision to a certain form of non-linearity in overhead costs which divides a firm's operation into small and large regimes. Marginal firms that find evolution into a large business too costly outsource in a bid to grow out of bounds instead of expanding internally. This process leads to a lumpy relationship between size and outsourcing, in which outsourcing is only practiced by narrow set of firms in the middle of the distribution. The theoretical implication for size distribution is a bunching of firms at the size where the transition to large regime takes place with a missing middle immediately following it. A panel of Australian small and medium-size firms is used to put the predictions to test with mostly supportive results. The findings open a new avenue to rethink growth and job creation amongst small businesses.

Keywords: Small Business, Outsourcing, Management Organization, Size Distribution.

JEL Code: C38, D2, L24, L6.

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1 Introduction

Firms adopt different vertical structures even within narrowly defined industries. In an influential work, Antras & Helpman (2004) make very broad predictions regarding the role of productivity as a determining factor, in which only the least productive firms outsource to domestic suppliers, while more productive firms either integrate or offshore outsource. In this paper, I focus on small and medium enterprises (SME) and reveal some details about their outsourcing habits that are neglected in the big picture of Antras & Helpman (2004).

One interesting peculiarity of SMEs is that the relationship between the number of managers and the size of firm is piecewise linear: small firms do not hire any managers, whereas medium-size firms hire a management team with a size almost proportional to their total. Again focusing on SMEs, outsourcing among firms of such small scale seems to be far from the framework of incomplete contracts which is the basis for the results of Antras & Helpman (2004) and more inline with the outsourcing of tasks with low asset specificity as outlined by Riordan & Williamson (1985) and Lileeva & Van Biesebroeck (2008). Putting the two ingredients together, the main conclusion is that outsourcing among the SMEs is lumpy and is only practiced by firms in a narrow range of sizes that are holding off growth lest evolving into a medium-size business is too costly. Outsourcing helps these firms scale up their operation without adding to the number of workers but by expanding their network of suppliers and contractors.

In my theoretical approach, there is a limit ϖ to an owner's sphere of control, beyond which the owner needs the assistance of extra managers or the production will break down as a result of workers shirking. In view of the empirical evidence that I will present, I choose the number of managers to vary linearly with the employment size when the number of employees requiring supervision exceeds ϖ. This functional form effectively divides the operation range of firms into small and large size regimes and designates ϖ as the evolution (transition) point. Evolving into a large firm additionally incurs a sunk cost of reorganization.

I then embed the above novelties into a model of monopolistic competition with firms differentiated by their productivities, where production requires two tasks, namely, manufacturing and support services (which can also be interpreted as parts manufacturing). In this context, manufacturing is taken to be asset specific, whereas services are fairly generic with low levels of asset specificity. The decision to outsource, hence, lies with the subcontracting of services. To an outsourcing firm, the strategy leads to cost savings as well as freeing up internal administrative resources for manufacturing.

The main theoretical result is that a set of marginal firms not efficient enough to absorb the anticipated costs of size evolution bunch at ϖ and outsource services instead. As a result, the relationship between size (productivity) and outsourcing is lumpy, and only a narrow set of marginal firms in the middle of the size or productivity distribution outsource, while smaller and larger firms integrate in different size regimes. The bunching of firms further implies that the distribution of size should exhibit a missing middle in equilibrium.

These prediction are then put to test using Australian firm-level data. The use of Australian data offers certain benefits for this study. Most importantly, the focus of the data on SMEs assures that evolution from no management to a management organization is the single major event and easily detected. Also, the extent of offshore outsourcing in Australia during the period covered by data has been shown to be very small even among large firms (partly because Australia is a remote country and does not share any land-borders), hence the distortion and biases introduced by offshore outsourcing are minimized. Finally, the data provides a wealth of information that proves crucial in defining the aforementioned marginal firms.

In the empirical phase, I focus on the marginal firms by constructing through mixture modeling a fuzzy indicator of ϖ. The fuzziness of this instrument reflects the fact that owners have different management abilities, so that ϖ is in reality better represented by a distribution. The application of the constructed instrument in a few econometric exercises reveals that marginal firms that lack any intention to grow (as a proxy for long-term behavior) are at least 5% likelier to outsource than firms of any other size. Those marginal firms with intentions to significantly grow (termed as transitioning firms, since they are still growing) are not directly addressed by the model, and they are not any more keen on outsourcing than larger or smaller firms. I also show that the ranking of firms by size class is almost identically projected onto the ranking among their productivities, so the size implications can equally be interpreted with productivity.

Finally, treating the size transitions as a Markov process and computing the steady-state distributions of size, I am able to detect a major bunching at around the size of 20 employees by the outsourcing firms. This finding fulfills the theory's prediction that outsourcing among the SMEs is with the ultimate goal of size bunching at ϖ, with ϖ duly set to 20. In contrast, the steady-state size distribution of firms that never outsource in the panel looks more conventional with a falling upper tail.

This paper is the first economic work to formulate an evolutionary picture of size growth and identify the transitioning empirically. There has been scant attention to the bunching behavior but purely within a regulatory context. Sneeringer & Key (2011) document a size bunching of hog-farms in response to the U.S. government's policy in penalizing large farms for causing excessive pollution. Dharmapala et al. (2011) use tax devices in a theoretical model to create a size distribution in which firms bunch either in small or large size with no firm choosing the middle sizes. Both papers rely on the assumption that the size thresholds are exactly known. In addition, they use government regulations to artificially generate the bunching behavior. This work makes itself distinct from those papers in two important aspects: 1) it talks about an inherent bunching among firms even in the absence of all taxes and regulations, and 2) it leaves the location of bunching a matter of search.

The rest of the paper is organized as follows: the next section motivates the topic using an organizational view of a firm's operation. Section 3 sets up the theory and makes predictions about the firms' choices of size and organizational structure. Section 4 describes the Australian Business Longitudinal Survey as the main source of data for the study and introduces the battery of measures used in the empirical exercises. Section 5 identifies the marginal firms and tests the main theoretical predictions through various econometric exercises. Conclusion follows afterwards.

2 The Conceptual Framework

The need to distinguish between small and large businesses in economic studies has been discussed at least as early as Storey (1989), where he despairs that

> "In almost all theoretical and empirical works ... firm size is viewed as a continuum, with large firms at one end of the spectrum. ... small firms are viewed as a 'scaled-down' version at the other end of the size spectrum."

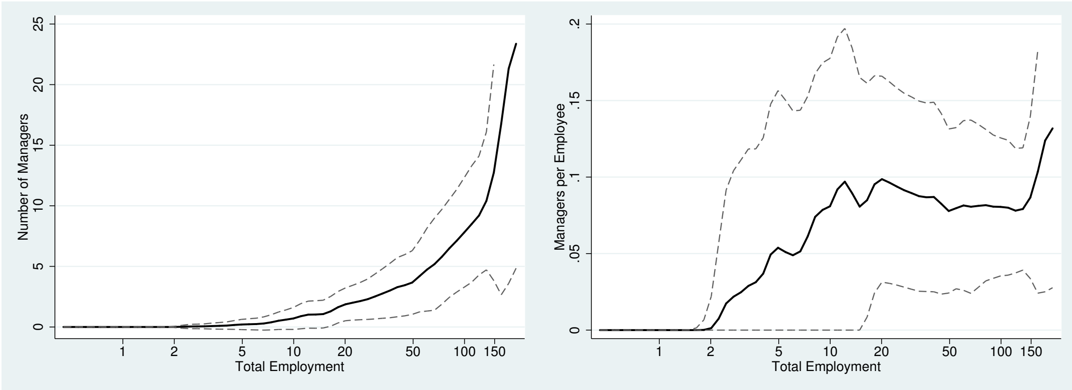
There are indeed qualitative distinctions in performance and organization between small and large firms; see Acs & Audretsch (1988), Storey (1989), and Haltiwanger et.al (2010) for instance. An existing body of business and management studies also points to discrete stages of evolution as a firm grows (Churchill & Lewis, 1983; Garnsey, 1998; Greiner, 1998).

To make this distinction, I appeal to the piecewise properties of the relationship between the number of managers and employees among the SMEs. There is an organizational explanation of what one would expect: in small scales, a firm has an owner who manages the entire operation of the firm all by herself. As the firm grows, it adds to its number of employees, but also expands in other dimensions such as the range of tasks and activities undertaken in-house and the number of locations. The owner's bounded rationality, however, only allows for a finite sphere of control (Williamson, 1975, c.2), so that, accounting for differences in abilities, the owner of firm j can effectively manage a maximum of ω_j employees. When the number of employees exceeds ω_j, a new management order must take over. At this stage, employees are divided into teams and divisions, and managers are appointed to oversee the performance of each group of workers, otherwise free-riding problems arise hurting the productivity and performance of the firm (Alchian & Demsetz, 1972). With further growth, another level of management is needed to oversee the performance of lower tier managers and also for coordination purposes. Optimally, a positive relation develops between the number of managers and employment size (Williamson, 1967). In brief, one would be looking at the following relationship between the number of managers and employees

$$MAN(EMP) = \max\Big\{f(EMP) - f(\varpi), 0\Big\}, \tag{1}$$

where ϖ aggregates the information in ω_js. Function $f(.)$ is increasing and weakly concave to reflect that overhead cost grows by employment size but not at such a rate to impede growth beyond a certain size. For Australian manufacturing firms, this relationship is illustrated in Figure 1(a) on a log scale. Panel (b), in particular, suggests that $f(.)$ can reasonably be approximated by a linear function.

The network of managers and the supporting administrators, though necessary, is expensive. This rise in overhead cost can completely wipe out a firm's increase in revenue. Especially, relation (1) suggests a dramatic rise in variable costs when firms operate beyond ϖ. Besides,



(a) (b)

Figure 1: The average number of managers (a) per firm, and (b) per employee per firm in Australia. Dashed lines are the one standard deviation range. $E[X|EMP]$ and $E[X^2|EMP]$ are estimated using kernel regressions with Gaussian kernels of bandwidth 0.2 for log-employment. The number of managers excludes owners. The sample and the measurement of size is described in the data section.

firms have to incur a cost of searching for the managers and reorganizing the firm's administration.[1] Only the most productive firms in an industry are poised to absorb these costs. The firms unable to absorb the expected costs bunch at ϖ. These marginal firms mature as small businesses and resort to outsourcing as an alternative to growing but out of boundary.

In characterizing the outsourcing decision, I also make a break from the current line of theoretical works such as Grossman & Hart (1986) and its application in Grossman & Helpman (2002). In these theories assets are fully specific, which paves the way for long-term and incomplete contracts. Instead, I assume that there are two types of jobs in a firm: jobs with high asset-specificity pertaining to manufacturing, and jobs with low asset specificity pertaining to support services or generic input parts. Riordan & Williamson (1985) in theory and Lileeva & Van Biesebroeck (2008) empirically show that outsourcing should and indeed does happen where assets are not very specific. Only when the firm gets so large that the transaction cost of internally administering asset specific inputs exceeds that of the arms-length trade is outsourcing of these tasks recommended (Williamson, 1975, c.7). Focusing on SMEs, I treat outsourcing as a cost-saving venture, where suppliers are abundant, short-

[1]There is some evidence for the presence of sunk costs in the transition described. Over the recent years, Commercialisation Australia (`www.commercialisationaustralia.gov.au`) has been offering eligible small businesses a grant of up to $350,000 over a 24 month period to cover their costs of searching and appointing their first executive officer. The grant is supposed to push small businesses over the tipping point and lead to job creation.

term contracts are preferred, and a firm is able and willing to assume the recurring cost of customization by suppliers. The ease of switching suppliers forces suppliers to consider business reputation as their central strategy and avoid opportunistic behavior.

3 Theoretical Setup

Industry is composed of a continuum of firms each producing a distinct variety of a consumption good and competing monopolistically. The representative consumer has a CES utility over the range of these varieties. Grossman & Helpman (2002) show that in such environment, each firm faces the inverse demand function $p = Ay^{\alpha-1}$, in which p and y are price and output, A is an industry-wide demand shifter taken as given by a firm, and $\alpha \in (0, 1)$. Parameter α controls the elasticity of substitution between any two varieties by setting it to $1/(1 - \alpha)$.

Firms are differentiated in their level of productivity, denoted by $\theta \in [0, \infty)$. The production of output takes two inputs, namely, manufacturing and service workers. Output is produced according to the constant returns production function

$$y = \theta \min\left\{m, \eta s\right\}, \qquad \eta > 0. \tag{2}$$

In the production function, m is the number of manufacturing workers in a firm, and s is the number of service workers whose contributions sustain the production environment, e.g., by maintaining machinery or keeping the work environment sanitary. Although termed as services, s can equally be interpreted as the supply of a generic part. Each unit of service staff provides η units of support to manufacturing. To simplify presentation, the innocuous scaling $\phi = \theta^{\frac{\alpha}{1-\alpha}}$ is applied, and ϕ is treated as a firm's productivity henceforth. All manufacturing and service workers are assumed low skill and their wages are normalized to one.

Besides workers, firms have to hire a number of managers to keep their workers sufficiently monitored. Let the number of managers be determined from

$$F(m + s) = \max\left\{f(m + s - \varpi), 0\right\}, \quad 1 > f > 0, \tag{3}$$

in which ϖ is the maximum sphere of control an owner can exercise by herself. The size ϖ

effectively divides the operating size of firms into small and large regimes, where transition takes effect at ϖ. f is the number of managers required per worker to keep the firm productive in large regime; otherwise, workers are left insufficiently monitored and their efforts plunge to zero, resulting in zero production. The management wage is also exogenously fixed at $w_f > 1$. The operation of firms and the rent that accrues in each regime are described below.

3.1 Small Integrated Firm

When operating in small regime, a firm's profit function is written as

$$\pi_S(m, s, \phi) = Ay(m, s, \phi)^\alpha - m - s.$$

This option can be taken regardless of productivity level but by confining total size to ϖ. The optimal firm's profit is then the solution to

$$\pi_S(\phi) = \max_{m,s} \ \pi_S(m, s, \phi), \qquad \text{subject to } m + s \leq \varpi \text{ and (2).}$$

Writing the first-order condition and noting that optimality demands that $m = \eta s$, the manufacturing size of a ϕ-type firm in small regime is found as

$$m_S(\phi) = \min\left\{ \left(\alpha A \eta_m\right)^{\frac{1}{1-\alpha}} \phi, \eta_m \varpi \right\}, \tag{4}$$

where $\eta_m = \eta/(1 + \eta) \in (0, 1)$ is the share of manufacturing labor from the total. See Appendix A for the details of derivations. The expression for optimal profit in this regime is

$$\pi_S(\phi) = \begin{cases} \Pi\phi, & \phi < \bar{\phi}, \\ \Pi\bar{\phi}\left(\frac{(\phi/\bar{\phi})^{1-\alpha} - \alpha}{1-\alpha}\right), & \phi \geq \bar{\phi}, \end{cases} \tag{5}$$

where $\Pi = \frac{1-\alpha}{\alpha\eta_m}(\alpha A \eta_m)^{\frac{1}{1-\alpha}}$ and $\bar{\phi} = \frac{(1-\alpha)\varpi}{\alpha\Pi}$. In the current context, $\bar{\phi}$ corresponds to the productivity level at which the size constrain becomes binding.

A look at (5) shows that the profit curve becomes flatter for $\phi > \bar{\phi}$ as α gets closer to one. To make matter more interesting, the assumption is built into the model.

Assumption 1 *Let* $\alpha > \frac{1}{2}$.

The assumption, though seemingly ad hoc, has its empirical ramifications: the estimates of α for the U.S. and Australian manufacturing average around 0.7 and 0.84, respectively.[2]

3.2 The Large Integrated Firm

The size constraint can be overcome by hiring the appropriate number of managers. The large firm maximizes the profit function

$$\pi_L(m, s, \phi) = Ay(m, s, \phi)^\alpha - m - s - w_f f(m + s - \varpi) - c_e.$$

Let the optimal profit of this firm be defined as

$$\pi_L(\phi) = \max_{m,s} \pi_L(m, s, \phi).$$

Note that the solution to this problem is only valid when $m + s \geq \varpi$. Especially, due to an increase in the variable costs in large regime (it is now $1 + w_f f > 1$), the least efficient firm that would optimally choose large regime is $\bar{\bar{\phi}} = (1 + w_f f)^{\frac{1}{1-\alpha}} \bar{\phi} > \bar{\phi}$. Solving the first order condition, now only subject to (2), leads to

$$m_L(\phi) = \left(\frac{\alpha A \eta_m}{1 + w_f f} \right)^{\frac{1}{1-\alpha}} \phi \tag{6}$$

$$\pi_L(\phi) = \Pi\phi(1 + w_f f)^{\frac{-\alpha}{1-\alpha}} + w_f f \varpi - c_e, \quad \phi > \bar{\bar{\phi}}. \tag{7}$$

The total size of a large firm is $(1 + f)(1 + \eta)m_L(e\phi) - f\varpi$, adding up both workers and managers. In the large regime operation is costlier, but profits can grow unboundedly at the linear rate of ϕ, compared to the rate $\phi^{1-\alpha}$ when firms are size constrained. At these rates, the large regime profit will eventually take over the small regime profit as $\phi \to \infty$.

Lemma 1 *When choices are integration in small or large regime only, there exists a threshold productivity $\phi^{(SL)}$ for which firms with $\phi < (\geq)\phi^{(SL)}$ opt for small (large) regime in equilibrium.*

[2]For the U.S., the NBER Manufacturing Database is used to compute industry-level markups by dividing the value of shipment by the sum of wage, material, and energy costs. Assuming monopolistic competition, α is the reciprocal of the ratio. In Australia, the ratio is computed using the value of sales and total labor, material and capital expenses reported in the Business Longitudinal Survey for manufacturing firms.

3.3 The Outsourcing Firm

Outsourcing allows firms to procure services from an open market instead of internally providing them. Purchase of services in an arms-length trade arrangement makes cheaper (lower w) or more specialized (higher η) services or parts available to a firm (Abraham & Taylor, 1996; Dube & Kaplan, 2010). Both cases lead ot a lower price per unit of services. Let the supply market be competitive with an infinite number of suppliers offering services at the cost of $w_o(< 1)$ per unit.

Services are further characterized by low levels of asset specificity.[3] Supplied services need some customization at the cost of c_o that the manufacturer is willing to pay. Since asset specificity is low, c_o is near zero, hence, the manufacturer signs short term contracts with suppliers while also considering switching suppliers at each contract renewal. With a zero chance of a supplier matching with another manufacturer, suppliers have zero outside option and avoid opportunistic behavior in order to get reassigned to the job. In equilibrium, each manufacturer signs one contract with a supplier and renews the contract indefinitely with the same supplier. Therefore, c_o also accounts for the recurring cost of arranging short-term contracts (Coase, 1937) as well as the running costs of administering the supplier (Williamson, 1985, p.21). In this light, let $c_o < w_f$ to reflect that outsourcing fixed costs are cheaper than that of hiring a manager (or the business rather grow internally).

Putting it all together, an outsourcing manufacturer faces the following profit function

$$\pi_S^m(m, s, \phi) = Ay(m, s, \phi)^\alpha - m - w_o s - c_o.$$

An outsourcing manufacturer is assumed to operate in small regime to emphasize the key assumption that outsourcing in this framework is a size control mechanism. Section 3.5 looks at the robustness of the implications with no size constraint on outsourcing firms. The optimal profit of the outsourcing manufacturer is defined as

$$\pi_S^m(\phi) = \max_m \ \pi_S(m, s, \phi), \quad \text{subject to } m \leq \varpi \ , \ s = m/\eta, \text{ and (2).}$$

[3] In a 1994 survey of large Australian manufacturing firms, Benson & Ieronimo (1996) find that the top candidates for outsourcing among large Australian firms are mostly generic tasks such as janitorial, catering, transportation, and maintenance jobs. More recently, Beaumont & Sohal (2004) add IT services to the list.

Solving the above problem determines the size of the manufacturer as

$$m_S^m(\phi) = \min\left\{\left(\alpha A\eta_o\right)^{\frac{1}{1-\alpha}}\phi, \varpi\right\}, \tag{8}$$

in which $\eta_o = \eta/(w_o + \eta) > \eta_m$. Furthermore, the profit that accrues to the manufacturer is

$$\pi_S^m(\phi) = \begin{cases} \Pi\phi(\bar{\phi}_o/\bar{\phi}) - c_o, & \phi < \bar{\phi}_o, \\ \Pi\bar{\phi}_o\left(\frac{(\phi/\bar{\phi}_o)^{1-\alpha}-\alpha}{1-\alpha}\right) - c_o, & \phi \geq \bar{\phi}_o, \end{cases} \tag{9}$$

where $\bar{\phi}_o = (\eta_o/\eta_m)^{\alpha/(1-\alpha)}\bar{\phi} > \bar{\phi}$. Note that the manufacturer is in fact benefiting from the labor provided by $(1+\eta)m_S^m$ workers, which could render such a firm large in operational scope but small in actual size. Also note that in this case profits grow at the rate of $\bar{\phi}_o^\alpha\phi^{1-\alpha}$ for $\phi \to \infty$ which is higher than the rate $\bar{\phi}^\alpha\phi^{1-\alpha}$ when the firm is integrated in small regime.

Lemma 2 *When choices are integration or outsourcing in small regime only, there exists a threshold productivity $\phi^{(S)}$ for which firms with $\phi < (\geq)\phi^{(S)}$ integrate (outsource) in equilibrium.*

In the same way that profits in large regime overtake that of the small regime, large regime operation will also be preferred to outsourcing for large enough ϕ.

Lemma 3 *When choices are outsourcing in small regime and integration in large regime only, there exists a threshold productivity $\phi^{(L)}$ for which firms with $\phi < (\geq)\phi^{(L)}$ outsource (integrate in large regime) in equilibrium.*

3.4 Choice of Size and Organization

The decision is made by comparing the profits from each operation and choosing the one with maximum returns. There is, nonetheless, a taxonomy as to whether $\phi^{(L)} \lesseqgtr \phi^{(S)}$. The resolution boils down to comparing c_o and $c_e - w_f f\varpi$, especially that with $c_o \to \infty$ there are no outsourcing firms. Given the low costs of outsourcing, nevertheless, it is plausible to focus on the case $c_o < c_e - w_f f\varpi$.[4] Figure 2 collates all the profit functions for this case, pointing to the following arrangement of decisions:

[4]One calibration using Australian data gives $w_f \simeq 2$, $f = 0.07$, $\varpi = 20$, $c_e = 6.5$. For the wage estimates, I use ABS Employee Earnings and Hours (Cat.No.6306.0) that reports average managerial and non-managerial

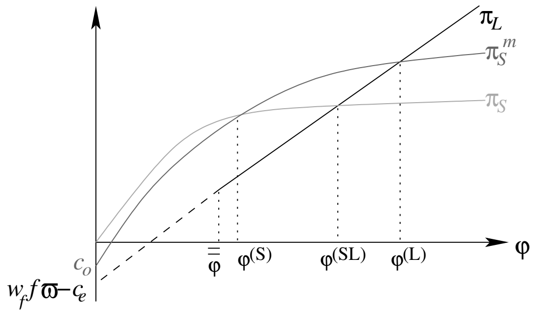


Figure 2: The ranking of profits by size regime and organization.

Proposition 1 *In equilibrium, the outsourcing of service tasks that are low in asset specificity is practiced by firms whose productivities range in the middle of the distribution, or more specifically, firms for which* $\phi \in [\phi^{(S)}, \phi^{(L)}]$.

The most efficient firms anticipate recovering the transaction costs associated with size transition and move in that direction. Firms that stay behind bunch at the size of ϖ. A large fraction of these firms use outsourcing as a vehicle to expand production without expanding internally. To see how outsourcing is acting as a size control mechanism, note that firms belonging to the productivity range $[\phi^{(SL)}, \phi^{(L)}]$ would have chosen large regime operation had they not the chance to outsource (Figure 2). The size distribution of outsourcing firms is also marginal to ϖ.

Proposition 2 *The support for the size distribution of outsourcing firms is* $[m_S^m(\phi^{(S)}), \varpi]$, *with the main mass of the distribution located at* ϖ. *In case* $\phi^{(S)} > \bar{\phi}$, *all the distribution mass is located at* ϖ.

In this model, similar to that of Dharmapala et al. (2011), the distribution of size is missing a middle: small firms have their size capped at ϖ. On the other hand, the smallest of large firms will choose a size larger than ϖ. Choosing a size close to ϖ by a large firm implies that $\phi \simeq \bar{\bar{\phi}} < \phi^{(L)}$, but this firm has already switched to outsourcing and capped its size at ϖ.

Proposition 3 *The support for the long-run size distribution of firms is*

$$[0, \varpi] \cup \Big[(1+f)(1+\eta)m_L(\phi^{(L)}) - f\varpi, \infty\Big),$$

wages over several years. To find c_e, I divided the figure \$350,000 of Commercialization Australia by \$53,600, which is the average non-managerial wage in 2012. For the value of f see Figure 1(b), and for the value of ϖ refer to Section 5.4. Using these numbers: $c_e - w_f f \varpi = 3.7 > w_f < c_o$.

which exhibits a missing middle.

3.5 Outsourcing Among Large Firms

So far, outsourcing was concentrated among small businesses as a size control mechanism, offering the rationale for the low asset specificity of the tasks being outsourced. Outsourcing in the large regime can be accommodated in this model insofar as the size chosen by those large firms is not so large that the low asset specificity assumption is jeopardized. First of all, outsourcing in large regime has two opposing implications in this model: the cost savings of outsourcing encourages expansion, but the overhead cost is likely to catch up with any gains. Let the outsourcing sunk cost for large firms be $c_o^L > c_o$ on the ground that large firms also need larger suppliers or have to contract multiple suppliers in parallel (to be justified shortly by the results). Maximizing the profit function for a large outsourcing firm gives:

$$\pi_L^m(\phi) = \Pi\phi \left(\frac{1/\eta_o + w_f f}{1/\eta_m} \right)^{\frac{-\alpha}{1-\alpha}} + w_f f \varpi - c_e - c_o^L, \quad \phi > \bar{\bar{\phi}}. \tag{10}$$

The intercept in π_L^m is lower than that of π_L in (7), whereas there is ambiguity about whether the slope is steeper or not depending on the values of parameters. Even when the slope of π_L^M is steeper than that of π_L, the outsourcing firms are the largest and the most efficient ones, an immediate contradiction to the assumption that only tasks with low asset specificity are outsourced. At this point, the outsourcing model of Antras & Helpman (2004), with asset specific tasks and incomplete contracts, is a more appropriate representation of the choices made by the firms. In reference to those results, the very large and efficient firms shun domestic outsourcing in favor of integration or offshore outsourcing.

3.6 Evolution as a Stochastic Process

Size evolution is this far treated as a deterministic process, and hiring the appropriate number of managers guaranteed that production would go ahead at a given productivity level. The opening cone in Figure 1(a), nevertheless, suggests that firms might experience evolution differently. An organizational explanation for this stochastic experience hinges on the ability of managers in conveying the intentions of owners to subordinates and finally to workers.

Instructions are often interpreted differently by managers and can be altered by those managers working in self-interest (Robinson, 1934). Subordinates might also misrepresent the truth as a self-promoting strategy (a problem that exacerbates with size) (Williamson, 1975, c.7). Owners only learn about the true level of compromises to be made, in terms of efficiency and control, after having sunk all the costs of searching and installing the managers.

To study the implications of a stochastic evolution on the results, let a firm's productivity be hit by an idiosyncratic shock $e \in [0, 1]$ drawn from the cumulative distribution $H(e)$ and observed after sinking c_e.[5] The perceived profits of a large firm then becomes

$$E\pi_L(\phi) = \Pi E\big[e^{1-\alpha}\big]^{1/(1-\alpha)}\phi(1 + w_f f)^{\frac{-\alpha}{1-\alpha}} + w_f f \varpi - c_e, \quad \phi > \bar{\bar{\phi}}, \tag{11}$$

which has a lower slope than that of (7). Ex ante, firms will adjust their size after realizing e. But, $\pi_L(e\phi)$ is monotonic in e, so there exists a $e^*(\phi)$ such that $e^*(\phi)\phi = \phi^{(L)}$. Firms drawing $e < e^*(\phi)$ find it ex post optimal to quit large regime plans and switch to outsourcing.

Proposition 4 *A fraction $H\big(e^*(\phi)\big)$ of firms that opt for large regime operation, quit evolution and switch to outsourcing. The distribution of these firms has a falling upper tail, or $\partial e^*(\phi)/\partial\phi < 0$.*

Going back to Propositions 1 to 3, there is only one change and that is to Proposition 1: the support for the productivity distribution of outsourcing firms is now extended to $[\phi^{(S)}, \infty]$, with the distribution showing a falling upper tail over the range $[\phi^{(L)}, \infty]$.

4 Data

The source of firm-level data is the Business Longitudinal Survey (BLS) conducted by the Australian Bureau of Statistics (ABS) in four waves over the fiscal years 1994–95 to 1997–98.[6] The data provides detailed information on the performance of Australian firms, at management level rather than physical plants. The data available to researchers is a Confidentialised Unit Record File (CURF), in which a small noise is added to quantitative values. Besides, all

[5] An equivalent way to model this process is to let f be stochastic. The interpretation is that managers are idiosyncratic and firms happening to pick weaker managers also need a larger number of them to realize the full production potentials.

[6] Fiscal year in Australia is from July 1 to June 30 next year.

firms with more than 200 employees are dropped from the data to prevent them from being identified by users.[7] Therefore, the results are to be strictly interpreted as pertaining to the operation of SMEs. The omission has minimal effect on the sample size since the ABS Business Counts (Cat.No.8165.0) report that only about 1% of Australian businesses have more than 200 employees.

The sample for the first wave is about 13,000 firms randomly selected from the Australian Business Register stratified by industry and size and represents several broad industries, such as mining, manufacturing, and services. Each firm is weighted in such a way that the sum of weights within the corresponding industry$\times$size stratum matches the business count. The response rate is about 86%, and the original weights are further adjusted by the ABS to account for non-responses. The ABS keeps about 6,400 of those firms in the continuing (panel) phase of the survey. These firms are additionally stratified by innovation and export status and also growth in sales, and those firms identified as innovators, exporters or showing high growth are oversampled in the panel. The data in each subsequent wave is also supplemented by about 450 new businesses to compensate for attritions. Sample weights for these waves are re-adjusted to match the population totals in the cells that are now additionally stratified by innovation, exports and growth. In view of these changes, I only use the original sample weights from wave 1, so that the estimates are better interpreted as representative. The level of bias introduced by the ABS selection seems to be small, since using a rich set of explanatory variables generates very similar results to those from other independent sources using the US and European data.

The Australian data is in many ways synergic with the theoretical model. For one thing, there are reasons to believe that most of the jobs contracted out during the period have been to domestic suppliers. Most importantly, the scope of the BLS is the SMEs, and the high sunk costs of offshoring inhibit them from aggressively pursuing an offshoring strategy. For instance, Federico (2010) uses a panel of Italian firms during 1989–1997 and finds that only 5% of firms with 10–200 employees are offshoring, while the real proportion would be much lower were firms smaller than 10 included. This claim is confounded with the fact that Australia does not share any land border, and in the absence of the present communication technologies

[7] For the composition of the BLS and the full list of variables see the technical manual ABS Catalogue Number 8141.0.15.001 available from `http://www.abs.gov.au`.

offshoring costs must have been unaffordable to most firms. In the same line, using a 1994 sample of 26 large Australian firms (with an average size of 2,200 employees), Benson & Ieronimo (1996) find that the jobs contracted out by those firms were mostly maintenance, transportation, janitorial, and catering services; all of these jobs are local in nature and cannot be sent overseas. The same finding is also supportive of the view that the subcontracted jobs should be treated as low in asset specificity.

Secondly, the SME nature of the data ensures that size evolution is the single major event in the data (assuming there are more evolution phases as firms transgress into large or mega-large domains), making it easier to isolate and detect the event. Thirdly, the BLS provides detailed information on non-managerial employment as well as the number of managers and working owners. This level of details is crucial for the identification of ϖ. Finally, the BLS provides the prospective business strategies by asking firms to outline their business intentions over the three years following the survey. This latter piece of information is immensely helpful in separating the short-term and long-term implications.

As part of the BLS, in waves 1 to 3 firms report if they contracted out jobs previously done by their own employees (yes–no answer). The contracting out question was not asked in wave 4. An affirmative answer indicates new incidences of jobs being contracted out (incremental outsourcing), while the stock of prior outsourced jobs remains unknown. As a result, there is the implicit assumption that the decision to contract out is independent of the total stock. On the other hand, knowing about incremental outsourcing makes a more concise temporal connection between a firm's status quo and contracting out. More importantly, the contracting out information directly pertains to jobs being sent out, as opposed to other works that use the value of contracts that could change because the price or the quality of input is changing (see for instance Morrison-Paul & Yasar (2009) and Pieri & Zaninotto (2011)).

Since the theoretical results of the previous section hinge on the long-term strategy of firms, I restrict myself to the balanced panel of manufacturing firms (ANZSIC 2x) that appear in all four waves of the panel. Year 1997–98 is included only to study size transitions, since it does not report contracting out. Firms for which valid productivity could not be computed for at least one year are also discarded (the productivity measuring is described below). Some firms in the data are coded as ANZSIC 20 (unknown manufacturing). Assuming industry codes are

ANZSIC	Description	# Firms	% Contracting out 1994–95	1995–96	1996–97
21	Food, Beverages and Tobacco	137	8.8	4.4	7.3
22	Textile, Clothing, Footwear and Leather	105	9.5	10.5	12.4
23	Wood and Paper Products	64	7.8	6.3	4.7
24	Printing, Publishing and Recorded Media	99	13.1	13.1	6.1
25	Petroleum, Coal, and Chemical Products	169	5.9	8.3	6.5
26	Non-metallic Mineral Products	61	8.2	9.8	4.9
27	Metal Products	186	11.8	4.8	7.0
28	Machinery and Equipment	340	14.1	8.8	6.8
29	Miscellaneous Manufacturing	180	12.2	11.1	9.4
2x	Manufacturing	1,341	11.0	8.4	7.4

Table 1: The count of firms by manufacturing subdivisions and the percentage of contracting out firms in the analysis sample.

time invariant, the industry codes reported for the later years are used to assign a possible subdivision. Otherwise, these firms are coded as Miscellaneous Manufacturing (ANZSIC 29). Table 1 reports the composition of the analysis sample.

Measuring Total Employment

The BLS reports the number of full-time and part-time non-managerial employees, the number of managers, and the number of working owners/partners as of the last pay cycle in June 1993 to 1998. I prorate part-time non-managerial numbers by the ratio of part-time to full-time hours obtained from the ABS annual reports on Earnings and Hours (Cat.No.6306.0) to get an equivalent number of full-time employees. The ratios of hours are around 0.44 in most years. The total number of full-time non-managerial employees ($WORK$) is then the sum of full-time and prorated part-time employments. The number of managers (MAN) and working owners (OWN) are reported in absolute counts in 1994–95 but broken into full-time and part-time in the following years. However, part-time managers and owners are a rarity in the data, and less than 3% of firms in the analysis sample report having any part-time managers or owners. In view of these facts, and for consistency across all years, all managers and working owners are assumed engaged on a full-time basis and absolute counts are used in all years. Total employment (EMP) in a firm is thus composed as

$$EMP = WORK + MAN + OWN.$$

For an over-the-year measure, EMP is averaged in two consecutive years.

Measuring Non-managerial Average Wage

An estimate of non-managerial wage proxies for the unskilled wage. The measure is constructed as

$$AWAGE = \frac{WAGES + SUPER + COMP}{WORK + 2(MAN + OWN)},$$

where $WAGES$, $SUPER$, and $COMP$ are wage, superannuation (Australian retirement funds), and worker compensation paid per annum, respectively. The ABS reports on Earnings and Hours (Cat.No.6306.0) indicate that managerial pay is on average about twice as much as that of the non-managerial worker over the years 1994–98. As a proxy for the number of non-managerial workers, the number of managers and owners is thus multiplied by two.[8]

Measuring Total Factor Productivity

To benchmark with other works, I introduce a productivity measure to rank the performance of firms. Production is assumed Cobb-Douglas with Total Factor Productivity (TFP) measured as the residual in

$$y_{ij,t} = \log(TFP_{ij,t}) + \beta_i^l l_{ij,t} + \beta_i^k k_{ij,t},$$

where $y_{ij,t}$ is the log of real value added for firm j in industry i at time t. $l_{ij,t}$ is the log of total employment and $k_{ij,t}$ is the log of real capital. Consistent estimates of β^l and β^k are computed using the two-stage method of Levinsohn & Petrin (2003) applied, by manufacturing subsector, to the full unbalanced panel.[9]

Value added is sales plus change in inventories minus purchase of input and other operational costs. The ABS reported commodity price indexes at two-digit ANZSIC (Cat.No.

[8] In the data, many working owners are being paid handsomely by their own business (especially observed among businesses with zero or one employee), possibly as a strategy to cut business taxes. For this reason, the number of owners is also included as wage earners.

[9] Using only the balanced panel to compute coefficients grossly underestimated the contributions of capital, returning negative β^k for some subsectors.

6412.0) are used to deflate the nominal value added. Capital is the sum of the asset value of plant and machinery and leasing stock. Following Breunig & Wong (2008), leasing stock is set to the reported leasing expenses divided by $(r + \delta)$, where $r = 0.0803$ is the average treasury bond rate over the period July 1994 to June 1998, and $\delta = 0.05$ is the depreciation rate for capital lasting 20 years on average. The nominal value of capital is further deflated by the price index of Machinery and Equipment (ANZSIC 28). The purchase of material deflated by the manufacturing PPI is used as instrument in the method of Levinsohn & Petrin (2003). Finally, the measured TFP is indexed by dividing individual productivities by the total average, so that the productivity of the average firm is set to one.

5 Empirical Findings

Propositions 1 and 2 basically establish that, focusing on SMEs, firms with sizes marginal to ϖ (or productivities corresponding to the same mid-range) and with no way forward outsource. The outsourcing is practiced with the ultimate goal of bunching at the size of ϖ. I will deal with the first part of the statement in Sections 5.2 and 5.3. Testing the second part is left to Section 5.4. Before all, however, I need to find ϖ and specify what constitutes the set of marginal firms as described by the model.

5.1 Transitioning and Marginal Firms

The main implications of the model hinge on a dichotomous notion of size, in which firms are clustered into small and large regimes across ϖ, with the firms at the intersection of the two clusters being the subject of scrutiny. The main obstacle to the analysis is that ϖ is itself unknown and to be discovered. There is a literature on identifying structural breaks in time series that can easily be adapted to this application; see Hansen (1999). I refrain from using these methods and instead turn to fuzzy clustering for two practical reasons: 1) the discussion in Section 2 and the preliminary evidence suggest that ϖ is most likely a fuzzy quantity driven by the extent of heterogeneity in management abilities across owners, and 2) the intersection between the two clusters of small and large firms must have a non-zero measure, so that the features of the marginal firms can be analyzed and statistically tested. Add to that the fact that threshold methods rely on exhaust search and are computationally very intensive, and the fuzzy approach emerges as the preferred choice.

I implement the fuzzy clusters using a mixture modeling. Mixture modeling, in this context, is based on the assumption that the sample of firm–years is randomly drawn from two populations of large and small businesses, and observations from each population are governed by a distinct model of management (McLachlan & Peel, 2000). Each firm–year, a priori, picks the small business model with probability θ and picks the large business model with probability $1 - \theta$. The latent probability, θ, varies with size as:

$$\theta(EMP) = \frac{1}{1 + e^{\gamma_0 + \gamma_1 \log(EMP)}}. \tag{12}$$

The specification reflects the belief that firms with a larger number of employees are less likely to pick the small business model. The non-linear form of the right-hand side is to ensure that probabilities stay within the acceptable range.

The average number of managers in each size class is then determined from

$$\textbf{Small:}\ MAN = a_{S,0} + a_{S,1} EMP + \epsilon, \tag{13}$$

$$\epsilon\ i.i.d., \qquad f_S(\epsilon) = \frac{1}{\sqrt{2\pi}\sigma_S} e^{-\frac{1}{2}\left(\frac{\epsilon}{\sigma_S}\right)^2},$$

$$\textbf{Large:}\ MAN = a_{L,0} + a_{L,1} EMP + b_{L,1} PART + b_{L,2} log(NLOC) + \eta \tag{14}$$

$$\eta\ i.i.d., \qquad f_L(\eta) = \frac{1}{\sqrt{2\pi}\sigma_L} e^{-\frac{1}{2}\left(\frac{\eta}{\sigma_L}\right)^2}.$$

Subscripts S and L stand for small and large, respectively. The number of business locations ($NLOC$) and the proportion of part-time workers from the total ($PART$) are included as possible influences on the number of managers in large businesses. The large-business model is also controlled for the industry of operation to absorb any differences in the coordination of industry-specific tasks. Small firms, on the other hand, are dominantly single-location and hire no managers. Therefore, no additional effects, other than employment size, are included in (13). The parameters are estimated by maximizing the following likelihood function:

$$\log(\mathcal{L}) = \sum_{j,t} \log\Big(\theta(EMP_{j,t}) f_S(\epsilon_{j,t}) + \big(1 - \theta(EMP_{j,t})\big) f_L(\eta_{j,t})\Big), \tag{15}$$

	Small	Large	θ
Constant	-0.035*	-0.231	3.527***
	(0.059)	(0.320)	(0.169)
EMP	0.034***	0.077***	-0.223***
	(0.004)	(0.005)	(0.015)
$PART$		1.474***	
		(0.337)	
$Log(NLOC)$		0.959***	
		(0.168)	
σ	0.342***	3.300***	
	(0.017)	(0.220)	
Industry Effect	No	Yes	No
Log Likelihood		-7208.0	
# Firm–years		4,023	

Table 2: The estimated two-component mixture model for the classification of firm size into small and large. The numbers in parentheses are robust standard errors. * and *** indicate significances at 10% and 1% levels, respectively.

in which (j, t) indexes a firm–year. Table 2 lists the estimated parameters pooling all firm-years in the analysis sample. The estimated model is especially capable of closely approximating the relationship over the observed range (Figure 3(a)). Applying the Bayes rule, the posterior probability that firm–year (j, t) picked the small business model is

$$P^S_{j,t} = \frac{\hat{\theta}(EMP_{j,t}) f_S(\hat{\epsilon}_{j,t})}{\hat{\theta}(EMP_{j,t}) f_S(\hat{\epsilon}_{j,t}) + \big(1 - \hat{\theta}(EMP_{j,t})\big) f_L(\hat{\eta}_{j,t})}. \tag{16}$$

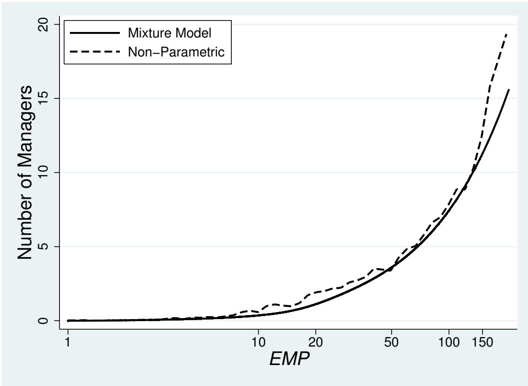
Borrowing from Zadeh (1965), I define the intersection between the two classes of firms as

$$P^{S\cap L}_{j,t} = 2 \min\big(P^S_{j,t}, 1 - P^S_{j,t}\big). \tag{17}$$

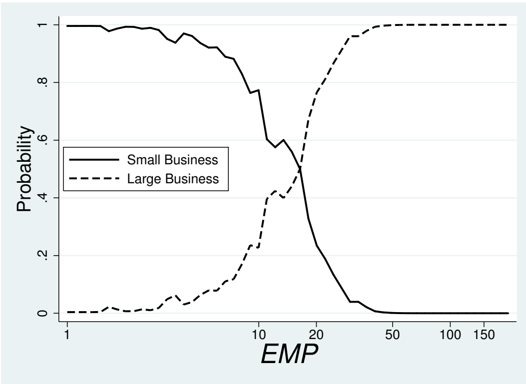
The above definition assigns higher probabilities when a firm is equally associated with either of business models and is maximum when $P^S = 0.5$. Multiplication by two is merely a normalization.

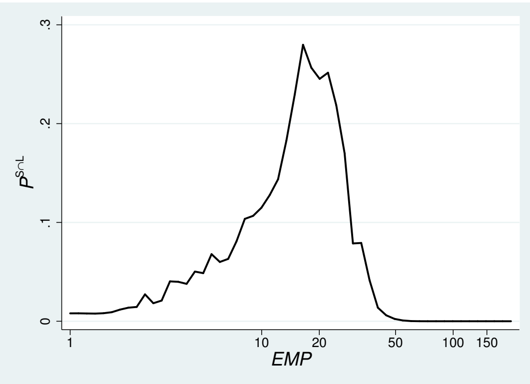
The average probability of being in transition is shown in Figure 3(c), estimated by a kernel regression.[10] Note that the prediction of $P^{S\cap L}$ is driven by both observed and unobserved firm effects besides employment size, causing firms of the same size to be assigned different

[10]The ABS demands discretion in disclosing results, and scatter plots are not permitted to be made publicly available lest individual observations can be identified.



(a)





(b) (c)

Figure 3: (a) The quality of fit by mixture model (solid line) compared to the non-parametric estimate of the relation (dashed line). (b) The average probabilities of small or large business. (c) The average probability of intersection area. Averages computed using kernel regressions with Gaussian kernel and a bandwidth of 0.05 for log employment. All results use the analysis sample of 4,023 firm-years from the BLS.

transition probabilities. The level of noise is particularly higher in the intersection area, which explains why the peak of average probability does not reach one. However, the general features of $P^{S \cap L}$ match the expectations.

The main argument of the theory is static and addresses only the long-term behavior of firms, whereas the definition of intersection is rather dynamic and also includes those firms that are still growing as they transition into a large firm. To make a better distinction between the short and long-term presence in the intersection area, I rely on the answer to the following survey question from the BLS:

During the next three years, does this business intend to significantly increase

Firm Class	1994–95 $\sum P$	1994–95 Average EMP	1995–96 $\sum P$	1995–96 Average EMP	All $\sum P$	All Average EMP
Small	593.5	7.7	576.1	7.9	1169.6	7.8
Small∩Large	123.0	17.1	116.2	17.4	239.1	17.2
Marginal 1	58.4	16.3	60.3	17.4	118.7	16.8
Marginal 2	43.7	16.7	36.2	17.3	79.8	17.0
Large	747.5	47.9	764.9	49.3	1512.5	48.6

Table 3: The (fuzzy) count of firms and the weighted average size by different classes of firms.

production? (yes/no)

Considering no growth intentions for three years into the future as long-term, I define the set of marginal (M) firms and the corresponding set of transitioning (T) firms as

M1: $P^{M1}_{j,t} = P^{S\cap L}_{j,t}$ if firm–year (j,t) has *no intention* to increase production significantly over $t+1$ to $t+3$, and zero otherwise.

T1: $P^{T1}_{j,t} = P^{S\cap L}_{j,t}$ if firm–year (j,t) has *the intention* to increase production significantly over $t+1$ to $t+3$, and zero otherwise.

The two sets of marginal and transitioning firms by definition partition the set $S \cap L$ into two mutually exclusive sets. I also define a stricter version of the above by requiring firms to have shown some growth in the prior period.

M2: $P^{M2}_{j,t} = P^{S\cap L}_{j,t}$ if firm–year (j,t) has *no intention* to increase production significantly over $t+1$ to $t+3$, and total employment grew from $t-1$ to t. $P^{M2}_{j,t}$ is zero otherwise.

T2: $P^{T2}_{j,t} = P^{S\cap L}_{j,t}$ if firm–year (j,t) has *the intention* to increase production significantly over $t+1$ to $t+3$, and total employment grew from $t-1$ to t. $P^{T2}_{j,t}$ is zero otherwise.

The last definition is consonant to the recent incidences of firms choosing the marginal status and can be a test for the timing of outsourcing. The two definitions will occasionally be referred to as type 1 or type 2 marginal (or transitioning) in the remaining. Table 3 reports the sum of probabilities (i.e. the fuzzy number of firms) and the average employment size of firms (weighted by sample weights and classification probabilities) in each size class.

5.2 Marginal Firms and Outsourcing

The goal of this section is to detect a lumpy relationship between size and outsourcing, one that briefly surges among the marginal firms and decays among small and large firms. It should be clear by now that the clustering of the last section serves not only to identify which firms can be potentially marginal, but also as a device to effectively pinpoint the sudden surge in contracting out. With a continuous size variable such as the log of employment, as is the case in all other economic works, it is not possible to observe a lump. Higher order terms help to provide evidence for a lump (given the high-order terms are not collecting noise) but cannot pinpoint its location. For comparison, I will appeal to both approaches by modeling the latent incentive level of a firm to contract out at time $t+1$ in the following forms, one using the continuous size variable and the other using the fuzzy indicators:

$$COUT^*_{ji,t+1} = a_0 + a_1 \log(EMP_t) + a_2 \log(EMP_t)^2 + X'_{j,t}b + \epsilon_{jit}, \tag{18a}$$

$$COUT^*_{ji,t+1} = a'_0 + a'_1 P^S_{ijt} + a'_2 P^T_{jit} + a'_3 P^M_{jit} + X'_{j,t}b' + \epsilon'_{jit}. \tag{18b}$$

in both specifications $COUT^*$ is the latent drive for firm j in industry i at time $t+1$ to contract out. The lagged model mitigates endogeneity issues. In the above specification, X is a vector of time t covariates that also influence the contracting out decision. Specification (18a) uses a quadratic function of log employment to detect a non-monotonic picture. In specification (18b), size is represented by the fuzzy instruments for small, transitioning and marginal firms, leaving out large firms as the control group. Transitioning and marginal firms could be either jointly type 1 or type 2. The probability that the firm chooses to contract out in each case conditional on its time t characteristics is then a probit transformation of $COUT^*$:

$$Prob[COUT_{ij,t+1}|t] = \Phi(COUT^*_{ij,t+1}),$$

where $\Phi(.)$ is the standard normal cumulative distribution.

The set of controls used in (18) primarily consists of recent contracting out experience, $COUT_t$, and productivity, TFP. Following Abraham & Taylor (1996), I also include controls for average non-managerial wage and union membership. Union membership is represented by two dummies indicating 25-50% ($UNION25$) and more than 50% ($UNION50$) membership

	1st Decile	1st Qrtl.	Median	3rd Qrtl.	9th Decile	Mean	Std.Dev.
MAN	0	0	0	1.0	3.0	1.14	2.93
EMP	2.0	3.0	6.0	13.6	35.7	15.0	25.0
TFP	0.26	0.47	0.77	1.21	1.77	1.00	1.05
$AWAGE$ ($000)	4.24	11.5	20.9	28.7	37.0	21.1	12.9
$NLOCS$	1	1	1	1	2	1.23	0.98

	$COUT = 1$	$UNION25 = 1$	$UNION50 = 1$	Total
Counts	359	287	474	2,682

Table 4: Table of weighted simple statistics for the measured variables and with the analysis sample of 4,023 firm–years from the BLS.

	EMP	MAN	TFP	$COUT$	$AWAGES$	$NLOCS$
MAN	0.767					
TFP	0.571	0.490				
$COUT$	0.057	0.053	0.032			
$AWAGES$	0.420	0.350	0.549	0.043		
$NLOCS$	0.411	0.422	0.240	0.060	0.174	
$UNION25$	0.159	0.142	0.093	0.008	0.130	0.064
$UNION50$	0.342	0.201	0.224	-0.011	0.230	0.080

Table 5: Table of weighted correlations among the covariates. Using 4,023 firm–years from the analysis sample.

among a firm's employees. Average wage is measured as $\log(1+AWAGES)$.[11] Another control is the log number of business locations, $\log(NLOCS)$: more segmented operation aggravates the costs of internal administration, and in view of Williamson (1975, c.7) the increasing complexity of operation is conducive to outsourcing. Additionally, X includes controls for the age and industry of firm and year dummies. See Appendix B for more details on the variables. Given the range of years in the data and the availability of contracting out information, $t = 1994 - 1995, 1995 - 1996$. Simple statistics for the covariates and the counts of dummies are listed in Table 4. Table 5 reports the correlation table between the covariates.

The disturbance terms, ϵ and ϵ', collect all other unobserved factors that also affect the contracting out incentive. The disturbances can be inter-temporally correlated due to the presence of firm fixed effects. Owing to the small number of years in the panel, directly estimating the fixed effects in the nonlinear model could lead to inconsistent estimates for the

[11] There are a few self-employed firms in the data with zero employees but still paying wages. To include them in the analysis the transformation $\log(1 + AWAGE)$ is used in the model.

coefficients (Heckman, 1981). The main source of the fixed effect, however, is the management's attitude towards outsourcing as a persistent source of favoritism or reluctance to go ahead with contracting out. To account for this persistence, I estimate a model of fixed effects as a function of a few time-invariant characteristics of the firm that are available in the data. As a result, the disturbance term is elaborated as

$$\epsilon_{jit} = \gamma_1 DECISION_{jit} + \gamma_2 INCORP_{jit} + \gamma_3 FAMILY \alpha_2 + \eta_{jit}. \tag{19}$$

In the above, $DECISION$ indicates whether the business has a major decision maker, $INCORP$ is one when the business is incorporated, and $FAMILY$ indicates if the business is family owned and run. I use the same fixed-effect structure to describe ϵ'.

Table 6 reports the probit estimates of (18a) and (18b) subject to (19) and for various specifications. Standard errors are bootstrapped to account for the presence of random regressors. Specification (1) is a benchmark model, and using a quadratic function of log employment it is able to detect an initial positive relationship between size and productivity and contracting out activity as in Pieri & Zaninotto (2011). However, the quadratic term suggests that the propensity to contract out starts to fall after peaking at the estimated size of 47 employees.

The rest of the estimated effects in this specification are especially useful in validating the model as a whole and the data set in particular. Above all, the widely documented negative relationship between productivity and contracting out is present here; see Federico (2010) and Pieri & Zaninotto (2011) for similar evidence. Other controls are also on the right path: recent successful contracting out can be a precursor to more contracting out, and the estimated positive effect supports this hypothesis. Having 25-50% union employees ($UNION25-50$) on the payroll raises the propensity by about two percent, but with more than 50% membership the propensity actually falls by almost two percent. Abraham & Taylor (1996) explain this U-turn by the dominance of unions in firms with more than 50% membership, which renders the firm inflexible in replacing the union workers. Non-managerial wage also has a positive influence as in Abraham & Taylor (1996) . The positive effect of the number of locations was already expected from the earlier discussion in this section.

Specifications (2) to (4) use (18b) to estimate the size effect on the propensity to contract out. The notable result is that in all these specifications, the class of small firms is the

Variables	Dependent: $COUT_{t+1}$ (1)	(2)	Type 1 (3)	Type 2 (4)
$\log(EMP_t)$	0.077***			
	(0.006)			
$\log(EMP_t)^2$	-0.010***			
	(0.001)			
P_t^S		-0.041***	-0.042***	-0.042***
		(0.004)	(0.004)	(0.004)
$P_t^{S\cap L}$		0.024**		
		(0.008)		
P_t^T			-0.039**	0.000
			(0.013)	(0.010)
P_t^M			0.073***	0.063***
			(0.010)	(0.012)
$\log(TFP_t)$	-0.016***	-0.019***	-0.020***	-0.019***
	(0.002)	(0.002)	(0.002)	(0.002)
$COUT_t$	0.084***	0.084***	0.085***	0.084***
	(0.004)	(0.004)	(0.004)	(0.004)
$\log(1 + AWAGE_t)$	0.003	0.022***	0.023***	0.023***
	(0.002)	(0.002)	(0.002)	(0.002)
$UNION25_t$	0.019**	0.021**	0.025***	0.023***
	(0.007)	(0.007)	(0.007)	(0.007)
$UNION50_t$	-0.020***	-0.019***	-0.020***	-0.019***
	(0.006)	(0.006)	(0.006)	(0.006)
$\log(NLOCS_t)$	0.018***	0.020***	0.019***	0.020***
	(0.004)	(0.003)	(0.003)	(0.003)
Log Likelihood	-7835.6891	-7956.5696	-7928.8499	-7948.0261
# Obs		2,682		

Table 6: The estimated marginal propensities to contract out computed at means. Numbers in parentheses are bootstrapped standard errors. *** and ** denote significance at 1% and 5% levels. A constant term along with industry, age, year, and fixed effects are also estimated but not reported. $t = 1994-95, 1995-96$.

least likely among the firms to contract out; the propensity for them falls by more than 4% relative to large firms, which are the control group. Specification (2) only looks at the intersection without making the distinction between the transitioning (dynamic group of) and the marginal (static group of) firms. Since the firms on the intersection are a mix of both, there is uncertainty about the direction of effect. The results in the table show a positive effect of about 2% relative to large firms, and the effect has some statistical significance. Once transitioning and marginal firms are separated (in specifications (3) and (4)), a clearer pattern emerges: marginal firms are 6% to 7% likelier than large firms to outsource, and the effects are statistically significant at 1% level. On the other hand, the propensity to contract out is either lower for the transitioning firms than that of large firms (in specification (3)) or not significantly different (specification (4)).

Two criticisms can still be directed to the analysis above. The first one is the timing of contracting out and bunching. If both actions are simultaneous, it is not clear if they are causally linked. With a causal connection, the effect would carry on to impact the propensity in the next period. Second, given the positive inter-temporal link between waves of contracting out, some confounding is possible. Serial outsources become less aggressive in hiring managers lest the newly hired managers will soon be redundant, owing to an anticipated reduction in the number of employees in the course of coming years, which biases the estimates for the bunching firms upwards. To explore the extent to which there is a bias, I re-estimate (18) by excluding firm–years that contracted out in t (no restriction on contracting out in $t+1$). These new results are listed in Table 7. The direction of effects are mostly unchanged, and the marginal firms are still showing positive and significant attitude towards contracting out. The estimates are, however, slightly smaller now that the serial outsources are out of the picture.

5.3 Role of Productivity

The results so far point to an outsourcing behavior that surges in the mid-range of the size distribution and falls over both tails. Does one get the same picture if one substituted size with productivity? In theory only a monotonic relationship between productivity and size is possible, so that the same pattern is projected onto productivity. In practice, a correlation coefficient of 0.57 (Table 5) points to the right, though imperfect, relationship. Dealing with

Variables	Dependent: $COUT_{t+1}$ (1)	(2)	Type 1 (3)	Type 2 (4)
$\log(EMP_t)$	0.073***			
	(0.006)			
$\log(EMP_t)^2$	-0.009***			
	(0.001)			
P_t^S		-0.047***	-0.048***	-0.047***
		(0.004)	(0.004)	(0.004)
$P_t^{S\cap L}$		0.016**		
		(0.008)		
P_t^T			-0.030**	-0.006
			(0.013)	(0.010)
P_t^M			0.054***	0.053***
			(0.009)	(0.011)
Log Likelihood	-6251.7016	-6341.8396	-6325.4773	-6333.9406
# Obs		2,422		

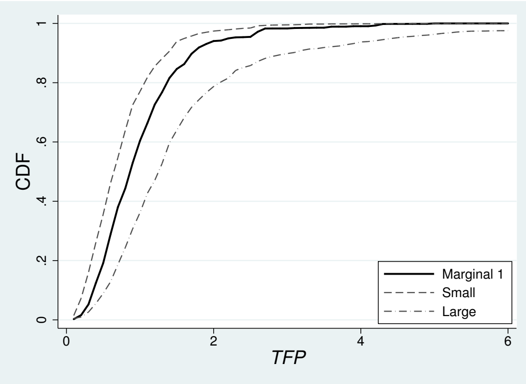
Table 7: The estimated marginal propensities to contract out conditioning on $COUT_t = 0$. Numbers in parentheses are bootstrapped standard errors. *** and ** denote significance at 1% and 5% levels, respectively. A constant term along with industry, age, year, and fixed effects are also estimated but not reported. $t = 1994-95, 1995-96$.

fuzzy indicators, I show that the same ranking of sizes between small, marginal, and large firms is projected onto the corresponding productivities, so that the qualitative results of specifications (3) and (4) in Tables 6 and 7 can identically be interpreted with size replaced by productivity. To investigate the ranking of productivities, I form the cumulative distribution function (CDF) of productivity for each group of firms and then test for the ordering of stochastic dominance. The empirical CDF is computed as

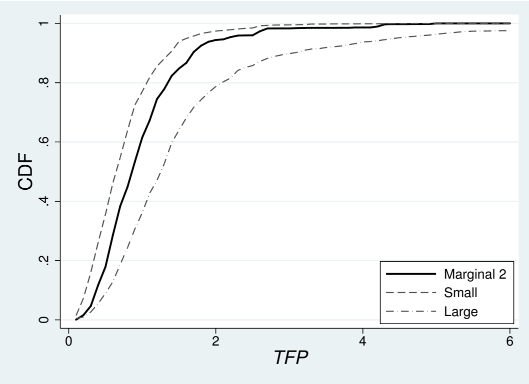
$$\hat{F}(\phi) = \widehat{Prob}(TFP \leq \phi) = \frac{\sum_{j,t} w_{j,t} p_{j,t} \mathbb{I}(TFP_{j,t} \leq \phi)}{\sum_{j,t} w_{j,t} p_{j,t}}, \tag{20}$$

in which the sample weight $w_{j,t}$ is supplemented by the probability weight $p_{j,t}$. $\mathbb{I}(.)$ is the indicator function. The probability weights used for small, large, and bunching firms are P^S, $1 - P^S$, and P^{M1} (P^{M2}), respectively.

Figure 4 shows the estimated CDFs for marginal (type 1 or 2) versus those of small and large firms. As the panels show, the distribution of marginal firms is sandwiched between



(a) Marginal 1



(b) Marginal 2

Figure 4: Comparing the CDFs of productivity for marginal, small and large firms. Using the analysis sample of 4,023 firm–years from the BLS.

those of small and large firms, so that these firms are stochastically dominated by large firms, but stochastically dominating small firms in productivity.

The significance of the ordering in each case is tested by forming the following Kolmogorov-Smirnov statistics:

$$KS_S^+ = \sqrt{\frac{N_{M1}N_S}{N_{M1}+N_S}} \sup_{\phi} \Big(\hat{F}_S(\phi) - \hat{F}_{M1}(\phi)\Big), \tag{21}$$

$$KS_S^- = \sqrt{\frac{N_{M1}N_S}{N_{M1}+N_S}} \inf_{\phi} \Big(\hat{F}_S(\phi) - \hat{F}_{M1}(\phi)\Big), \tag{22}$$

$$KS_L^+ = \sqrt{\frac{N_{M1}N_L}{N_{M1}+N_L}} \sup_{\phi} \Big(\hat{F}_{M1}(\phi) - \hat{F}_L(\phi)\Big), \tag{23}$$

$$KS_L^- = \sqrt{\frac{N_{M1}N_L}{N_{M1}+N_L}} \inf_{\phi} \Big(\hat{F}_{M1}(\phi) - \hat{F}_L(\phi)\Big). \tag{24}$$

S, L and $M1$ stand, respectively, for small, large and marginal firms of type 1. N is the number of observations (here, also weighted by both sample and the appropriate probability weights) in each class. For the right order of stochastic dominance, it is expected that KS_S^+ and KS_L^+ be statistically significance and KS_S^- and KS_L^- be insignificant statistically. The same exercise is repeated using marginal firms of type 2. The reported results in Table 8 support the hypothesis in almost all cases with the proper statistical (in)significances. In case of the marginal firms of type 2 ($M2$), the CDF seems to fall below that of the large firms at some point with some statistical significance. Close inspection of the data shows that there

Firm	Test Statistics			
Type	$KS_S^+ > 0$	$KS_S^- < 0$	$KS_L^+ > 0$	$KS_L^- < 0$
Marginal 1	8.702***	-0.009	11.373***	-0.098
	[0.000]	[0.650]	[0.000]	[0.278]
Marginal 2	7.063***	-0.007	10.133***	-0.147**
	[0.000]	[0.800]	[0.000]	[0.034]

Table 8: Kolmogorov-Smirnov tests of stochastic dominance for marginal firms against small and large ones. Numbers in brackets are bootstrapped p-values. Using the analysis sample of 4,023 firm–years from the BLS.

are eight large firms with sizes ranging from 30 to 50 employees and productivities less than 0.1. There are no marginal firms of type 2 in the same range of productivity. Apart from this anomaly, for all other ranges of productivity the CDFs fall into the right ordering.

5.4 Outsourcing to Bunch

The results so far have established that firms reaching the intersection area with no intention to grow are the ones that are most keen on outsourcing. In this section, I will turn the question around and seek whether firms are contracting out to control their sizes as the model suggests or do they contract out for other reason? For instance, if outsourcing facilitates growth and makes size evolution a smoother and cheaper process by making available to the firm skills and experiences that are missing in a small firm but essential to its success as a medium-sized or large firm, such as professional advertising and marketing, then outsourcing firms will continue to grow and shift the center of gravity for the whole size distribution to the right.

By definition, the marginal firms lack any growth plans and by virtue of this information they are automatically bunching. I will, hence, focus on the broader class of outsourcing firms, by defining them as all firms that contracted out during t ($COUT_t = 1$, 359 firm–years). To make the contrast between the outsourcing firms and a control group as large as possible, I define a set of *non-outsourcing* firms as those that never contracted out over the first three years of the panel ($COUT_t = 0$, t=1994–95 to 1996–97, 3141 firm–years). Table 9 lists the mean and standard deviation of employment size for each of these subsets. The figures put the average size of an outsourcing firm around 20 employees both at the time of contracting out and one year after, with the standard deviation staying much the same over the period. In comparison, the average size of non-outsourcing firms stays around 14 employees, however,

Variable	Outsourcing		Non-outsourcing	
	Mean	Std.Dev.	Mean	Std.Dev
EMP_t	19.9	30.8	13.9	14.4
EMP_{t+1}	20.0	30.7	14.4	24.0
# Firm–years	359		3,141	

Table 9: Simple statistics on the size of outsourcing and non-outsourcing firms. Using $t = 1994-95$ to $1996-97$.

the standard deviation shows a significant increase from t to $t+1$ which is indicative of the more dynamic nature of these firms. In any case, the standard deviations are too large to indicate any statistically significant size differences and do not point to a bunching of size in particular (also see Figure 5(a)).

Even if the numbers in Table 9 indicated a bunching, it was not clear whether the bunching is a long-run phenomenon or caused by the short-run dynamics of firms in the panel. In addition, using a selected sample casts doubt on whether the distributional features are representative of the industry. One way around these problems is to let the firms run for a long time according to the implied one-year size transition probabilities and study the resulting steady-state size distribution as a counter-factual test of the hypothesis. To implement this idea, I treat the size transition of firms from t to $t+1$ as a Markov process. Let the range of employment size be discretized into intervals of length 0.5 over the log-employment (a total of 11 states). For the transition matrix T, the matrix elements are defined as

$$[T]_{kl} = Prob\big[EMP_{ij,t+1} \in l | EMP_{ij,t} \in k\big], \tag{25}$$

where probabilities are estimated as the fraction of firm–years belonging to size class k at t ending up in size class l at time $t+1$. The fixed length division of size over the log employment range is especially to ensure that each size class is populated enough to make the probability estimates meaningful, given that size distribution has a falling upper tail and observations get sparser as size increases. The standard definition for the steady-state distribution, ξ, of this transition matrix is then

$$\xi T = \xi.$$

I find a separate transition matrix for outsourcing firms (T_O) and non-outsourcing firms (T_N)

$T_O =$

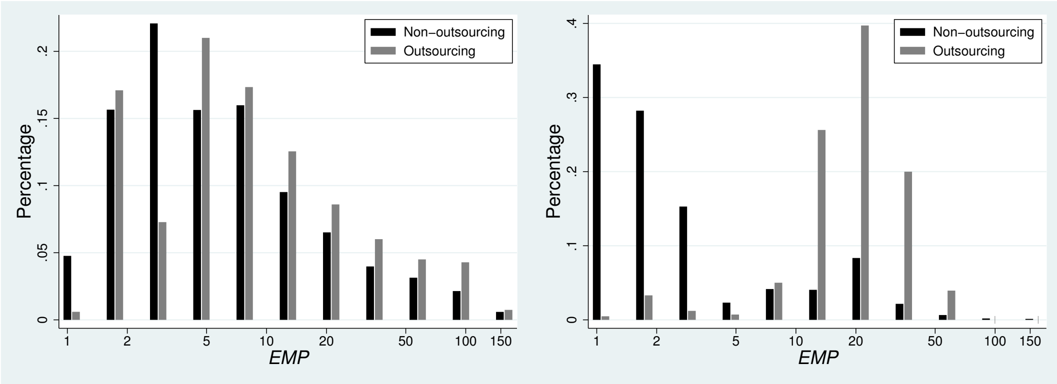
1	0	1	0	0	0	0	0	0	0	0	0
2	0.145	0.737	0.094	0.024	0	0	0	0	0	0	0
3	0	0.302	0.487	0.168	0	0.043	0	0	0	0	0
4	0	0.030	0.435	0.470	0.065	0	0	0	0	0	0
5	0	0	0	0	0.952	0.048	0	0	0	0	0
6	0	0	0	0.004	0.008	0.906	0.082	0	0	0	0
7	0	0	0	0	0	0.053	0.747	0.175	0.025	0	0
8	0	0	0	0	0	0	0.398	0.574	0.028	0	0
9	0	0	0	0	0	0	0	0.394	0.606	0	0
10	0	0	0	0	0	0	0	0	0.374	0.564	0.061
11	0	0	0	0	0	0	0	0	0	0.097	0.903

Table 10

and compare the steady-state distributions to highlight any qualitative differences. For illustration purposes, the transition matrix T_O is listed in Table 10. At this point, it is also worth noting that in finding the steady state one is implicitly assuming that firm dynamics for each group are prescribed by the same transition matrix over several years in succession. Subject to the truncation window of the panel, this is the case with the non-outsourcing firms by definition. For outsourcing firms, Table 6 shows that prior contracting out is the most significant factor in deciding whether there is another round of contracting out in a firm, hence, the approximation has its merits.

Figure 5 shows the size distributions for the outsourcing and non-outsourcing firms. Panel (a) illustrates the initial distributions whence the process started from, which is simply the percentage of firm–years in the data falling into each size bin by treatment. The reason I am plotting these distributions is to emphasize that the long-term distributions are not merely mirroring the initial distributions but point to some directed dynamics. Panel (b) shows the steady-state distributions for the outsourcing and non-outsourcing firms.

In panel (a), the two groups of firms are distributed much the same way, and there is no clear indication of a bunching behavior for either group. Panel (b), however, exhibits profound differences between the steady-state distribution of the two groups. The most striking feature of the outsourcing firms in Panel (b) is that their size distribution exhibits a bunching behavior centered around the size 20 with very little dispersion. In fact, the average steady state size of



(a) Initial Distribution

(b) Steady-State Distribution

Figure 5: The size distributions of outsourcing and non-outsourcing firms: (a) the initial distributions, and (b) the steady-state distributions implied by the Markov transition matrices. The size bins have a length of 0.5 over log-employment.

an outsourcing firm in the counter-factual distribution is in fact 20.4 with a standard deviation of 10.2 employees, which is much narrower than the statistic listed in Table 9. Coincidentally, the bunching range of the outsourcing firms correlates very strongly with the probability of being a marginal firm (from Figure 3(c) the ranges almost overlap). This finding was already expected given the lead from the theory that marginal firms will eventually bunch at the size ϖ (in this context $\varpi \simeq 20$).

The steady-state size distribution of non-outsourcing firms shows a more conventional shape, one with a falling upper tail. This distribution also exhibits a small bunching similar to that of the outsourcing firms. The difference is that the percentage of non-outsourcing firms bunching is much smaller than that of the outsourcing firms (in the latter case it is almost all of them). The theoretical model never ruled out bunching by integrated firms, and as long as $\phi^{(S)} > \bar{\phi}$ there will be a fraction of integrated firms that bunch too.

Lastly, prima facie, the distributions in this section do not show a missing middle as is suggested by the model. Instead distributions imply a *hollow-tail*: bunching of firms creates a vacuum in the upper tail of the size distribution and makes it thinner. However, recall that the data is missing all firms with more than 200 employees. Since these larger firms are old and static in size (Evans, 1987), there is the possibility of generating a hollow middle with a thicker upper tail when the censored firms are added to the picture.

6 Conclusion

Firms outsource for various reasons, and so far the spotlight has been on productivity as the major determinant. Outsourcing lowers costs, therefore, it is embraced most eagerly by the least efficient firms. Often neglected is that some firms also outsource as an anti-growth strategy by which the firm is trying to avoid exposing itself to the extra overhead costs and risks of evolving into a large business. The latter behavior, more typical of SMEs, has less to do with efficiency and happens because fixed costs are not "fixed" as in the existing theories, but vary with size non-linearly. Outsourcing is also offering firms an alternative way to grow by expanding the network of suppliers and shifting the internal focus on manufacturing instead. The findings of the paper also bring to light a peculiarity of the size distribution being ignored so far, that the long-term distribution of size should exhibit an extra lump in the middle where the transition from small to large regime is taking place. The hope is that this lump is more pronounced in the size distribution of firms in larger countries with a larger number of firms available for study.

As the final thought, this paper in principal emphasizes the discrete and evolutionary nature of firm operation and the implied discontinuities that exist in a firm's choice of strategy. Small businesses are the ones receiving tax benefits that are supposed to be invested into job creation and growth. Growth incentives, however, could be missing among a substantial number of small businesses. We will be over-estimating the contribution of small businesses to job creation, unless we allow for the discontinuities discussed in this work. The paper also makes the point that focusing on outsourcing only in the context of trade, as is the case in the mainstream economics, is bound to miss some fine details of firm growth mechanisms by putting too much weight on larger firms and exporters.

A Details of Derivations

Deriving (4) **and** (5)**:** Using $s = m/\eta$, the profit function in the small regime can be written as $\pi_S(m, \phi) = A\phi^{1-\alpha}m^\alpha - m/\eta_m$. Taking derivative with respect to m and setting it to zero gives (4). However, $m_S(\phi) + s_S(\phi) \leq \varpi$, therefore, the solution must be bounded by $\eta_m \varpi$. Now, simply plug (4) back into the profit function and use the definition of Π. Labor size reaches ϖ when $m_S(\bar{\phi}) = \eta_m \varpi$, where it yields

$$\bar{\phi} = (\alpha A \eta_m)^{\frac{-1}{1-\alpha}} \eta_m \varpi = \frac{1-\alpha}{\alpha \Pi} \varpi.$$

Firms with $\phi > \bar{\phi}$ have the size ϖ, so their profits will be

$$\begin{aligned}
\pi_S(\phi) &= A\phi^{1-\alpha}(\eta_m \varpi)^{\alpha} - \varpi = \varpi \left(A\eta_m^{\alpha} \phi^{1-\alpha} \bar{l}^{\alpha-1} - 1 \right) \\
&= \frac{\alpha \Pi \bar{\phi}}{1-\alpha} \left(A\eta_m^{\alpha} \left(\frac{(1-\alpha)\phi}{\alpha \Pi \bar{\phi}} \right)^{1-\alpha} - 1 \right) && \text{using } \bar{\phi} = \frac{1-\alpha}{\alpha \Pi} \varpi, \\
&= \frac{\alpha \Pi \bar{\phi}}{1-\alpha} \left(\frac{1}{\alpha} \left(\frac{\phi}{\bar{\phi}} \right)^{1-\alpha} - 1 \right) && \text{using } \frac{\alpha \Pi}{1-\alpha} = \frac{(\alpha A \eta_m)^{\frac{1}{1-\alpha}}}{\eta_m}.
\end{aligned}$$

Rewriting the last result gives the second line in (5). ■

Deriving (6) **and** (7)**:** The derivation of (6) is similar to that of (5), with the only difference that variable cost is now $1 + w_f f$. ■

Deriving (8) **and** (9)**:** Is very similar to those of (4) and (5) by replacing η_m with η_o. ■

Deriving (10)**:** This firm has the profit function

$$\pi_L^m(\phi) = Ay(\phi)^{\alpha} - m_L^m - w_o \eta s - w_f f(m_L^m - \varpi) - c_e - c_o^L,$$

subject to $s = m_L^m / \eta$. Maximizing with respect to m_L^m gives

$$m_L^m(\phi) = \left(\frac{\alpha A}{1/\eta_o + w_f f} \right)^{1/(1-\alpha)} \phi.$$

Plug this m_L^m back into the profit function, and after some algebra the profit function becomes

$$\begin{aligned}
\pi_L^m(\phi) &= (1/\eta_o + w_f f)^{\frac{-\alpha}{1-\alpha}} \frac{1-\alpha}{\alpha} (\alpha A)^{1/(1-\alpha)} \phi \\
&= (1/\eta_o + w_f f)^{\frac{-\alpha}{1-\alpha}} \left(\Pi \eta_m^{\frac{-\alpha}{1-\alpha}} \right) \phi,
\end{aligned}$$

which generates the required result. ■

Deriving (11)**:** Is very similar to that of (7) except that expected revenue is equal to

$A\phi^{1-\alpha}E[e^{1-\alpha}]m^{\alpha}$. ■

Proof of Proposition 4: e^* is where $\pi_L(e^*\phi) = \pi_S^m(\phi)$. Solving for e^* yields

$$e^*(\phi) = K_1\phi^{-\alpha} + K_2\phi^{-1},$$

where

$$K_1 = \frac{\bar{\phi}_o^{\alpha}/(1-\alpha)}{\Pi(1+w_f f)^{-\alpha/(1-\alpha)}}, \quad K_2 = \frac{c_e - c_o - w_f f \varpi - \frac{\alpha}{1-\alpha}}{\Pi(1+w_f f)^{-\alpha/(1-\alpha)}},$$

are constants with respect to ϕ. It is immediate that $de^*(\phi)/d\phi < 0$. ■

B Description of Variables

INNOVAT: Dummy indicating if a firm introduced a substantially new product during the year. Using the BLS variable INNOVAT. Firms with product innovation are more likely to outsource, which steps up their future innovation rate.

NLOC: The number of business locations in the BLS is indicated by the variable BUSLOCS.

UNION25-50: Dummy indicating if a 25 to 50% of employees in a firm are union members. The BLS variable UNIONME indicates whether the percentage of employees in a firm with union membership is 0%, 1%-10%, 11%-25%, 26%-50%, 51%-75%, 76%-100%. A positive response to 26%-50% is used to construct this dummy.

UNION50: Dummy indicating if more than 50% of employees in a firm are union members. A positive response to any of the percentages above 50% in UNIONME is used to construct this dummy.

AGE: Dummy for a firm's age. The BLS variable AGE5 is used as the dummy with the age of a business already descretized into the bins of 0-1, 2-4, 5-9, 10-19, and 20+.

INTINC: Intention to significantly increase production over the next three years.

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