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DO SMALL PLANTS REALLY CREATE MOST JOBS?
Testing Convergence of Establishments in the U.K.

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Abstract

This paper investigates the "convergence" hypothesis: small plants grow, while large plants shrink, which lead to the believe that small plants are the major job creators. We start with decomposing net job creation into gross job creation and gross job destruction. We then investigate the growth-size type of regression and show that a negative effect of a plant's initial size on its growth rate is the result of a *regression-to-the-mean* or *Galton's fallacy*. We then compute 1-year Markov transition matrices which suggest a relative stable size distribution of plant sizes in the U.K..

I. Introduction

There seems to exist a conventional wisdom that small, rather than large firms are the major job creators. In the U.S., Birch (1979), Armington and Odle (1982), Brock and Evans (1989), amongst others and in the U.K., Gallagher et al. (1990, 1991), have emphasized the crucial role small firms play in the net job generation process. The New York Times for instances publishes "Small businesses have become the superstars of job creation, producing up to 80 percent of new jobs in recent years.... Considering the success of small businesses in today's service sector and their willingness to take on and retain new employees, it would be innovative and economically sound for the Clinton Administration and Congress to give business a tax credit for hiring additional people" (Muriel Siebert, New York Times, January 6, 1992). For the U.K., similar quotes can be found, "A recent study of U.K. businesses reveals that small firms continue to make a disproportionate contribution to job creation"(Employment Gazette, February, 1990) and "... firms employing fewer than 10 people created over 1/2 million jobs during 1987-89. This was almost half of the total net job growth, even though they contained less than one fifth of the employment" (Employment Gazette, November, 1991).

In this paper we seriously question the general belief that it is small firms who constitute the "engine" of the economy. This casts a different view on economic policy directed towards stimulating and promoting small firms, defended by Birch (1979) and others. It is important to address this question given the huge unemployment problem in the

U.K. and elsewhere. Should public policy really be directed toward stimulating small businesses? How persistent are the new jobs created by small business compared to large firms?

Traditionally, the focus has been on the *net job creation rate* or *net employment growth*. In this paper we first decompose this net job creation rates into two components, the *gross job creation rate* and the *gross job destruction rate*, the difference of them gives the *net job creation rate*. Gross job creation is defined as the sum of all employment gains by firms relative to the size of the economy, similarly gross job destruction is the sum of all employment losses by firms relative to the size of the economy, expressed as a positive number. We will show that the way how we define size is going to matter. Studying gross job flows rather than net flows allows us to obtain additional information on employment dynamics that is not available from traditional employment statistics. For instance if aggregate employment grew 4%, this could be the result of 8% of gross job creation and 4% of gross job destruction, or of 30% gross job creation and 26% gross job destruction. Thus looking at gross job flows gives a better idea of the turbulence and structural change in an economy. Furthermore, recent empirical evidence on gross job flows shows that at all phases of the business cycle and even within narrowly defined sectors there is a lot of *simultaneous* gross job creation and destruction[2]. Figure 1 shows the aggregate gross job creation and

[2]The process of gross job creation and destruction has been analysed in detail for the U.S. by Davis and Haltiwanger (1990, 1992), Konings (1993) for the U.K., Boeri and Cramer (1993) for Germany and Contini and Revelli (1991) for Italy. Blanchflower and Burgess (1993) have used the three WIRS surveys to analyse gross job creation and destruction and its relation to plant growth.

destruction rate of the U.K. manufacturing sector for 1973-86 (Konings, 1994). It is immediately clear that the gross job destruction rate is more volatile over the cycle than the gross job creation rate and it has sharp spikes in recessions. While traditionally the emphasis has been on net job creation, figure 1 shows that low net job creation is the result of two forces: the gross job creation rate is relatively stable over the cycle, but the gross job destruction rate is not. Thus it is important to analyse both aspects together in order to understand the net job generation process. Moreover, this cyclicallity suggests that the underlying *cross-section distribution* of firm sizes might change over time due to economic shocks. Finally, if policy is concerned with stimulating small business, how stable are the job opportunities in different size classes? An idea of stable job opportunities can be obtained from studying gross job flows.

This process of job creation and destruction is ultimately linked to the evolution of the cross-section distribution of firms size. The growth and decline of establishments implies job creation and job destruction and hence changes in the industry structure and organisation. In the industrial organisation's literature this is usually analysed in the "convergence" framework: firms or plants of different sizes eventually converge to the same size. Thus small plants are more likely to grow, while large plants are more likely to shrink. If employment is used as a measure for size, then a negative relationship between a firms's net growth rate and its size reflects that small firms create more jobs inn percentage terms than large firms.

The type of regression analysis which is usually performed in this kind of work was first to compute an average growth rate over time for each plant or firm and second to regress it on initial size. Good examples include Hymer and Pashigian (1962), Singh and Whittington (1975), Kumar (1985), Evans (1987a,b) and Dunne, Roberts and Samuelson (1989). There are however two major concerns with this approach which are very similar to the criticisms in the recent cross-country income growth literature (Quah, 1993a,b). The first concern relates to the use of an *average* growth rate as the dependent variable. By using the average growth rate the time dimension is completely ignored and hence a lot of useful information is not used. Thus large economic shocks, which fall in the middle of the sample period over which the average is computed, are not controlled for. Thus the underlying assumption is a stable growth path for each plant. The second major concern is the *regression-to-the-mean fallacy* or Galton's fallacy. This fallacy has been discussed by Leonard (1986) and Quah (1993) amongst others. We will discuss this fallacy in detail in section III.

The remainder of this paper is organised as follows. In section II we show gross job creation, destruction and net job creation rates for different size classes and illustrate that it does matter how one defines size: lagged employment, current employment or average employment? The answer why it really matters is given in sections III and IV where we discuss the regression-to-the-mean fallacy which leads to the (possibly false) conclusion that small plants or firms are the major job creators. We illustrate this by reporting and replicating for the U.K. the typical growth rate-size regressions which are common in the Industrial Organisation's literature. We continue with computing Markov transition matrices and infer from them a relatively stable size distribution of plants in the U.K. over time and hence test the convergence hypothesis in a non-parametric way. To do this we make use of plant level data based on three occasional surveys, the Workplace Industrial Relations Survey. In section V we conclude and summarize.

II. Gross Job Creation viz. Net Job Creation

In this section we illustrate the difference between net and gross job creation. Moreover, we explore the cross-section dimension, rather than the time-series dimension, in other words we investigate the relationship between gross job flows and different size classes. The data we use are drawn from the Workplace Industrial Relations Surveys in 1980, 1984 and 1990 (see Millward et al., 1992 for details and description of the datasets). These are occasional surveys sampling over 2000 plants across the U.K. and across different sectors in both the manufacturing and the non-manufacturing sector. To be included in the survey the plant must have at least 25 employees. Thus one drawback of the sample is that we do not observe entry and exit. Small plants are more likely to fail, however, high exit rates are often compensated by high entry rates (Brock and Evans, 1989). We are able to compute growth rates since the surveys asked retrospective questions on employment levels 12 months before the survey, as well as a few years before.

We have experimented with three different definitions of size, a) lagged employment, b) current employment, c) average employement, i.e. lagged employment plus current employment divided by two. We have only considered those plants which reported positive employment in the previous year, because there is no information on whether the plant was new if there was 0 employment a year earlier. We have defined four size (s) class categories, $s \leq 99$, $100 \leq s \leq 249$, $250 \leq s \leq 499$ and $s \geq 500$. This partition is of course somewhat arbitrary and we lose information on what happens within size classes. However, by increasing the number of size classes the number of observations per size class is reduced which implies a loss of statistical representativeness. Table 1 shows the frequency of job creation and destruction by plant size relative to the total number of jobs created resp. destroyed for the three survey years taken together. Irrespective of the size measure we use, it is clear that the majority of the jobs is being created and destroyed in plants whose size is larger than 100. It is remarkable how similar these results are to those found by Davis et al. (1993) for the U.S.. They report that plants averaging at least 100 employees accounted for roughly 70% of newly created and newly destroyed manufacturing jobs. This result is in fact not surprising since the majority of jobs is concentrated in the larger plants as can be seen in the last column of table 1. Thus the large plants not only provide most jobs, the large plants carry the major share of job creation and job destruction. Even when we take as definition for a "small" plant those plants employing less than 500 people as is done in the small business literature, we still find that most jobs are created and destroyed in the large plants, irrespective of the definition of size we use.

In table 2 we show the average gross job creation, destruction and net job creation *rate* taken over the three survey years, again using the three alternative measures of size. The first panel of table 2 shows the base year measure of size. *Net* job creation is highest in the smallest plants and decreases monotonically with size. In contrast, when we use current employment as the measure for size, the monotonic relationship between plant size and net employment growth disappears. The largest plants have the largest net employment growth (least negative). When we look at the gross job creation and destruction measures there is a monotonic relationship between size and the gross job creation rate and this relationship remains irrespective of the definition of size: Small plants have higher gross job creation rates than large plants. Somewhat surprising, the same is not true for the job destruction rate. There is, however, no clear pattern between size and the gross job destruction rate. This contrasts with other studies like Davis et al. (1993) for the U.S., where the gross job destruction rate is highest in small plants. The gross job destruction rate can provide, assuming stationarity, information on the stability of job opportunities. The expected duration of a job opportunity equals the inverse of the job destruction rate (Leonard and Schettkat, 1991). From table 2 we find that the expected duration of a job opportunity in the smallest size category varies between 12.5 and 28 years, depending on which measure for size is used. Similarly, for the largest size category we cannot be very precize, the expected duration of a job opportunity varies between 16 and 24 years.

We can learn two main points from table 2, first, underlying the net employment growth rate there exists a substantial amount of *both* job creation and destruction, second, it is not at all clear that there exists a monotonic relationship between the net job creation rate and size of the plant. This relationship crucially depends on which measure is used for size. This, as we shall argue in section III, reflects the *regression-to-the-mean* fallacy.

III. The Regression-To-The-Mean Fallacy

The size-growth relationship illustrated in section II has been presented in a more rigourous way by regressing a plant's (average) growth rate on its initial size, which resulted in a negative coefficient on initial size. However, Leonard (1986) has shown that this relationship is a biased result. If the distribution of firm size is time invariant, then random fluctuations in firm size can easily generate such a negative relationship. We shall illustrate this with a simple example. A simple process embodying these characteristics is as follows[3],

$$(1) \qquad \ln x_{it} = \boldsymbol{\beta}'\mathbf{z} + \epsilon_{it}$$

where $\boldsymbol{\beta}$ is a vector of parameters capturing the effect of $\mathbf{z}$ a vector of explanatory variables of establishment characteristics and ϵ_{it} is a random error that may include measurement error and which is assumed to be Normally distributed with zero mean and finite standard deviation. Specification (1) assumes that size of a plant is determined by certain

[3]Quah (1993a) provides a more rigourous exposition of the regression-to-the mean or Galton's fallacy.

characteristics like for instance sunk costs, regional effects, age, etc.. This is the maintained hypothesis in the existing literature. The alternative would be that size simply follows a random walk. However, the point here is to show that the result that initial size affects a plant's growth rate negatively is a pure spurious result, given specification (1). It follows that

$$(2) \qquad E[\ln x_{it} - \ln x_{it-1} | \ln x_{it-1}] = \boldsymbol{\beta}'\mathbf{z} - (\boldsymbol{\beta}'\mathbf{z} + \epsilon_{it-1}) = - \epsilon_{it-1}$$

where E stands for the expectations operator. From (2) it follows that large plants, compared to their expected size, are expected to shrink or grow less, while small plants are expected to expand or grow more. There is no a priori reason to take the expectation as in (2), conditional on lagged size. Alternatively it is possible to take the expectation as in (2), but conditional on current size or

$$(3) \qquad E[\ln x_{it} - \ln x_{it-1} | \ln x_{it}] = \boldsymbol{\beta}'\mathbf{z} + \epsilon_{it} - \boldsymbol{\beta}'\mathbf{z} = \epsilon_{it}$$

Thus (3) suggests that large plants are expected to grow, compared to their expected size, while small plants are expected to shrink or grow less. Thus, in this framework differences in plant sizes are purely generated by transitory random shocks, although one would be inclined to conclude from an estimation like (2) that there exists convergence of plant sizes.

We illustrate this fallacy by reporting growth type regressions like Evans (1987a,b). The empirical specification that we seek to estimate can be summarised in its most general form as the following,

$$(4) \qquad [\ln x_{it} - \ln x_{it-1}] = \ln g(x_{it-1}, \mathbf{z}) + \epsilon_{it}$$

where **z** is a vector of other control variables, including age of the firm, regional and industry effects. Age often enters as one of the explanatory variables to test theories of passive learning (Jovanovic, 1982). It is possible to take a first or a second order polymonium expansion of (4) and then test what variables enter significantly. This is what is usually done. The growth rate we work with is the one year net employment growth rate. The data we use are the same as in section II, but now we treat the three surveys seperately and report for each year a seperate regression of equation (4). We report both OLS and heteroscedastic consistent estimators, for the latter we have used Huber consistent standard errors which is similar to White's method (1967). Table 3 reports the results. Panel A shows the results for 1980, panel B for 1984 and panel C for 1990.

The results for the three years all point to the same conclusion. Even after controlling for industry effects, regional effects and age category (column 3) there is a significant and negative effect of initial size on the rate of growth of plant level employment. The elasticity of the growth rate with respect to size a year earlier varies between -2.1% and -3.4% depending on the type of specification and the sample year. Moreover, age of the plant, industry and regional effects are controlled for, so this negative size effect cannot be attributed to different phases in the life cycle of plants nor to different minimum efficiency scales in various industries or regions. So these results all suggest the same conclusion as in Evans (1987a,b) amongst others that employment growth is concentrated in small plants. Thus this would comfirm the convergence hypothesis. However, let us consider a different measure for size, current size. If the results of table 3 reflect a *regression-to-the-mean* fallacy, we should obtain a positive effect of current size on a plant's growth rate. Table 4 reports the results. Interestingly, we do obtain a positive effect of current size on growth for all three survey years, although the effect is not statistically significant for 1984. Thus this type of regression suggests that large plants have larger growth rates than small plants, as predicted by the simple models above. What does seem to be a robust result is the age effect. In both type of regressions age has a negative effect on a plant's growth rate, which would be consistent with "learning" theories.

IV. The Size Distribution of Plants in the U.K.

In this section we explore in detail whether the "convergence" hypothesis is indeed true or merely a spurious result. We do this by exploring how the cross-section distribution of plant size evolves over time. In figures 2,3 and 4 we have plotted the logarithm of employment in year t-1 against the one in year t, we get the impression that the size distribution of plants is relatively stable. The scatter plot of observations lies around the 45° - line for all three surveys. Thus small plants today are also small tomorrow as well as large plants today are going to be large tomorrow. This result remains true even if we compare current size with lagged size more than 1 year, we did however not report these figures since they do not contain extra information due the time period they cover. In the three samples the earliest initial size with which to compare is 6 years ago in WIRS90, 4 years ago in WIRS84 and 5 years ago in WIRS80. It would be much more informative if we could compare initial size 20 years ago, because then inferences on the steady state distribution of plant size would be possible.

In order to evaluate the nature of the dependency on size of plant growth, we have computed Markov 1-year transition matrices. Transition matrices quantify what we observe in figures 2,3 and 4. They provide information on the stability of the underlying distribution of employment across different size classes or states and illustrate how jobs flow from one state to another, hence they illustrate in which size classes jobs are destroyed and created. Let $S_i(t)$ denote the number of plants in size class or state i at time t and let $S'(t)$ denote the vector summarizing all possible states. Then, assuming no entry or exit, we can represent job flows as

$$(5) \qquad S(t+1) = M'S(t),$$

where M is a square non-negative migration matrix describing transitions of movements of plants from one state to another. To compute this transition matrix we first need to define the discrete space of size classes. This is always somewhat arbitrary, but given our data this is the best we can do. We have chosen 4 different size classes: $25 \leq size < 100$, $100 \leq size < 250$,

$250 \leq size < 500$ and $size \geq 500$. Again, we repeat that this choice is arbitrary and it is possible to experiment with more size classes at the expense of the number of observations within a size class.

The entries of the M matrix are simply the relative frequencies or

$$(6) \qquad m_{ij}(t,t+1) = n_{ij}(t)/n_i(t),$$

where $n_{ij}(t)$ stands for the number of plants moving from state i to state j, while $n_i(t)$ stands for the number of plants in state i at time t. Under the assumption that plant growth follows a first-order Markov chain, these coefficients can be interpreted as unrestricted maximum likelihood estimators of transition probabilities. Thus $m_{ij}(t,t+1)$ is the probability of moving from state i to state j over a one-year period. We report these transition matrices in table 5 panel A,B and C refering resp. to the three survey years. A striking result is the relative stability over time of the size distribution of plants as can be seen by the high values on the main diagonal. Moreover, the value is highest for the smallest size categories indicating that a small plant is more likely to stay small than a large plant to stay large. Of course, these transition matrices are one-year transition matrices and refer only to three cross-section distributions. Thus it is not feasible to infer from them an ergodic distribution, nevertheless they provide us with interesting information. In 1980 it seems that small plants were more likely to move to a higher size class than large plants and large plants were more likely to move to a lower size class. However, in 1984 and 1990, the smallest plants were less likely than the larger ones to move to a higher size class. Thus these probabilities seem to vary, albeit by tiny amounts, over time. The observed pattern in the transition matrices is consistent with table 1 where we computed the frequencies of job creation and job destruction. We saw that in the 3 smallest size categories there was some job creation and destruction, but that most jobs were created and destroyed in the largest size category. Thus turbulence occurs predominantly in the largest size class, although there is some turbulence going on in smaller size classes as well. Movements between different size classes are of minor importance.

Definite statements can only be made once the steady state distribution is computed, but this is not justifiable given the limited number of time observations in our dataset. Nevertheless, this section has pointed towards evidence in the direction of relatively stable size distribution of plants, with high persistency, rejecting the convergence hypothesis.

V. Conclusion and Summary

Employment growth undoubtfully is one of the crucial aspects to eliminate the unemployment problem. In this paper we analysed the process of employment growth using three occasional surveys of plant level employment data in the U.K.. There exists a common belief that small plants are the engine of the economy and that they are the main job creators. Evidence has been reported in both the labour economics literature as well as in the industrial economics literature. The latter was concerned with testing the growth-size relationship and industry evolution. The current state of knowledge is that there exists a negative relationship between intial size of a plant and its growth rate, after controlling for age. Hence, small plants create more jobs than large plants. We have found that this is true in the U.K.. Furthermore, there exists a negative relationship between the age of the plant and its growth rate which is consistent with the passive learning hypothesis. However, we have shown that this relationship is driven by a *regression-to-the-mean* effect. The relationship between a plant's current size and its growth rate turns out to be positive, suggesting that large plants are the main job creators. Thus we find no strong systematic relationship between net employment growth and size. We find evidence that suggests that plant size is relatively stable over time, however, due to the limited number of time observations we could not compute the ergodic distribution of plant size.

The findings reported in this paper are similar to the recent research on the topic in the U.S. and can therefore be seen as extra evidence which clashes with the conventional wisdom that small plants are the main job creators. Policy implications can be numerous. In any case, it seems to be clear that policy should take into account not only the process of net job generation, but also the processes which lead to it: gross job creation *and* destruction.

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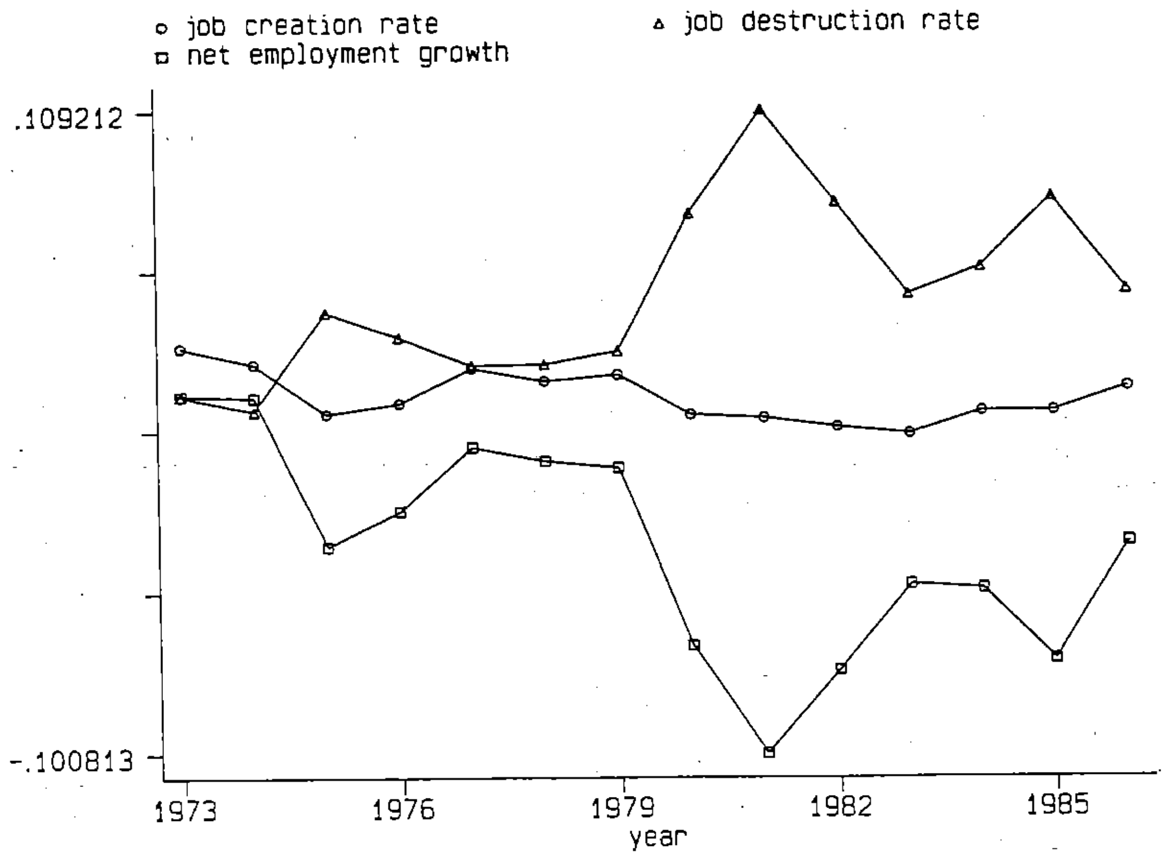
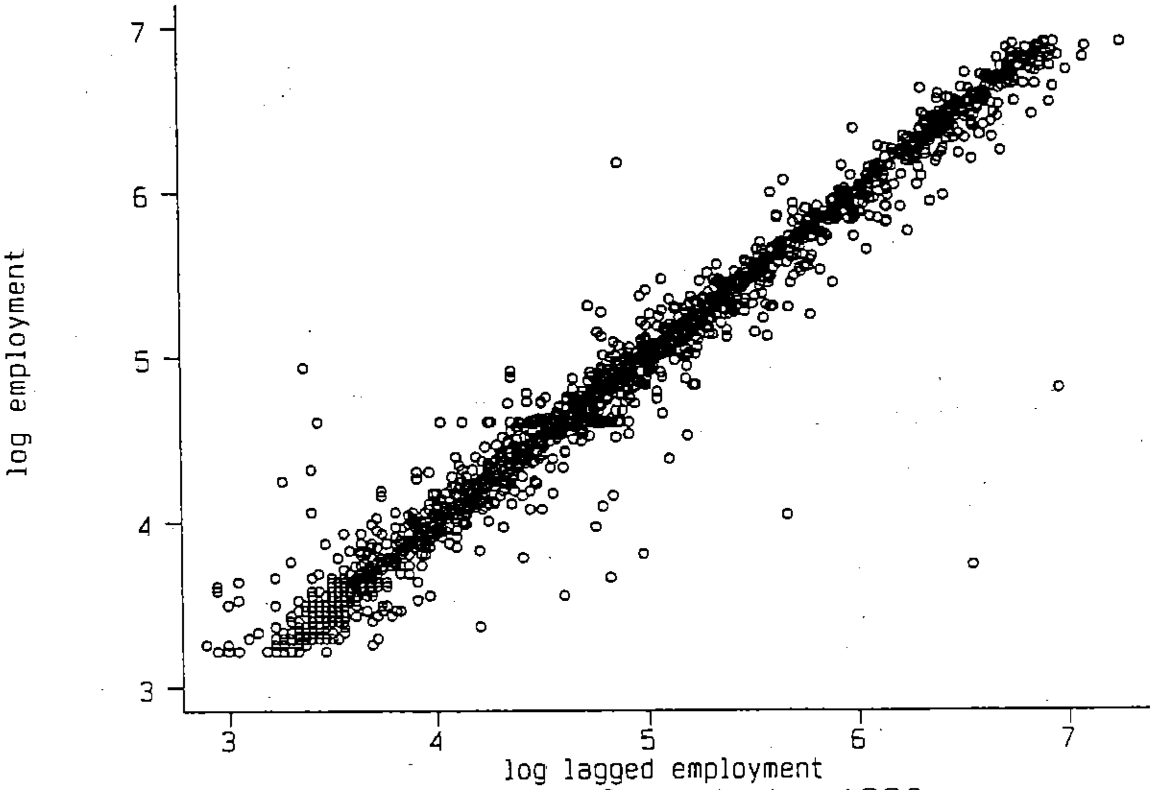
Figure 1



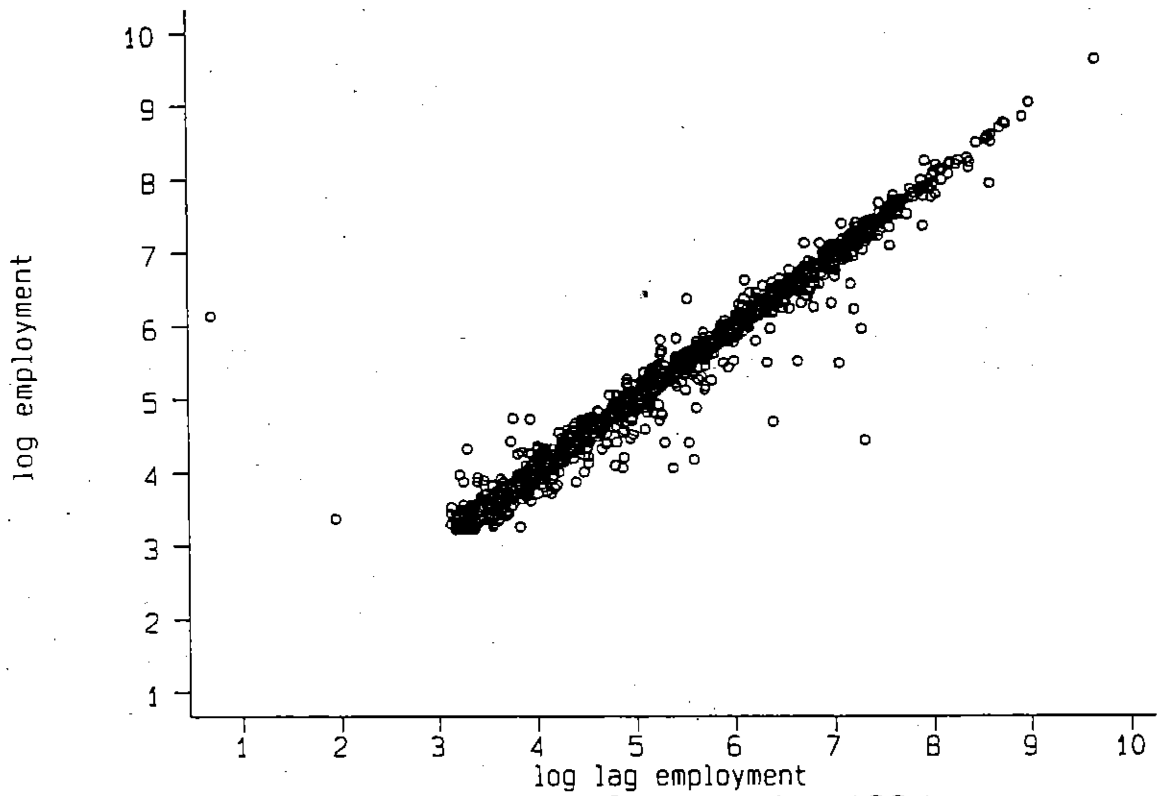
Source: Konings (1993)

Figure 2



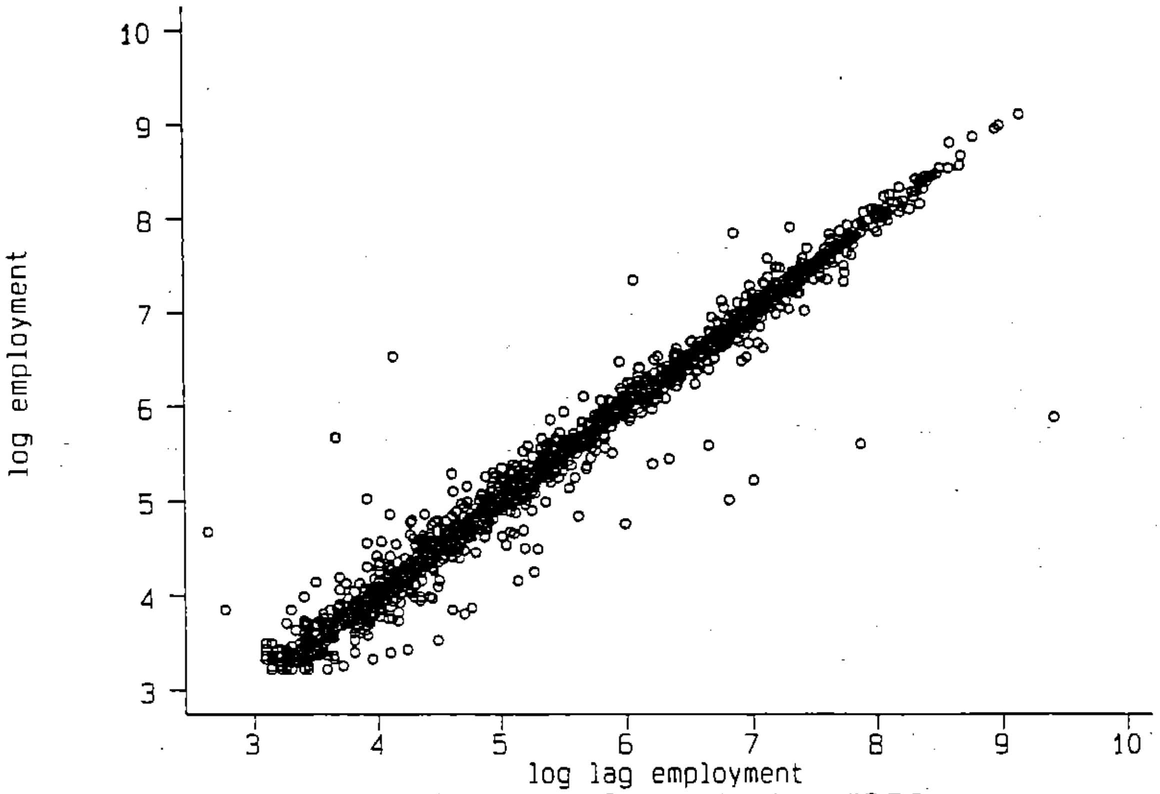
current size viz. lagged size,1980

Figure 3



current size viz. lagged size,1984

Figure 4



current size viz. lagged size,1990

Table 1

Frequency of Gross Job Creation and Gross Job Destruction

	POS%	NEG%	Employment
lagged employment as size			
≤99	0.26	0.037	0.0646
100≤s≤249	0.14	0.106	0.124
250≤s≤499	0.127	0.12	0.126
s≥500	0.467	0.73	0.684
current employment as size			
≤99	0.084	0.090	0.0584
100≤s≤249	0.17	0.16	0.1352
250≤s≤499	0.137	0.21	0.1303
s≥500	0.60	0.53	0.6771
average size as size			
≤99	0.12	0.049	0.0607
100≤s≤249	0.16	0.119	0.1278
250≤s≤499	0.14	0.131	0.1277
s≥500	0.57	0.69	0.6777

Table 2

Average Gross Job Creation, Destruction and Net Creation Rates

	POS	NEG	NET
lagged employment as size			
≤99	8.04	3.52	4.51
100≤s≤249	4.57	4.94	-0.36
250≤s≤499	4.51	5.26	-0.74
s≥500	2.82	6.31	-3.49
current employment as size			
≤99	4.04	7.97	-3.93
100≤s≤249	3.78	6.78	-3.00
250≤s≤499	3.18	9.84	-6.65
s≥500	2.50	4.10	-1.59
average size as size			
≤99	5.54	4.38	1.11
100≤s≤249	4.63	5.35	-0.71
250≤s≤499	3.89	5.58	-1.69
s≥500	2.72	5.90	-3.17

Table 3

Regression Results
Dependend Variable: Growth Rate Plant i

A/1980	(1)	(2)	(3)
$\ln(\text{employment})_{it-1}$	-0.034 (0.004) [0.005]	-0.030 (0.004) [0.005]	-0.028 (0.004) [0.005]
Age	–	–	-0.013 (0.004) [0.005]
Industry and Regional dummies	NO	YES	YES
B/1984			
$\ln(\text{employment})_{it-1}$	-0.030 (0.003) [0.008]	-0.028 (0.004) [0.009]	-0.028 (0.004) [0.009]
Age	–	–	-0.00008 (0.0045) [0.0057]
Industry and Regional dummies	NO	YES	YES
C/1990			
$\ln(\text{employment})_{it-1}$	-0.023 (0.0039) [0.0059]	-0.023 (0.0041) [0.0063]	-0.021 (0.004) [0.0062]
Age	–	–	-0.0014 (0.0007) [0.0008]
Industry and Regional dummies	NO	YES	YES

Notes: (.) denotes standard error from OLS regression; [.] denotes Huber standard error.

Table 4

Regression Results
Dependent Variable: Growth Rate Plant i

A/ 1980	(1)	(2)	(3)
$\ln(\text{employment})_{it}$	-0.001 (0.004) [0.004]	0.007 (0.004) [0.004]	0.008 (0.004) [0.004]
Age	_	_	-0.017 (0.046) [0.006]
Industry and Regional Dummies	NO	YES	YES
B/ 1984			
$\ln(\text{employment})_{it}$	-0.003 (0.003) [0.003]	0.0021 (0.004) [0.003]	0.0024 (0.004) [0.003]
Age	_	_	-0.003 (0.004) [0.005]
Industry and Regional Dummies	NO	YES	YES
C/ 1990			
$\ln(\text{employment})_{it}$	0.0036 (0.004) [0.003]	0.0061 (0.004) [0.003]	0.009 (0.004) [0.003]
Age	_	_	-0.002 (0.0007) [0.0009]
Industry and Regional Dummies	NO	YES	YES

Notes: As in table 3.

Table 5

Transition Matrices

A/1980	1	2	3	4
1	0.85	0.15	0	0
2	0.065	0.92	0.013	0
3	0.004	0.11	0.84	0.033
4	0.123	0.11	0.108	0.66

B/1984	1	2	3	4
1	0.96	0.03	0	0
2	0.066	0.90	0.033	0
3	0.009	0.11	0.835	0.041
4	0.057	0.072	0.071	0.798

C/1990	1	2	3	4
1	0.95	0.040	0.0016	0.0016
2	0.066	0.872	0.0611	0
3	0	0.065	0.848	0.0858
4	0	0	0.026	0.973

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