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# Size Evolution and Outsourcing: Theory and Evidence from Australian Manufacturing

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**Abstract**

This paper sheds new light on the forces shaping outsourcing decision by considering a certain form of non-linearity in overhead costs which effectively discretizes a firm's size into small and large regimes. Extending Grossman & Helpman (2002) in this line shows that firms unable to fully transition from small to large due to their level of efficiency would outsource to downsize and save on overhead costs. A panel of Australian manufacturing firms is used to construct an instrument for the transitioning firm and to test the hypothesis. In support of the theory, those firms in transition with no growth plans have stronger incentives to contract out and downsize. The findings open a new avenue to rethink growth and job creation amongst small businesses.

**Keywords:** Small Business, productivity, outsourcing, Overhead Cost.

**JEL Code:** C38, D23, L24, L6.

## 1 Introduction

Firms adopt different vertical structures even within seemingly similar groups. Theory has established a clear link between productivity and outsourcing, with Antras & Helpman (2004) making sharp and useful predictions regarding the organization of an industry with global sourcing possibilities in which outsourcing by the least productive firms is explained as an attempt to avoid exit, whilst most productive firms offshore outsource in order to benefit from cheap overseas labor. Focusing on domestic outsourcing, this paper extends those results by making a distinction between outsourcing for survival and outsourcing to downsize and to keep one's business under control. The latter group of firms, not necessarily inefficient or underachievers, do grow but mostly out of their boundaries, by expanding their network of suppliers and contractors, rather than expanding physically by hiring.

The study is motivated by an extension to the classic model of Grossman & Helpman (2002) with productivity heterogeneity a lá Antras & Helpman (2004) but without offshoring. Firms require two types of workers, namely, manufacturing and support services (such as maintenance), to produce. Moreover, firms growing beyond some threshold in size have to use a more complex managerial structure in order to operate without loss of efficiency. The additional overhead cost that stems from this management overhaul can be absorbed by the most efficient firms, whereas firms finding themselves operating close to the threshold outsource service tasks in order to keep their size small and their overhead cost low while their manufacturing operates at the scale of a large business. Consistent with previous theories, the model also predicts that the least efficient firms outsource but to avoid exit.

Empirically, this paper contributes by applying a mixture model to establish a discrete classification of firm sizes into "small" and "large". The identification results are then used to build an instrument indicating the probability that a firm is in size transition. Borrowing from the vast literature on firm organization, small firms are specified as those run entirely by their owners and not needing assistance from managers, and large firms are those increasingly relying on managers to support their operation. Furthermore, there are firms in transition that behave a bit like both. The transitioning firms are further broken into those that are growing and those that lack a growth plan in the midst of transition. The study primarily focuses on this second group of firms to study the link between *size devolution* and contracting out.

Using an Australian firm-level data, the transition instrument is constructed and plugged into various econometric models, and the impact on the propensity to contract out is estimated. The findings consistently show significantly stronger outsourcing incentives for firms in transition that have either downsized or contemplate doing so in the near future.

The rest of the paper is organized as follows: the next section motivates the topic by discussing the relationship between size and overhead costs, here portrayed as the number of managers in a firm. The organizational outcomes are then generated using a model of outsourcing with contractual incompleteness. Section 3 describes the Australian Business

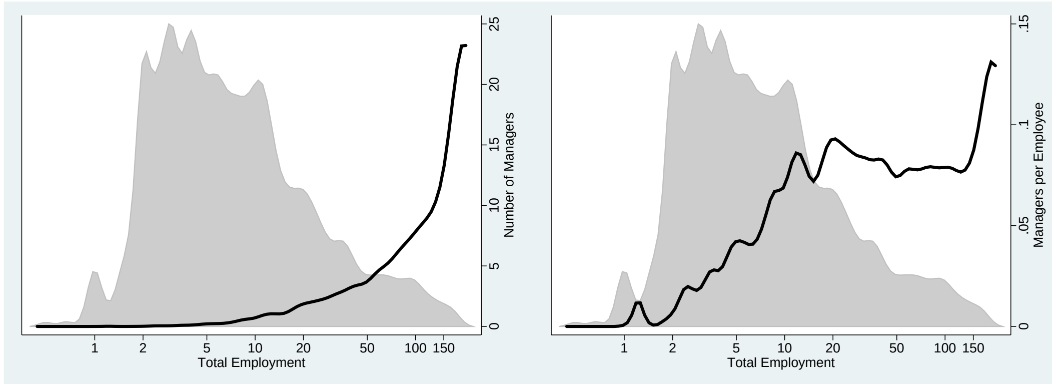
Longitudinal Survey as the main source of data for the study and introduces measures of size, wage and productivity used in the empirical exercises. Sections 4 clusters firm sizes and estimates the transition probability for each firm. The section also characterizes roll-back firms (firms that are at a turning point in the midst of transition) using a few different definitions for robustness check. Section 5 looks at the validity of the instrument and performs various tests to link size transition, downsizing and contracting out. Conclusion follows afterwards.

# 2 Motivation

## 2.1 An Organizational Framework

The general line of economic theory often treats firms as fully scalable entities. Under this assumption, a firm with 100 employees operates exactly as ten firms of 10 employees put together. The scalability assumption, however, poses serious faults when dealing with survey data. Small and large firms are remarkably different in their performance and operation; for instance, see Acs & Audretsch (1988), Storey (1989), and Haltiwanger et.al (2010) . An already existing body of works in the business and management studies also points out the discrete nature of firm evolution during its life cycle (Churchill & Lewis, 1983; Garnsey, 1998; Greiner, 1998).

The existing strand of studies in the organizational economics, in particular, offers a basis for this discreteness. In small scales, a firm is composed of one or two founders/owners, has a few employees, and the whole operation is entirely managed by the owners without any assistance from professional managers. As the firm grows, it adds to its number of employees, but also expands in other dimensions such as increasing the range of tasks and activities undertaken within the firm and adding to the number of locations. Under this circumstance, the coordination of tasks and locations is infeasible by only the owner taking full control, and a new management order must take over (Robinson, 1934). Employees are divided into teams and divisions and managers are installed to oversee the performance of each group of workers, otherwise free-riding problems could arise hurting the productivity and performance of the firm (Alchian & Demsetz, 1972). With further growth, another level




(a) (b)

Figure 1: The non-parametric estimates of the relation between (a) the number of managers and employment size, and (b) the number of managers per employee and employment size. A kernel regression with Gaussian kernel and bandwidth 0.2 for log-employment is used. The shaded area is the kernel density estimation of firm size distribution. The number of managers excludes owners. The sample and the measurement of size is described in the data section.

of management is needed to oversee the performance of lower tier managers and also for coordination purposes. As a result, a positive relation between the number of managers (and the number of management hierarchies as well) and employment size develops (Williamson, 1967).

Put in abstract, the relationship between the number of managers and employees in a firm should follow the piecewise non-linearity depicted below

$$MAN(EMP) = \begin{cases} 0, & \text{if } EMP < \overline{EMP}, \\ f_1(EMP) - f_1(\overline{EMP}), & \text{Otherwise}, \end{cases} \tag{1}$$

where $\overline{EMP}$ is the threshold size over which transition takes effect. When the number of employees is below $\overline{EMP}$, the business owner is taking full control, thus hires no managers. $f_1(.)$ is an increasing and weakly concave, possibly linear, function. The properties of $f_1(.)$ reflect the fact that overhead cost grows by employment size but not at such a rate to inhibit growth beyond a certain size. For Australian manufacturing firms, this relationship and its implied non-convexity is illustrated in Figure 1 on a log scale. Figure 1(b) especially shows that the relation is almost linear among larger firms of sizes 20 to 150 employees.

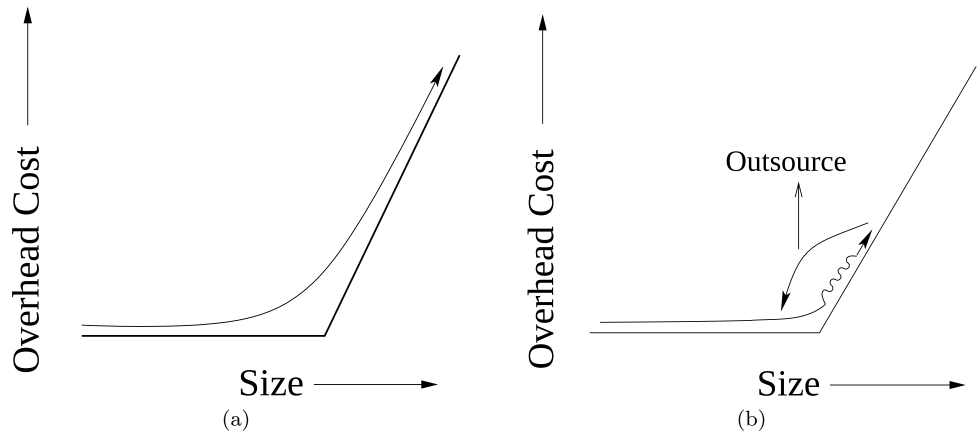



Figure 2: The growth path of a firm: (a) firms with high momentum pushing forward, and (b) rolling-back firms with low momentum.

Thinking of this non-linearity, we hypothesize some level of discreteness in a firm's decision to move fully through the transition and to evolve into a large business depending on its relative efficiency. Foremost, relation (1) suggests that evolving into a large business embodies some loss of efficiency, and the more is the management requirement per employee the more the damage. A relatively efficient firm in that position can still generate enough additional revenue, despite the fall in its efficiency, to absorb the increased overhead cost and to justify the transition. In an illustrative way, this firm has enough *momentum* to overcome the initial climb and continue with the ascent (Figure 2(a)).

Without enough momentum, however, a firm would slip back from the initial climb and never make it far enough on the slope (Figure 2(b)). Correspond this firm to the one that is fairly efficient, has some potential to grow, but badly hurt with the efficiency loss that it experiences by moving beyond the transition point. The firm is compelled to roll back its size to just below the transition point and outsource the difference in employment. This way, the business keeps its scale of operation at the level of a large business, but internally operates at the level of a small business, hence, saves costs.

The next section puts together a theory that mimics this situation by incorporating a nonlinear cost function similar to (1) in a model of outsourcing with incomplete contracts.

## 2.2 Theoretical Setup

Industry is composed of a continuum of firms each producing a distinct variety of a consumption good and competing monopolistically. Let the representative consumer have a CES utility over the range of these varieties. Grossman & Helpman (2002) show that in such environment, a firm producing a distinct variety faces the demand $p = Ay^{\alpha-1}$, where $p$ is the offering price, $y$ is the level of output, and $A$ is an industry-wide demand shifter. $\alpha$ is the parameter that controls the elasticity of substitution between any two varieties by setting it to $1/(1-\alpha)$, where $\alpha = 1$ corresponds to perfect substitution. In the remainder, the assumption $\alpha \in (0, 1)$ is enforced.

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

$$y = \theta \min\big\{m, ks\big\}, \qquad k > 0. \tag{2}$$

In the production function, $m$ is the number of manufacturing workers hired by the firm, and $s$ is the number of service workers whose contributions sustain the production environment, e.g., by maintaining and calibrating machinery to the specific product. Each unit of service staff provides $k$ units of support to the manufacturing. To simplify the presentation, the innocuous scaling $\phi = \theta^{\frac{\alpha}{1-\alpha}}$ will be applied, and $\phi$ will be 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 run their business efficiently (up to productivity level $\phi$), where the size of the management team is determined by

$$f(l) = \begin{cases} f_0, & l < \bar{l}, \\ f_0 + f_1(l - \bar{l}), & l \geq \bar{l}, \end{cases} \qquad f_0, f_1 > 0. \tag{3}$$

In the above, $l$ is the total number of workers, manufacturing and service, hired by the firm, and $\bar{l}$ is a milestone size where evolution from small into large size occurs. Failure to hire the appropriate number of managers, as dictated above, will leave workers insufficiently monitored and drives their efforts to zero, so that there will be no revenue. The management wage is exogenously given and fixed to $w_f > 1$.[1] Management cost in small size regime is still positive ($w_f f_0 > 0$), although no manager is hired, to reflect the opportunity cost of the owner spending time to manage her own business rather than indulging in leisure.

For the moment, set aside outsourcing and focus on the decision made by an integrated firm. A $\phi$-type firm has the option to operate in small size regime, making the profit of

$$\pi_S(m, s, \phi) = Ay(m, s, \phi)^\alpha - m - s - w_f f_0.$$

This option can be taken regardless of productivity level but by confining employment size to $m + s \leq \bar{l}$. In this case, the optimal firm's profit is the solution to

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

Solving the first-order conditions and noting that optimally $m = ks$, the size of manufacturing for a $\phi$-type firm operating in small size regime is

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

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

$$\pi_S(\phi) = \begin{cases} \Pi\phi - w_f f_0, & \phi < \bar{\phi}, \\ \Pi\bar{\phi}\left(\frac{(\phi/\bar{\phi})^{1-\alpha} - \alpha}{1-\alpha}\right) - w_f f_0, & \phi \geq \bar{\phi}, \end{cases} \tag{5}$$

where $\Pi = \frac{1-\alpha}{\alpha k_m}(\alpha A k_m)^{\frac{1}{1-\alpha}}$ and $\bar{\phi} = \frac{(1-\alpha)\bar{l}}{\alpha \Pi}$. In the current context, $\bar{\phi}$ corresponds to the productivity level at which an integrated firm experiences change in its size regime.

A firm can overcome the size constraint by hiring the appropriate number of managers

[1] Reports from the Australian Bureau of Statistics indicate that $w_f \simeq 2$ in Australia.

and paying the increased overhead cost. Such firm makes a profit of

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

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 the above is only valid when $m+s \geq \bar{l}$. Especially, due to some loss of efficiency in large size regime (marginal cost is now $1+w_f f_1 > 1$), the least efficient firm that would optimally choose the large regime has the productivity level $\bar{\bar{\phi}} = (1+w_f f_1/\bar{l})^{\frac{1}{1-\alpha}}\bar{\phi} > \bar{\phi}$. Solving the first order condition, now only subject to (2), the manufacturing size chosen by a $\phi$-type firm in large size regime is

$$m_L(\phi) = \left(\frac{\alpha A k_m}{1+w_f f_1}\right)^{\frac{1}{1-\alpha}} \phi, \tag{6}$$

which is making the profit of

$$\pi_L(\phi) = \Pi\phi(1+w_f f_1)^{\frac{-\alpha}{1-\alpha}} - w_f f_0 + w_f f_1 \bar{l}, \quad \phi \geq \bar{\bar{\phi}}. \tag{7}$$

The two profit relations (5) and (7) are illustrated in Figure 3 using dashed lines. With the monotonicity of the two profit functions and the steeper slope of $\pi_L(\phi)$ in higher productivity ranges, a unique threshold productivity level $\tilde{\phi} > \bar{\phi}$ can be identified, so that firms with $\phi \leq \tilde{\phi}$ choose small size regime and firms with $\phi > \tilde{\phi}$ choose large size regime. Firms with productivity level $\phi \in (\bar{\bar{\phi}}, \tilde{\phi})$ are size constrained but refuse to switch regimes lest their overhead cost increases.

Some firms also find operation unprofitable. These firms are those for whom $\pi_S(\phi) < 0$. Given the monotonicity of profit $\pi_S(\phi)$, a threshold productivity level $\phi^*$ exists, where $\pi(\phi^*) = 0$ and firms with $\phi < \phi^*$ exit in the absence of any outsourcing possibility.

When outsourcing is allowed, firms can let their service division run independently, forfeiting their ability to supply services internally. The service supplier, in turn, adapts to the

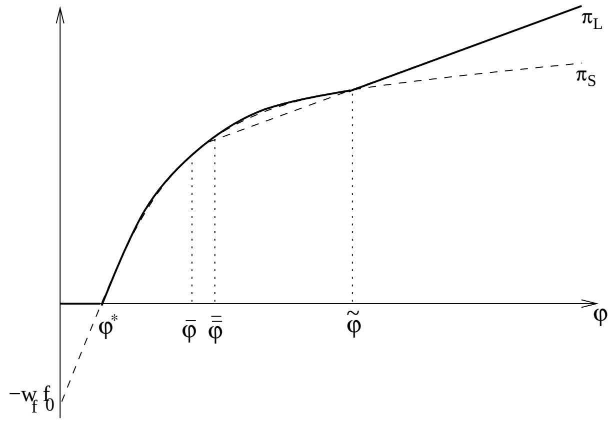



Figure 3: The choice of size regime by integrated firms.

needs of the manufacturing firm, e.g., develops a maintenance and calibration plan specific to the output designed and produced by the manufacturing firm and the machinery used. The customized service does not hold any value outside the specific relation. As a result, both the manufacturing firm and its supplier are tied in a relation with no outside option.

As in Grossman & Helpman (2002), this outsourcing relation is also governed by contractual incompleteness, so that the quality of service cannot be fully specified and verified by a third party. In the maintenance of machinery, this unverifiable aspect could be whether the contractor is just keeping the machines running or takes care to prolong the life of machinery and reduce wear and tear. As a result, the supplier is intent to provide low quality service to increase its own profit margin. Low quality service, however, is costly to the manufacturer, e.g., physical capital depreciates quickly, forcing production shutdown or very costly reinvestments by manufacturer well before the manufacturer's perceived life for the machinery (which, for simplicity, is assumed to be infinity here), while the contracted service provider still has to be paid. Grossman & Helpman (2002) resolve this incentive problem by letting the manufacturing firm transfer an $\omega \in (0, 1)$ share of its revenue to the supplier under a Nash bargaining scheme after service is provided.

With the outsourcing of services, nevertheless, only one manageable task remains within the manufacturing firm, and a lower level of coordination is demanded. At the same time, the incentive design of the problem makes sure that the supplier offers satisfactory service and does not need to be constantly watched for performance. Summing up, the owner needs to spend less time managing, so that $f_0^m < f_0$, where $w_f f_0^m$ is now the opportunity costs of owner taking full control of manufacturing. Similarly, the owner of the supplying firm incurs an opportunity cost of $w_f f_0^s > 0$. To simplify the analysis, it is assumed that in an outsourcing relation, both the firm and its supplier operate in small size regime to emphasize the main intention of keeping size and overhead cost small.

In this problem, unlike Grossman & Helpman (2002), both parties can choose the size of operation simultaneously by making their own hiring decisions. However, due to Leontieff nature of the production function, the final size of operation is decided by the minimum of the two. The problem each party solves is

$$\text{Supplier} : \max_{s,m} \; \omega A y(l,\phi)^\alpha - s - w_f f_0^s, \tag{8}$$

$$\text{Manufacturer} : \max_{m,s} \; (1-\omega) A y(l,\phi)^\alpha - m - w_f f_0^m. \tag{9}$$

Both problems are subject to (2) and the size constraint. The outcome of this two-part problem is

$$m_o(\phi) = \min\left\{ (\omega\alpha A k)^{\frac{1}{1-\alpha}}\phi,\; \big((1-\omega)\alpha A\big)^{\frac{1}{1-\alpha}}\phi,\; \bar{l} \right\}, \tag{10}$$

in which, the first term inside the minimization is the size selected by supplier, the second term is the size selected by manufacturer. Depending on $\omega$ and $k$, the selected size of the supplier or manufacturer will prevail. To resolve the deadlock, the following assumption is made:

**Assumption 1** $\omega(1+k) < 1$.

The assumption ensures that the supplier's decision turns into action, which makes the manufacturer hire below its optimal level and leads to the well known holdup problem in outsourcing relations. In this case, either the supplying party is not core to the production, hence, does not have much bargaining power (small $\omega$), or it is labor intensive (small $k$). In either case, the supplier lacks a strong incentive to contribute to manufacturing.

With the size of manufacturing determined, the optimal profit of the manufacturer in small regime becomes

$$\pi_S^m(\phi) = \begin{cases} \frac{(\omega k/k_m)^{\frac{\alpha}{1-\alpha}}}{1-\alpha}\Pi\phi(1-\omega-\alpha\omega k) - w_f f_0^m, & \phi < \bar{\phi}_o, \\ \frac{(\omega k/k_m)^{\frac{\alpha}{1-\alpha}}}{1-\alpha}\Pi\bar{\phi}_o\left((1-\omega)\left(\frac{\phi}{\bar{\phi}_o}\right)^{1-\alpha} - \alpha\omega k\right) - w_f f_0^m, & \phi \geq \bar{\phi}_o, \end{cases} \quad (11)$$

where $\bar{\phi}_o = \frac{1}{k_m}(\omega k/k_m)^{\frac{-1}{1-\alpha}}\bar{\phi}$. Assumption 1 guarantees that $\bar{\phi}_o > \bar{\phi}$ and $\pi_S^m > 0$. Besides, if products are differentiated enough ($\alpha$ is small enough), outsourcing will reduce the effective productivity, i.e., the slope of the profit function, for manufacturer. The following assumption describes the level of product differentiation needed for this situation to hold.

**Assumption 2** $\alpha < \frac{1-\left((1+k)\omega\right)^{\frac{\alpha}{1-\alpha}}(1-\omega)}{1-\left((1+k)\omega\right)^{\frac{\alpha}{1-\alpha}}k\omega} < 1$.

**Proposition 1** *With Assumption 2, the effective productivity of the outsourcing manufacturer is smaller than* $\phi$.

**Proof:** See Appendix A.

The profit function (11) is illustrated in Figure 4, superimposed over an integrated firm's decision. The decision on vertical structure and size regime is listed underneath the figure. Two subsets of firms are identified that choose outsourcing over integration: 1) analogous to Antras & Helpman (2004) the least efficient firms can avoid exit by outsourcing ($\phi^*$ is lower now than without outsourcing). 2) There is also a subset of firms with sizes $\bar{l}$ and above that outsource and roll back their size to operate in small regime, thus lowering their overhead cost. Unlike Antras & Helpman (2004) this second set of firms are present exactly in the absence of any global sourcing opportunities and merely out of size concerns.

As the last comment, the current model can readily be extended to multiple size regime changes with threshold values $\bar{l}_1, \bar{l}_2, \ldots, \bar{l}_n$ .[2] Each threshold holds potential for some outsourcing activity. However, with firms getting increasingly productive, the extra overhead cost is easily absorbed and outsourcing is not anticipated at larger sizes.

[2] Greiner (1998) identifies five stages where managerial overhaul is required.

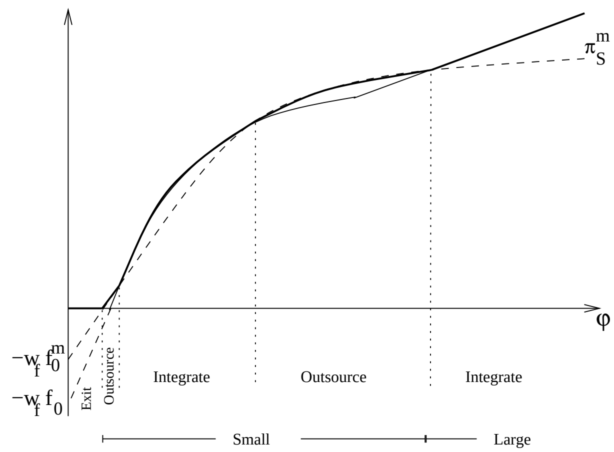



Figure 4: The choice of organizational structure and size regime by firms.

# 3 Data

This study benefits from the Confidentialised Unit Record File (CURF) version of the Business Longitudinal Survey (BLS) provided by the Australian Bureau of Statistics (ABS). The BLS is an unbalanced panel formed from four waves of the Business Growth and Performance survey conducted in years 1994–95 to 1997–98 and covers production and performance data on a sample of Australian firms, at management level rather than physical plants.[3] The sample in 1994–95 is composed of about 13,000 firms randomly selected from the Australian Business Register and represents several broad industries, such as mining, manufacturing, financial, etc., and each firm is weighted in such a way to make the number of businesses representative within the corresponding industry×size stratum (Will & Wilson, 2001). The original weights are further adjusted to account for non-responses too. The response rate is about 86%. In the later years, the ABS keeps about 8,400 of those firms in the data. Half of these firms are selected for having demonstrated growth in sales, exports and innovation activity. The other half are selected from the rest of the firms. In each year, the data are also supplemented with a sample of about 500 new firms to compensate for exiting and non-responsive firms. Sample weights in these years are also readjusted to account for growth and innovation too, but as will be explained shortly, these readjusted weights are not used in this study.

Using Australian data is especially helpful in minimizing the impact of offshoring on the

[3]The fiscal year in Australia is from July 1 to June 30 next year, the reason for the two-year combination.

results, so that outsourcing and organizational choices are better correlated with size evolution. All the firms in the data are small and medium-size firms, and once asked if planning to establish overseas operation over the next three years, only 2% of the selected sample respond affirmatively. During the same period, Benson & Ieronimo (1996) independently verify that service jobs such as maintenance, transportation, janitorial, and catering jobs have been the main targets of outsourcing among many large Australian manufacturing firms; all these jobs require physical presence and cannot be offshored.

In addition, the BLS provides detailed information on employment (full-time, part-time and in some years also by gender), and also the number of managers and working owners, separately. This level of details is crucial for the discretization of size into small and large operation regimes. Some other information reported for each firm that is used in the study includes total sales, capital assets, capital depreciation, purchases of input and other operational costs, changes in inventories, total wages and benefits paid, and the value of exports. The age of business is also reported in categories.[4]

Another advantage of the BLS is that it does not only contain information about the current performance of the firm, but also offers a prospective look at firms by asking them to outline their business intentions over the three years following the survey. This latter piece of information is immensely helpful in distinguishing those firms that are caught up in transition and ready to turn back, knowing this is their long-term strategy and not a snapshot view. Section 4.2 offers a more detailed discussion of this issue.

Most importantly, in 1994–95 and 1996–97 firms are asked if they contracted out jobs previously done by their own employees (yes/no answer). In 1995–96, firms are not directly asked if they contracted out jobs, but indicate whether they had a major change in their contracting out activities. The combination of the latter answer with the former ones determines if firms contracted out in 1995–96. Note that contracting out in this context is an incremental activity, and firms report having contracted out a new set of in-house jobs.[5] Also, contracting out in the context of the BLS is synonym with job destruction and downsizing, and at least one in-house job disappears as a result of contracting out.

[4]For the full list of variables and the survey questions of this data please refer to ABS Catalogue Number 8141.0.15.001 on http://www.abs.gov.au.

[5]Bakhtiari (2011) shows that about 80% of firm–years reporting contracting out in one year, do not report contracting out for the next year.

| 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 Recorder 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 total counts of firms and the percentage of contracting out firms in the selected sample.

**Sample Selection**

The applicable data are restricted to a balanced panel of manufacturing firms (ANZSIC 2x) that appear in all four years of the panel, in order to keep the most stable firms. Year 1997–98 is eventually discarded, since it does not report contracting out. The sample weights available for 1994–95 are applied to all firm–years to avoid the selection bias introduced by the ABS in the last three years of the panel. Firms for whom valid productivity could not be computed for at least one year are also discarded.[6] Some firms in the data are coded as ANZSIC 20 (unknown manufacturing). Assuming industry codes stay the same over time, the industry codes reported for the following years are used to assign a possible subdivision. Otherwise, these firms are coded as Miscellaneous Manufacturing (ANZSIC 29), so that ANZSIC 29 is a proxy for *average* manufacturing and is subsequently used as the control group. Table 1 reports the counts of firms by manufacturing subdivision and the percentage of firms contracting out in each year.

Finally, due to ABS measures to protect the confidentiality of individual firms, all firms with more than 200 full-time employees are dropped from the data. However, those firms are not thought to be in size transition, and their omission should not affect the validity of the analysis conducted here.[7] For the same reason, the analysis of this paper applies to

[6] The measuring of productivity is described shortly in the same section.

[7] The ABS Business Counts (Cat.No.8165.0) show that 99% of manufacturing firms in Australia are less than 200 employees.

small and medium-sized firms, but for the simplicity of notation the medium-size firms are subsequently called "large".

**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 payment cycle in June of each year starting from 1993. Part-time non-managerial numbers are prorated by the ratio of part-time to full-time hours obtained from the ABS report on earnings and hours in each year (Cat.No.6306.0) to get a full-time equivalent. The ratios are around 0.44 in most years. The total number of 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, less than 3% of firms in the selected sample ever report having part-time managers or owners. Moreover, those firms that report having part-time managers, only hire one or two of many, pointing to the fact that management is practically a full-time job. 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 hereafter. Total employment ($EMP$) in a firm is then

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

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 unskilled average wage. The measure is constructed as

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

where $WAGES$, $SUPER$, and $COMP$ are wages, superannuations (Australian retirement funds), and worker compensations paid per annum, respectively.[8] $k$ is the ratio of average weekly pay for manager to that of non-managers. The ratio for each year is obtained, again,

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

from the ABS report on earnings and hours (Cat.No.6306.0), where the ratios rise from 1.73 to 2.04 successively over the three years.

**Measuring Total Factor Productivity**

Production is assumed Cobb-Douglas with Total Factor Productivity (TFP) measured as the residual in

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

where $y_{ij}$ is the log of real value added for firm $j$ in industry $i$. $l_{ij}$ is the log of total employment and $k_{ij}$ is the log of real capital. Values of $\beta^l$ and $\beta^k$ are picked from Breunig & Wong (2008). They apply a two-stage Olley & Pakes (1996) method to the uncensored original BLS to find consistent estimates of $\beta_l$ and $\beta_k$ and control for selection bias. In particular, they do not impose any CRTS assumption on the productivity function, and the estimates demonstrate slightly increasing returns to scale, in line with the evidence independently found by Diewert & Fox (2008) and Olive (2004) on the U.S. and Australian manufacturing, respectively.

Value added output is constructed as 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.6412.0) are used to deflate the nominal value added. For unknown manufacturing (ANZSIC 20), the manufacturing price index is used.

Similar to Breunig & Wong (2008), capital is constructed as the sum of asset value of plant and machinery plus the leasing stock. The leasing stock is found by dividing the reported leasing expenses by $(r + \delta_i)$, where $r = 0.05$ is the average return on capital. $\delta_i$ is the depreciation rate of capital within each ANZSIC computed as

$$\delta_i = \frac{Depreciation_i}{Plant\ and\ Machinery_i + Depreciation_i},$$

where the firm-level book value of plant and machinery capital and depreciation reported in each year are aggregated to ANZSIC level. Leasing stock is not included as part of this capital.

The nominal value of capital found above is further deflated for an estimate of real capital. The ABS input-output reports show that more than 90% of the value of capital input to every

| | 1st Decile | Median | 9th Decile | Mean | Std.Dev. |
|---|---|---|---|---|---|
| TFP | 0.24 | 0.70 | 1.84 | 1.00 | 1.27 |
| Total Employment | 2.0 | 6.0 | 35.7 | 15.0 | 25.0 |
| Value Added($000) | 45.4 | 244.8 | 1,966.2 | 906.0 | 2,500.9 |
| Average Wage($000) | 4.24 | 20.9 | 37.0 | 21.1 | 12.9 |

Table 2: Simple statistics for the selected sample. The sample of 4,023 firm–years from the BLS is used.

manufacturing sector is supplied by the sector "machinery and equipment" (ANZSIC 28). Therefore, to estimate real capital, I deflate the asset values by the price index of machinery and equipment. TFP is further index by dividing individual productivities by the total average, so that the productivity of the average firm is set to one. Simple statistics for a few performance measures are reported in Table 2.

# 4 Firms in Transition

The theoretical argument is primarily based on a dichotomous notion of size, in which the range of a firm's operation is broken into small and large regimes. This section is dedicated to the identification of the two size classes by empirical means. A two-component mixture model with soft transition properties is applied to build an instrument that measures the probability that an observed firm–year in the data is in transition. In doing so, it is also emphasized that, in reality, transition is not happening over a threshold, but is spread over a range of sizes due to the heterogeneity among firms and the graduality of the evolution process. Then, a few indicators are sought from data that signal whether a firm is abandoning further growth. Firms that are assigned non-zero probability of transition and have curbed growth are treated as potential roll-back firms and later used in various econometric models for evidence to support the theoretical hypothesis.

## 4.1 Statistical Clustering of Firm Size

In the mixture model approach, the sample of firm-years is assumed composed of two populations of large and small businesses, and observations from each population are governed by a distinct model of management. Each observed firm–year, a priori, picks a small business model with probability $\theta$ and picks the large business model with probability $1-\theta$, where the latent probability $\theta$ is modelled to change with employment size in the following way:

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

The specification above 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 [0,1] range.

The number of managers in each size class is then determined by an extended form of (1). Precisely, the number of managers in each size class is dictated by

**Small:**

$$\begin{aligned} MAN_{ij} =& a_{S,0} + a_{S,1}EMP_{ij} + \epsilon_{ij}, \\ & \epsilon_{ij}\ i.i.d., \qquad f_S(\epsilon) = \frac{1}{\sqrt{2\pi}\sigma_S} e^{-\frac{1}{2}\left(\frac{\epsilon}{\sigma_S}\right)^2}, \end{aligned} \tag{13}$$

**Large:**

$$\begin{aligned} MAN_{ij} =& a_{L,0} + a_{L,1}EMP_{ij} \\ & + b_{L,1}PART_{ij} + b_{L,2}log(NLOC_{ij}) + \sum_{i=21}^{28} c_{L,i}ANZSIC_i + \eta_{ij}, \\ & \eta_{ij}\ i.i.d., \qquad f_L(\eta) = \frac{1}{\sqrt{2\pi}\sigma_L} e^{-\frac{1}{2}\left(\frac{\eta}{\sigma_L}\right)^2}. \end{aligned} \tag{14}$$

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 workforce ($PART$) are included as possible influences in large businesses. The level of coordination needed for normal operation could be higher when operation is decentralized. Having more part-time workers on the payroll could reduce management load when part-time and full-time jobs are substitutes, but could increase it if part-time jobs are distinct tasks, so the direction of effect is ambiguous at this point. Finally, $ANZSIC$ absorbs any differences in the coordination of industry-specific tasks.[9] Small firms, on the other hand, are dominantly single-location and

[9] The management requirements are, however, not that different across manufacturing subdivisions. Data shows that the difference between the most and least management-intensive subdivisions is about two man-

| | Small | Large | $\theta$ |
|---|---|---|---|
| Constant | -0.035* | -0.317 | 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) | |
| $\sigma$ | 0.342*** | 3.300*** | |
| | (0.017) | (0.220) | |
| Log Likelihood | | -7208.0 | |

Table 3: The estimated two-component mixture model for the classification of firm size into small and large. The numbers in parentheses are robust standard errors. The sample of 4,023 firm-years from the BLS is used.

hire no managers. Therefore, no additional effects, other than employment size, are included for them.

The mixture model above is estimated by maximizing the log-likelihood function, where the log-likelihood function for this problem has the form

$$\log(L) = \sum_{j=1}^{n} \log\Big(\theta(EMP_{ij}) f_S(\epsilon_{ij}) + \big(1 - \theta(EMP_{ij})\big) f_L(\eta_{ij})\Big). \tag{15}$$

Table 3 lists the estimated parameters pooling all firm-years in the selected sample. The estimated model is especially capable of closely approximating the relationship over the range of observed employment sizes (Figure 5(a)).

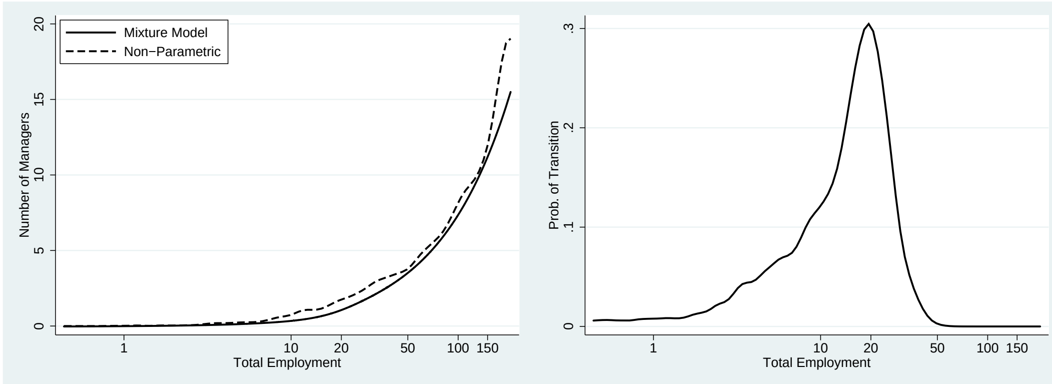
Given the estimated model and by the application of Bayes rule, it is now possible to determine the posterior probability that observation $j$ in the sample is governed by small business model conditional on the firm's observable characteristics, which leads to the probability estimate

$$p_j^S = \frac{\hat{\theta}(EMP_j) f_S(\hat{\epsilon}_j)}{\hat{\theta}(EMP_j) f_S(\hat{\epsilon}_j) + \big(1 - \hat{\theta}(EMP_j)\big) f_L(\hat{\eta}_j)}. \tag{16}$$

Lastly, the probability of observation $j$ being in size transition is defined as

$$P_j = 2 \min\big(p_j^S, 1 - p_j^S\big). \tag{17}$$

agers per hundred employees.




(a) (b)

Figure 5: (a) The quality of fit by the mixture model (solid line) compared to the non-parametric estimate of the relation (dashed line). (b) The non-parametric average estimate of the transition probability as a function of employment size.

The above definition assigns higher probabilities when a firm is not strongly associated with either business model and has its management structure practically split between the two. Multiplication by two is just a normalization and makes the resulting probability range from zero to one. This definition is not without its precedent, and were the probabilities interpreted as fuzzy membership grades, operation (17) would be the fuzzy intersection of the two sets of large and small businesses (Zimmermann, 1996).

The average probability of transition by employment size is shown in Figure 5(b), estimated by a kernel regression.[10] Note that $P_j$ depends not only on a firm's employment size, but also on other characteristics of the firm such as the number of locations. There is also estimation noise involved. Therefore, firms of the same employment size can be assigned different transition probabilities. The level of noise is particularly higher in the transition region, which explains why the pick of average probability does not reach one. However, the general features of Figure 5(b) is exactly as expected: firms have zero probability of transition on both tails and a relatively higher probability in the middle.

[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.

### 4.2 Roll-Back Firms

Transitioning firms in the data, characterized by probability $P$, are the mix of two types of firms. First, there are those firms that are growing through the transition region and evolving into a large firm. These firms might be quite efficient and do not particularly relate to the implications of the theoretical model. Second, there are those firms that abandon growth in the midst of the transition. This drastic action signals that the firm faced a mishap and might be contemplating to roll-back size. Contracting out should be more prevalent among this last group of firms. How do we know the firm has abandoned growth? For robustness check, a few different indicators are derived from the data.

The crudest sign that a firm's growth is at a turning point is that a firm is momentarily not adding to employment. Take an operating firm in time $t$ with the possibility of contracting out in $t+1$, then the probability of rolling back is defined as

**RB1:** $R_t = P_t$ if the number of non-managerial employees has not increased from $t-1$ to $t$, and zero otherwise.

No hiring, and some layoffs, during the year could be precursor to rolling back and the possibility of contracting out. This definition, however, is a short-term point-in-time view of a firm's growth. It only reflects the past activity of the firm, with no indication of doing the same thing in the future. In particular, the downsizing could have been temporary and in response to demand shocks, having nothing to do with a longer term strategy. Each year the BLS also asks firms to describe their future business intentions. In one question, firms respond if they plan to increase production over the next three years. A negative answer to this question is clearly a stronger and more robust indication of a firm abandoning growth. Hence, the second definition is

**RB2:** $R_t = P_t$ if the firm has no intention to increase production over $t+1$ to $t+3$, and zero otherwise.

The third definition is a stricter version of the above, by requiring firms to have shown some growth prior to curbing it altogether:

**RB2:** $R_t = P_t$ if the firm has no intention to increase production over $t+1$ to $t+3$, and the number of non-managerial employees increased from $t-1$ to $t$. $R_t$ is zero otherwise.

| | $R>0$ | | | $R>0.5$ | | |
|---|---|---|---|---|---|---|
| | Roll-Back | | | Roll-Back | | |
| Year | RB1 | RB2 | RB3 | RB1 | RB2 | RB3 |
| 1994–1995 | 43.7% | 45.1% | 20.1% | 2.2% | 2.5% | 1.3% |
| 1995–1996 | 57.4% | 46.6% | 14.5% | 2.8% | 2.2% | 0.5% |
| # firms | | 1341 | | | 1341 | |

Table 4: The percentage of roll-back firms in each year.

Table 4 reports the percentage of roll-back firms by each definition in each year. The numbers show that more than one-third of firms in each year. The characteristics of these roll-back firms are discussed in the next section, and the conformity of each definition to the expectations will be demonstrated.

# 5 Anatomy of Roll-back Firms

## 5.1 Relative Productivity of Roll-Back Firms

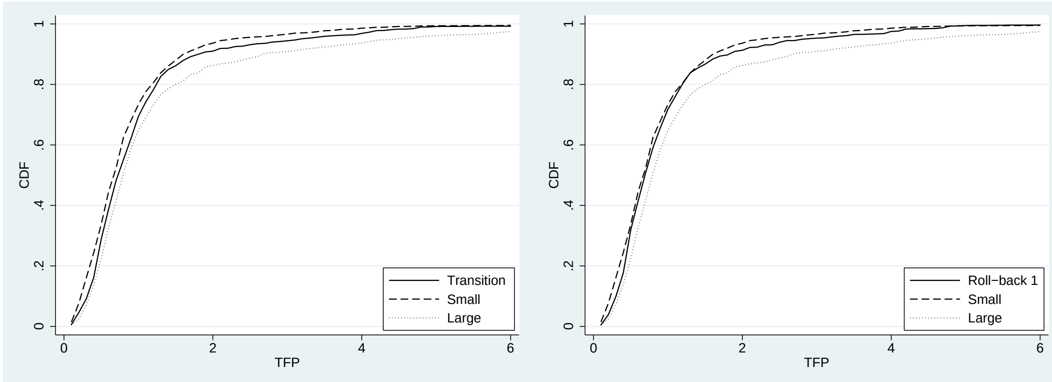
In our first exercise, we offer some ramification for the roll-back definitions presented by detecting systematic differences in the distribution of productivity that roll-back firms exhibit versus those for firms categorized as small or large. The theory already predicts an ordering in which roll-back firms are located in between small and large firms in terms of the productivity distribution.[11]

Empirically, the productivity distribution for each group of firms can be ranked using the notion of stochastic dominance. The cumulative distribution function (CDF) of productivity for each group of firms is formed using the simple counting rule, except that now each firm is additionally weighted by the probability that it belongs to a certain class of interest. Put formally, the empirical CDF is formulated as

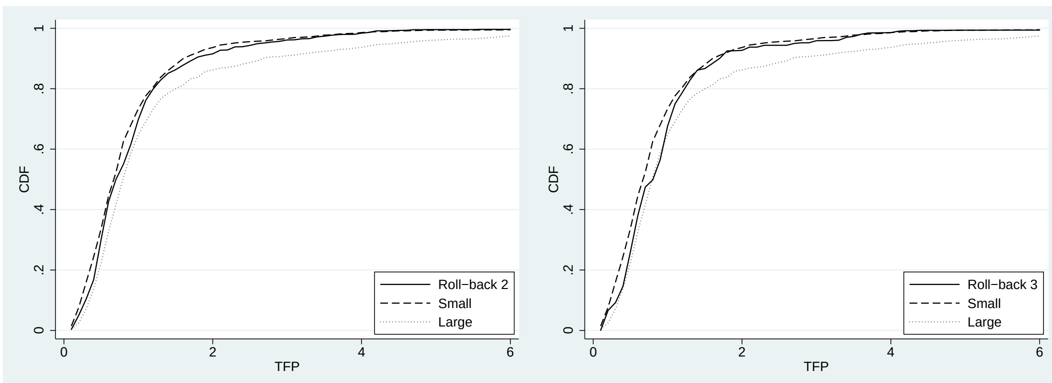
$$\hat{F}(\phi) = \widehat{Prob}(TFP \leq \phi) = \frac{\sum_j w_j p_j I(TFP_j \leq \phi)}{\sum_j w_j p_j}, \tag{18}$$

in which the sample weight $w_j$ is supplemented by the probability weight $p$. $I(.)$ is the

[11] The theory suggests that the ranking of distributions should hold in long-term, while some small firms in the data could still be young. However, the average age of small firms in the selected sample is close to 10 years, which means that young firms are not a major force here. The average age of large firms in the data is 16 years, so that some selection effect of age exists after all.




(a) Transitioning (b) Roll-back 1




(c) Roll-back 2 (d) Roll-back 3

Figure 6: Comparing the distributions of the transitioning and roll-back firms to those of small and large firms using the CDFs and the concept of stochastic dominance. The sample of 4,023 firm-years from the BLS is used.

indicator function. The probability weights used for roll-back, small and large firms are $R$, $p^S$, and $1 - p^S$, respectively.

The estimated CDFs are plotted in Figure 6. The four plots each use transitioning firms and the three definitions of roll-back as the comparison point, respectively. The distribution of transitioning firms, as a whole, is sandwiched between those of small and large firms (Figure 6(a)). It is stochastically dominated by large firms, but stochastically dominating small firms in productivity. The same ordering holds for roll-back firms, especially with the forward-looking definitions (RB2 and RB3). The distribution for RB1 firms mostly robs against that of small firms. It will also turn out in the later exercises that RB1 is the weakest indication of roll back.

| Test | Roll-Back RB1 | RB2 | RB3 |
|---|---|---|---|
| $KS_S^+ > 0$ | 3.127*** | 3.516*** | 5.919*** |
| | [0.000] | [0.000] | [0.000] |
| $KS_S^- < 0$ | -0.106 | -0.127 | -0.240 |
| | [0.999] | [0.999] | [0.999] |
| $KS_L^+ > 0$ | 4.363*** | 4.588*** | 4.059*** |
| | [0.000] | [0.000] | [0.000] |
| $KS_L^- < 0$ | 0.009 | -0.050 | -1.051 |
| | [0.999] | [0.999] | [0.220] |

Table 5: Kolmogorov-Smirnov tests of stochastic dominance of roll-back firms against small and large firms. Numbers in brackets are p-values.

The significance of the ordering in each case is also tested using Kolmogorov-Smirnov test of stochastic dominance. The test statistics have the form

$$KS_S^+ = \sqrt{\frac{N_{RB}N_S}{N_{RB}+N_S}} \sup_{\phi} \Big(\hat{F}_S(\phi) - \hat{F}_{RB}(\phi)\Big), \tag{19}$$

$$KS_S^- = \sqrt{\frac{N_{RB}N_S}{N_{RB}+N_S}} \inf_{\phi} \Big(\hat{F}_S(\phi) - \hat{F}_{RB}(\phi)\Big), \tag{20}$$

$$KS_L^+ = \sqrt{\frac{N_{RB}N_S}{N_{RB}+N_S}} \sup_{\phi} \Big(\hat{F}_{RB}(\phi) - \hat{F}_L(\phi)\Big), \tag{21}$$

$$KS_L^- = \sqrt{\frac{N_{RB}N_S}{N_{RB}+N_S}} \inf_{\phi} \Big(\hat{F}_{RB}(\phi) - \hat{F}_L(\phi)\Big). \tag{22}$$

$S$, $L$ and $RB$ stand, respectively, for small, large and roll-back. $N_{Class}$ is the number of observations (here, also weighted by both sample and the appropriate probability weights for each group $S$, $L$ and $RB$). For the right order of stochastic dominance, it is expected that $KS_S^+$ and $KS_L^+$ be positive with statistical significance, and we must have $KS_S^-$ and $KS_L^-$ insignificant statistically. The respective tests in Table 5 support the hypothesis in all cases.

## 5.2 Rolling Back and Contracting Out

In this section, the longitudinal aspect of the selected sample is utilized in a probit model to estimate the contribution of rolling-back firms to the propensity of contracting out. The probit model estimates the following conditional probability

$$Prob\big[CONOUT_{j,t+1} = 1|t\big] = \Phi\Bigg(\alpha_0 + \alpha_1 P_{j,t} + \alpha_2 R_{j,t} + X'_{j,t}\beta\Bigg). \tag{23}$$

Given the range of years in the data and the availability of contracting out information, $t = 1994 - 1995, 1995 - 1996$. $X$ is the vector of firm specific characteristics in year $t$ that are also deemed to influence contracting out decision. Past successful contracting out could lead to an increase in the propensity to contract out in the present. The inter-temporal link between contacting out activity is accounted for by including $CONOUT_t$ in $X$. Abraham & Taylor (1996) postulate that high unskilled wages and major union membership among the employees push firms to outsource those jobs in a bid to reduce union influence and save costs. Using the information available in the BLS, two dummies are constructed that indicate whether 25-50% and more than 50% of a firm's employees are union members ($UNION25{-}50$ and $UNION > 50$, respectively). The average non-managerial wage is used as a proxy for unskilled wages.[12] Innovation and exporting each drive firms to focus on competition and marketing by sending out non-core jobs. The dummy $INNOVAT$ is included that indicates whether a firm had a substantial product innovation in the year prior to contracting out. Export intensity ($EXPINT$), i.e., nominal export divided by nominal sales, and the intention to commence exporting ($STARTX$) are introduced to take care of export incentives. Multi-location operation also demands a higher-level of coordination and might push a firm to reduce management load by sending out non-core jobs. The number of locations, $NLOC$, is included to account for the possible link. An increase in the number of employees can also correlate with an increase in the range of in-house activities, therefore, has the same implication as increasing the number of locations. The measure of total employment, $EMP$ is included to absorb the effect. Not the least, a firm's productivity is considered a determinant of outsourcing (Antras & Helpman, 2004), and $TFP$ accounts for this important factor. The estimates are controlled for the age of the business expressed in 2-4, 5-9, 10-19, and 20+ year-old bins. Industry and year effects are also controlled for by including the appropriate dummies. The detailed description and the construction of all these variables can be found

[12] A few firms in the sample pay zero wages. These firms do not have employees either, so they are thought to be non-employers. To include them in the analysis the transformation $\log(1 + WAGES)$ is used in the model.

in Appendix B.

Table 6 reports the probit estimates for various specifications excluding and then including roll-back indicators. Specification (1) is just a benchmark model and iterates the findings of other independent sources where low productivity, by itself, is found to increase the likelihood of contracting out.[13]

Specification (2) adds in the probability of transition, but there is no statistical significance attached to the estimated effect. This was expected as the transitioning firms are the mix of two types of firms, roll-back firms and firms that are growing normally, and each type is pushing in a different direction. This claim is put to test in the last three specifications by estimating an additional coefficient using each of the definitions for roll back. With all the three definitions, the effects are positive, meaning that, roll-back firms are more likely to contract out when compared to an average transitioning firm. The intention to curb future growth (RB2) turned out to be the strongest signal that the firm is at a turning point, and, accordingly those firms are about 11% more likely to contract out than a transitioning firm, which is much larger than with the other definitions. The effects are also statistically very significant.

The overall contribution of rolling back to the propensity can be found by summing up the coefficients for $P$ and $R$. The tests at the bottom of Table 6 show that a roll-back firm is about 2% to 5% more likely than an average firm to contract out, with high statistical significances attached to all three effects.[14] This effect is economically remarkable too. Compared to productivity (also an important determinant of outsourcing), the effect of full transition status ($P = 1$) for a roll-back firm is equivalent to at least one unit drop in the average log of productivity (or productivity getting three times lower). The effect is on par with a much larger productivity drop if we stress the forward-looking definitions.

The estimated model can be further validated by noticing that the rest of the effects also has the expected signs. There is positive inter-temporal correlation between contracting out, and recent contracting out raises the propensity by about 11%. Having 25-50% union employees on the payroll raises the propensity by about 2%, but when more than 50% of employees are union members, the propensity is actually 2.5% lower than the average firm.

[13] See, for instance, Morrison-Paul & Yasar (2009), Farinas & Martin-Marcos (2010), and Federico (2010).

[14] As part of the empirical exercises conducted for this paper, the probability model is also estimated using a logit functional form, which produces the same implications.

| Variables | (1) | (2) | Def.1 (3) | Def.2 (4) | Def.3 (5) |
|---|---|---|---|---|---|
| $CONOUT_t$ | 0.113*** | 0.113*** | 0.113*** | 0.114*** | 0.113*** |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| $UNION_t 25-50$ | 0.018* | 0.018* | 0.018* | 0.023** | 0.020** |
| | (0.007) | (0.007) | (0.007) | (0.008) | (0.007) |
| $UNION_t > 50$ | -0.024*** | -0.024*** | -0.024*** | -0.024*** | -0.024*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| $INNOVAT_t$ | 0.016*** | 0.016*** | 0.016*** | 0.017*** | 0.016*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| $Log(1+WAGES_t)$ | 0.010*** | 0.010*** | 0.011*** | 0.011*** | 0.011*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| $STARTX_t$ | 0.039*** | 0.039*** | 0.040*** | 0.042*** | 0.040*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| $EXPINT_t$ | 0.051*** | 0.051*** | 0.052*** | 0.049*** | 0.049*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| $Log(NLOCS_t)$ | 0.009** | 0.009** | 0.009** | 0.007* | 0.009** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| $Log(EMP_t)$ | 0.015*** | 0.015*** | 0.015*** | 0.015*** | 0.015*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| $Log(TFP_t)$ | -0.018*** | -0.018*** | -0.018*** | -0.019*** | -0.019*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| $P_t$ | | 0.001 | -0.031** | -0.062*** | -0.012 |
| | | (0.007) | (0.011) | (0.012) | (0.009) |
| $R_t$ | | | 0.054*** | 0.112*** | 0.058*** |
| | | | (0.013) | (0.014) | (0.015) |
| $P_t + R_t > 0$ | | | 0.023** | 0.050*** | 0.046*** |
| | | | (0.084) | (0.083) | (0.126) |
| Log Likelihood | -7915.2 | -7915.2 | -7907.4 | -7881.2 | -7908.7 |
| $\chi^2$ | 2184.866 | 2196.128 | 2210.455 | 2350.977 | 2243.104 |

Table 6: The estimated marginal effects for the propensity to contract out using a probit model. Numbers in parentheses are robust standard errors. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively. Constant term and industry, age and year dummies are also estimated as part of the model, but not reported. $t = 1994-95, 1995-96$. The sample is 4,023 firm-years from the BLS.

This latter effect can be explained by the increased union influence on business decision, which renders the firm inflexible in replacing the union workers (Abraham & Taylor, 1996). Non-managerial average wage has a positive and significant effect. Exporting, large size, and the number of locations also have positive effects as explained above.

So far, the specification of roll-back firms relied primarily on the estimated transition probabilities from the mixture model. The transition probabilities, although outlining a gradual evolution process, could be influenced by noise for various reasons, including the existence of outliers and also by the quality of fit. One may wonder how much of the positive effect of rolling-back found in Table 6 is the real effect and how much attributed to noisy probabilities. For robustness, the transitional effect is re-estimated but using the traditional approach by defining an ad hoc dummy for transitioning firms ($TRANS$). However, in this application we can avoid making a wild guess, and the choice dummy is regulated using the rough picture provided by Figure 5(b).

The model is essentially the same as (23), except for the use of dummies, so that it will now look like

$$Prob\big[CONOUT_{j,t+1} = 1|t\big] = \Phi\Bigg(\alpha_0 + \alpha_1 TRANS_{j,t} + \alpha_2 RBACK_{j,t} + X'_{j,t}\beta\Bigg). \tag{24}$$

$RBACK$ is an extra dummy for roll-back firms that is equal to one if $TRANS = 1$ and the definition of no growth in Section 4.2 is met. As a result, $RBACK$ is defined in three different ways corresponding to RB1 to RB3. Several sets of results are estimated using the probit model, assigning different dummies for transition and using the three definitions of roll-back. These results are reported in the three sections of Table 7. To save space and to facilitate comparison, only the coefficients relevant to transition and productivity are listed in the table.

The first set of results assigns the transition region to cover the employment range 15 to 25, in order to make it approximately align with the peak of transition probability in Figure 5(b) and to make it narrow enough. The transitioning firms in this configuration are less likely to contract out than the average firm, while there is a significant and positive effect if the firm is a potential roll-back.

In the second set of results, the transitional range is expanded to cover sizes 10 to 30

| | | STALL | | |
|---|---|---|---|---|
| | | RB1 | RB2 | RB3 |
| Variable | (1) | (2) | (3) | (4) |
| $Log(TFP_t)$ | -0.019*** | -0.019*** | -0.019*** | -0.019*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| $TRANS_t$ | -0.012*** | -0.020*** | -0.017*** | -0.013*** |
| | (0.003) | (0.004) | (0.003) | (0.003) |
| $RBACK_t$ | | 0.023* | 0.070*** | 0.056*** |
| | | (0.010) | (0.009) | (0.014) |
| | TRANS: $15 < EMP \leq 25$ | | | |
| $Log(TFP_t)$ | -0.018*** | -0.018*** | -0.018*** | -0.018*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| $TRANS_t$ | 0.005 | 0.006 | 0.001 | 0.004 |
| | (0.003) | (0.004) | (0.003) | (0.003) |
| $RBACK_t$ | | -0.001 | 0.057*** | 0.045** |
| | | (0.005) | (0.009) | (0.014) |
| | TRANS: $10 < EMP \leq 30$ | | | |
| $Log(TFP_t)$ | -0.018*** | -0.018*** | -0.018*** | -0.018*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| $TRANS_t$ | -0.021*** | -0.024*** | -0.021*** | -0.021*** |
| | (0.004) | (0.005) | (0.004) | (0.004) |
| $RBACK_t$ | | 0.010 | 0.058*** | 0.049*** |
| | | (0.013) | (0.009) | (0.013) |
| | TRANS: $25 < EMP \leq 35$ | | | |

Table 7: The estimated marginal effects for the propensity to contract out using a probit model and the transition dummy. Numbers in parentheses are robust standard errors. ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively. Estimates are all controlled for industry, age and year effects by including the appropriate dummies. $t = 1994-95, 1995-96$. The sample is 4,023 firm-years from the BLS.

employees to check robustness to the width of the region. Apart from the roll-back definition RB1 (which was the weakest, by the way) the transitional effect shows robustness to changing the width of the region.

In the third set of results, transitional region is chosen out of alignment with the bulk of the estimated transition probability, so that the sensitivity of the results to the precise location of the transitional region can be tested. Again, apart from definition RB1, the transitional effect shows robustness to the location of the selected region.

# 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. The results of Section 5.2 do not stray from this line. Often neglected is that some firms also outsource not to grow. The latter behavior has nothing to do with efficiency and merely happens because fixed costs are not "fixed" as in the existing theories, but vary with size non-linearly. The non-linearity is shown to have important implications, in fact, holding firms back and stopping them from further growing internally. Using various definitions of transitioning, it is shown that those firms that are caught up in transition with no way forward would resort to outsourcing peripheral jobs to expand their scale of operation without really growing in size. These firms are fairly efficient, but not efficient enough to absorb the increased overhead cost and transition well into large size.

A side story of this paper emphasizes the discrete nature of firm size and the importance of this discreteness in the analysis of firm behavior and performance. Small firms are the ones receiving tax benefits to invest in job creation and growth. The discreteness of size, however, shows that the growth incentive is actually missing among a subset of small firms. We will be over-estimating the contribution of small businesses to job creation, unless we allow for discontinuity in the decision making process of small versus large firms.

# A Details of Derivations

**Deriving** (4)**:** Using $s = m/k$, the profit function in the small regime can be written as

$$\pi_S(m, \phi) = A\phi^{1-\alpha} m^\alpha - m/k_m - w_f f_0. \tag{25}$$

Taking derivative with respect to $m$ and setting it to zero gives (4). However, $m_S(\phi)+s_S(\phi) \leq \bar{l}$, therefore, the solution must be bounded by $k_m \bar{l}$. ■

**Deriving** (5)**:** Simply plug (4) into (25) and use the definition of $\Pi$. The size of hired labor reaches $\bar{l}$ when $m_S(\bar{\phi}) = k_m \bar{l}$, or when

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

Firms with $\phi > \bar{\phi}$ have to keep their size fixed at $\bar{l}$ and their profit will be

$$\begin{aligned}
\pi_S(\phi) &= A\phi^{1-\alpha}(k_m \bar{l})^\alpha - \bar{l} - w_f f_0 = \bar{l}\left(A k_m^\alpha \phi^{1-\alpha} \bar{l}^{\alpha-1} - 1\right) - w_f f_0 \\
&= \frac{\alpha \Pi \bar{\phi}}{1-\alpha}\left(A k_m^\alpha \left(\frac{(1-\alpha)\phi}{\alpha \Pi \bar{\phi}}\right)^{1-\alpha} - 1\right) - w_f f_0 && \text{using } \bar{\phi} = \frac{1-\alpha}{\alpha \Pi}\bar{l}, \\
&= \frac{\alpha \Pi \bar{\phi}}{1-\alpha}\left(\frac{1}{\alpha}\left(\frac{\phi}{\bar{\phi}}\right)^{1-\alpha} - 1\right) - w_f f_0 && \text{using } \frac{\alpha \Pi}{1-\alpha} = \frac{(\alpha A k_m)^{\frac{1}{1-\alpha}}}{k_m}.
\end{aligned}$$

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 $1 + w_f f_1$. Solving the first order condition gives

$$m_L(\phi) = \left(\frac{\alpha A k_m}{1 + w_f f_1}\right)^{\frac{1}{1-\alpha}} \phi.$$

Note that the least efficient firm that can operate in large size regime is the one with $m_L(\bar{\bar{\phi}}) + s_L(\bar{\bar{\phi}}) = \bar{l}$, which yields

$$\bar{\bar{\phi}} = (1 + w_f f_1)^{\frac{1}{1-\alpha}} (\alpha A k_m)^{\frac{-1}{1-\alpha}} \bar{l} = (1 + w_f f_1)^{\frac{1}{1-\alpha}} \bar{\phi}.$$

Plugging the solution for $m_L(\phi)$ into the profit function readily gives (7). ■

**Deriving** (10)**:** Each party solves for its optimal labor size and the smaller requirement determines the scale of operation. The decision by the supplier and the manufacture are, respectively,

$$(\omega\alpha Ak)^{\frac{1}{1-\alpha}}\phi \text{ and } \big((1-\omega)\alpha A\big)^{\frac{1}{1-\alpha}}\phi.$$

The final scale of operation is the minimum of the two, bounded above by $\bar{l}$. ■

**Deriving** (11)**:** Given Assumption 1, the supplier's production plan takes effect. Plug the suppliers choice of manufacturing size into (9) to get

$$\begin{aligned}
\pi_S^m(\phi) &= (1-\omega)A\phi^{1-\alpha}m_o(\phi)^\alpha - m_o(\phi) - w_f f_0^m \\
&= m_o(\phi)\Big(A\phi^{1-\alpha}m_o(\phi)^{\alpha-1} - 1\Big) - w_f f_0^m \\
&= (\omega\alpha Ak)^{\frac{1}{1-\alpha}}\phi\left(\frac{(1-\omega)A\phi^{1-\alpha}}{\omega\alpha kA\phi^{1-\alpha}} - 1\right) = w_f f_0^m && \text{replace } m_o(\phi) \\
&= \frac{(\omega k/k_m)^{\frac{\alpha}{1-\alpha}}}{1-\alpha}\frac{(1-\alpha)(\alpha Ak_m)^{\frac{\alpha}{1-\alpha}}}{\alpha k_m}\phi(1-\omega-\omega\alpha k) - w_f f_0^m && \text{replace with } \Pi \\
&= \frac{(\omega k/k_m)^{\frac{\alpha}{1-\alpha}}}{1-\alpha}\Pi\phi(1-\omega-\omega\alpha k) - w_f f_0^m. && (26)
\end{aligned}$$

The size of manufacturing firm hits $\bar{l}$ at $\bar{\phi}_o$, where $\bar{\phi}_o$ is found from

$$\begin{aligned}
\bar{\phi}_o &= (\omega\alpha Ak)^{\frac{-1}{1-\alpha}}\bar{l} = \frac{1}{k_m}(\omega k_m)^{\frac{-1}{1-\alpha}}(\alpha Ak_m)^{\frac{1}{1-\alpha}}k_m\bar{l} \\
&= \frac{1}{k_m}(\omega k_m)^{\frac{-1}{1-\alpha}}\bar{\phi} > \bar{\phi}.
\end{aligned}$$

The last results is inferred from Assumption 1 and since $k_m < 1$. Beyond $\phi > \bar{\phi}_o$, the manufacturing firm operates at the size $m_L(\phi) = \bar{l}$. Plug this into $\pi_S^m$ and follow similar procedure as in (26) to get the second line in (11). ■

**Proof of Proposition 1:** Comparing (5) and (11), the effective productivity of an outsourcing manufacturer is

$$\frac{(\omega k/k_m)^{\frac{\alpha}{1-\alpha}}}{1-\alpha}(1-\omega-\alpha\omega k)\phi = \frac{\big(\omega(1+k)\big)^{\frac{\alpha}{1-\alpha}}}{1-\alpha}(1-\omega-\alpha\omega k)\phi.$$

Now set the above less than $\phi$ and solve for $\alpha$, and you'll get

$$\alpha < \frac{1 - \big((1+k)\omega\big)^{\frac{\alpha}{1-\alpha}}(1-\omega)}{1 - \big((1+k)\omega\big)^{\frac{\alpha}{1-\alpha}} k\omega},$$

which is the specified condition in Assumption 2. By Assumption 1, the right-hand side above is less than one. ■

# 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.

**EXPINT:** Is formed by dividing the nominal value of exports by the nominal value of sales. The nominal value of exports in the BLS is reported in the variable EXPORTS, and the nominal value of sales is obtained from the variable SALES.

**STARTX:** Dummy indicating if a firm intends to start exporting. The BLS variable INTCOEX indicates whether a firm intends to commence or continue exporting. If EXPORTS is zero for the same year, then the response is taken as the intention to commence exporting.

**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.

**AGE2-4:** Dummy indicating if the firm is two to four years old. The BLS variable AGE5 is used that reports the age of a business in 0-1, 2-4, 5-9, 10-19, and 20+ bins.

**AGE5-9:** Dummy indicating if the firm is five to nine years old. Using the BLS variable AGE5.

**AGE10-19:** Dummy indicating if the firm is 10 to 19 years old. Using the BLS variable AGE5.

**AGE20+:** Dummy indicating if the firm is 20 years or older. Using the BLS variable AGE5.

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