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A DESCRIPTIVE ANALYSIS OF THE GROWTH AND FLUCTUATIONS OF FRENCH MANUFACTURING FIRMS

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This paper is a first report on an analysis of the pattern of fluctuations in the growth firms in the French manufacturing sector as measured by employment, sales, and capital stock. By studying the behavior of individual firms and assessing the variability of growth and decline across the firms, I hope to learn something about the way in which aggregate shocks to the economy are transmitted through single firms to changes in observables such as employment. In particular, by comparing the French firms to a similar sample of American firms which I have already analyzed, it is possible to determine which elements of the adjustment of capital and labor are in common between the two countries, and what differences (if any) exist in the way that the two sectors respond to changes in the macroeconomy.

At the outset, one might ask what we can learn from a time series analysis of firm data. From the point of view of the economy as a whole, the primary interest in such an exercise is in describing how the

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aggregate shocks are made up: what is it about movements in the shocks to individual firms which add up to the observed aggregates? From the point of view of an individual firm, one can describe the time lags of its adjustment of employment levels, capital stock, inventories, etc. to aggregate macro shocks to the economy. The essence here is an exploration of the heterogeneity across firms -- using a model where the parameters are the same for all firms may not be an adequate description of the data and may produce misleading conclusions about aggregate behavior.

I have chosen initially to compare univariate analyses of sales, capital stock, and employment, because these variables are a basic description of the firm, and because I had data for them for both countries. The univariate nature of the analysis allows me to focus on the dynamic response of the firms to shocks without introducing complications which describe the interrelatedness of, for example, the capital and labor variables. It represents a way station on the road to the complete understanding of these data, and I will consider a more complete multivariate model in the near future (possibly in a revision of this paper).[2]

1. Description of the Data

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2. This version of the paper is restricted in its results by my lack of access to the MOMENTS program (which allows the fitting of complex nonlinear models to a covariance matrix) while I am in France. Both the autoregressive models described below and the multivariate analysis await future work for this reason.

The basic dataset is a panel of 427 French manufacturing firms from 1966 to 1979 (14 years) which has been prepared from data collected at INSEE by Jacques Mairesse and co-workers for the purpose of analysing productivity growth at the firm level. The average size of these firms both overall and by industry is given in Table 1, with the corresponding numbers for my U.S. sample (1972-1979) for comparison. The firms are on average smaller than the U.S. firms: the geometric mean of employment is equal to 658 employees as opposed to 2,841 in the United States, a ratio of about 2.3. For comparison, the ratio of population in France to population in the U.S. in 1980 was about one quarter.

Because the number of firms in the French sample is also substantially less than that in the United States, the total employment involved is only four percent of that in the U.S. sample. Although in both cases we have the very largest firms, this discrepancy does raise questions about the comparability of the samples. The main difference seems to be that the sampling methodology we used in the United States, which was to take all publicly traded firms, yields many more small but rapidly growing firms than the French sample, which has a more stable long-term character. This is particularily evident if one compares the electrical machinery and electronics industries, where the average firm sizes are nearly comparable, and where there has been substantial entry in the United States during this period.

Of course, there is no reason to expect the average firm size in manufacturing to be determined by population size, except to the extent that the size of the (domestic) market influences the optimal firm size. Technological considerations matter too, and unless the countries have vastly different production possibility frontiers or natural resource endowments, I would expect the ratio of firm sizes to be larger than the population ratio rather than further apart. This turns out to be true for these two samples in most of what I would label the "product-oriented" industries (the bottom half of the table), while the "process-oriented" industries typically have much smaller firms in France than in the United States. The most striking is the Chemicals industry, where the average firm size is only one tenth the average firm size in the same industry in the United States. This industry also has very few firms (only 13) and a total of 12,000 employees, so it is relatively insignificant in France. This may be due to the absence of a petroleum refining industry which is a natural complement to chemicals.

The chief variables on which I focus are the nominal sales (in 1000s of French francs), the book value of the capital stock at the beginning of the year (1000s FF), and the number of employees (in most cases an average of the number at the beginning of the year and the end of the year). In some of the work I also use the inventory stock, the materials purchased during the year, and the total labor compensation paid during the year. For the purpose of the analysis, I use the logarithms of the variables, since there is a large size range of firms, and previous work by myself and others with this kind of data has shown that the distributions are more nearly symmetric in logarithms. This choice has the advantage that when I work with differenced data, as I do much of the time, I am working with growth rates (approximately); if I also remove year means from these growth rates, it does not matter whether or not I deflate the data.

Unfortunately, the way employment has been measured (averaging the beginning and the end of the year) has consequences for my later analysis. As was pointed out long ago by Working (195), data constructed by a moving average methodology will induce correlated errors in the presence of any kind of stochastic structure. In particular, measurement errors in employment levels, when coupled with the averaging technique being used here, will induce a second-order moving average in employment, rather than merely first order. The problem is made more complicated by the fact that the averaging is being done in levels, but the analysis is in terms of logs. This latter fact will present no major problems if the year-to-year growth rates are of the order of twenty percent or less.

To show this, I let y_{it} denote the true level of the log of employment for the ith firm in the tth year, and I let the growth rates of employment evolve as

(1) $$\Delta y_{it} = \alpha_i + \varepsilon_{it}, \qquad \varepsilon_{it} \text{ white noise.}$$

$Y_{it} = \exp(y_{it})$ is the true number of employees at a point in time and $E_{it} = (Y_{it} + Y_{it-1})/2$ is the measured number. I choose to work with the growth rate of E_{it}, which is

(2) $$\begin{aligned}\Delta e_{it} = \Delta \log E_{it} &= \log(Y_{it}+Y_{it-1}) - \log(Y_{it-1}+Y_{it-2}) \\ &= (\Delta y_{it}+\Delta y_{it-1})/2 + O(\Delta y^2) \\ &= \alpha_i + (\varepsilon_{it}+\varepsilon_{it-1})/2\end{aligned}$$

Thus as long as the changes within firm are not too great from year to year, we can proceed with our analysis as though the logarithms of employment were averaged rather than the levels. But we still must be careful to correct any variance estimates for the fact that some of the movements in the variable are averaged out by the data collection process. The situation is made even more complicated by the fact that this data collection procedure was followed only for some of the firms (over eighty percent of them) for some of the time, so the simplest averaging model is not appropriate. I will have more to say in this in the next section after I present some results on the time series behavior of employment.

Table 2 shows a comparison of the average growth rates of French and U.S. firms for the three key variables. Both the sales and capital stock variables suffer from two problems which make a direct comparison difficult: first, the numbers have not been deflated, and I do not have all the deflators I need at the present time. This is easily corrected however, and will be in a revised version of this paper.

Second, for the work with sales and capital stock, my sample of U.S. firms is a technologically oriented R&D-doing subset, which grew much faster than the whole sector, and so I cannot compare it directly with the French numbers shown. Therefore, in the second pair of columns in the table, I restricted the French sample to those firms in the chemical, pharmaceutical, machinery, electrical, automotive, and transportation industries. This sector grew somewhat faster than manufacturing as a whole, but not by enough to change any conclusions.

The average growth rates show that for this sample employment growth is higher and more variable over time in the United States than in France; the higher variability also holds across individual firms as we will see in the next section. On the other hand, the output growth looks about the same in both countries (up to the difference in inflation rates), with the primary feature being a large dip in 1975 due to the oil price shock. The capital stock growth rates are a bit difficult to interpret, since there seems to be some kind of revaluation of the French capital stock which took place in 1978 and caused the large jump in growth rates (Mairesse, private communication).

2. Firm Size and Growth: a Comparison

In a recent paper (Hall (1987)) I presented evidence that departures from Gibrat's law for large manufacturing firms are not very big (a regression coefficient of approximately one percent in a regression of growth on the log of size), but cannot be accounted for by either measurement error or sample selection due to the exit of small firms from the panel. In Table 3, I compare the results from my previous paper for the United States with new results obtained with the French sample. Since I do not have data on attrition, it is not possible to correct for sample selection, but my work with the U.S. data suggested that performing this correction was difficult and not very conclusive - the coefficient of interest did not change much after this correction.

Note that in computing the results shown in the table I have used longterm (seven year) average annual growth rates, which mitigates the problem which arises in the French data due to the averaging used for construction. The table shows that French data violates Gibrat's Law even more weakly than the U.S. data, and that once again there is no room for measurement error (at least under the null hypothesis of no serial correlation in growth rates). In Hall (1987) I showed that if the true model were Gibrat's Law, but size was measured with error, then instrumenting size with lagged size (the last column of the table) should cause the coefficient to rise, not fall. In the case of the French data, I must use an instrument dated two periods before due to the averaging, but the argument still holds otherwise. The results show that the coefficient of size moves away from zero (by a small amount) when size is instrumented by lagged size; this was also what I found in the U.S. data.

To make this more explicit, consider the following simple model (abstracting for the moment from the measurement problem in the French employment data):

$$(3)\quad \Delta y_{it} = d_t + a_i + \varepsilon_{it}$$
$$\Delta Y_{it} = \Delta y_{it} + \Delta w_{it}$$

where y_{it} is the "true" value of the variable, Y_{it} is the measured value (in logs), w_{it} is the measurement error, d_t is a year specific growth rate, a_i is a firm specific growth rate (measured relative to the overall mean for each year, and ε_{it} is a random error term. d_t is treated as a "fixed effect" and is removed from the data before it is analyzed (all growth rates are measured relative to the overall year mean). The following stochastic assumptions are made:

$$(4)\quad Ea_i = 0 \qquad Va_i = \sigma_a^2 \qquad Ea_i\varepsilon_{it} = 0$$
$$E\varepsilon_{it} = Ew_{it} = E\varepsilon_{it}w_{it} = Ew_{it}w_{is} = 0$$
$$Vw_{it} = \sigma_w^2 \qquad V\varepsilon_{it} = \sigma_\varepsilon^2 .$$

These assumptions imply that the measurement error is uncorrelated over time and with the other shocks, the variances are constant over time and firm (this can be relaxed in the case of σ_ε^2), and that each firm has its own permanent rate of growth, but these rates are randomly distributed with respect to the measurement error.

With the year means removed, the estimating equation becomes

$$(5)\quad \Delta Y_{it} = a_i + \varepsilon_{it} + w_{it} - w_{it-1}$$

As it stands this equation is not really identified without further assumptions on the form of the ε_{it} process. At first I make the simplest assumption: that the shocks ε_{it} are serially uncorrelated, as my analysis of the U.S. employment data suggested. Then the regression of growth on size is

$$(6) \quad E(\Delta Y_{it}|Y_{it-1}) = E(a_i|Y_{it-1}) - E(w_{it-1}|Y_{it-1})$$

and

$$E(\Delta Y_{it}|Y_{it-2}) = E(a_i|Y_{it-2})$$

If the growth-size relationship is stable over time, the difference between the regression coefficients in columns 2 and 3 of Table 3 is a measure of (σ_w^2/Var Y). Since I have used growth rates averaged over seven years here, the measure is divided by seven, but it should still be positive if there is nonzero measurement error. The argument is modified slightly if the growth-size relationship changes from year-to-year, but the basic conclusion remains: for both countries, serially uncorrelated measurement error in the number of employees at a firm accounts for an infinitesimal part of the total variance in log employment and it is swamped by the large variance in the random shocks experienced by the firms, and by the changes in these variances from year to year.[3]

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3. It is also possible to test for errors in the size variable in this equation using a suggestion of Hausman (1978) by including the residual from the first stage in the second stage regression (and estimating it by ordinary least squares). Doing this resulted in a barely significant coefficient (t=2.3), which again suggests that measurement error is not very important. This is not different evidence from that in the table, just a different way of looking at the evidence.

The interesting differences between the two countries shown in the results in Table 3 are the following: first, during the seventies the U.S. manufacturing firms experienced much higher overall growth rates in employment (except during 1974-75, where the oil shock had more impact on employment in the United States). Second, the overall variance of growth rates is five times higher in the U.S. than in France. Finally, the relationship between size and growth is much steeper in the United States. Firms with one hundred employees in the U.S. experienced average growth rates from 1972 to 1979 of 5.3 percent per annum, whereas in France it was 0.1 percent per annum. At 10,000 employees, the outer range of the size of French firms, they were shrinking (in employment) at a rate of 2.7 percent per annum, while U.S. firms of that size were stagnant, at 0.7 percent per annum. We have already seen that this slow growth in employment is not paralleled by that in capital stock or output, implying increases in measured labor productivity over the period in France, as documented by Griliches and Mairesse (1984).

3. The Dynamics of Output, Employment, and Capital

In this preliminary investigation, the primary tool I use to examine the dynamics of growth in sales, employment, and capital is the autocorrelogram, estimated from the panel of firms using methods due to Macurdy (1986). Briefly, he suggests estimating the autocorrelogram for a panel of firms by first removing the year means, and then forming a full covariance matrix of the data, where the number of observations contributing to each covariance is the number of firms. By treating each firm's covariance for each year pair as an observation on the population covariance, one can both estimate the covariogram and test for covariance stationarity using fourth moments of the data to obtain standard errors on the covariances. The advantage of such a technique is that it does not require strong assumptions (such as normality) on the form of the disturbances in order to obtain asymptotically correct standard erros and tests. I have reported results using this method in the column labelled "Robust" in Table 4; the test for stationarity is given in the column labelled "Test".

Since in these data (both French and United States) I typically find that stationarity is accepted when first differences of the logarithms are used, except for the variances (zeroth order covariance), in the interests of readability, I have presented the correlogram averaged over all years for which the appropriate covariance is available (13 years in the case of the variance, down to 2 years for the lag 11 correlation). The standard errors were computed from the fourth moments, using a model which allows correlation within firm across the covariances, and are therefore reasonably large.

The column labelled "Avg. Firm" presents estimates of the correlogram obtained by a different method: in this case, I did not wish to impose that all firms follow the same time series process. Accordingly, I form a correlogram for each firm by dividing each covariance by the square root of the product of the corresponding diagonal elements of the covariance matrix (to obtain approximate stationarity). I then average the correlations for each lag across firms in order to obtain a correlogram. This correction for the changing variance in the innovation in each year is only approximately correct if the true model has other structure such as measurement errors in addition to a year-specific variance for the underlying shock, but given the fact that the correlation coefficients are all near zero, it is not too bad an approximation. This method results in correlation coefficients which are not that different from those computed by the first method; in particular, there is no evidence of a systematic difference in the two methods. This suggests that treating all the firms as though they follow the same process will not produce estimates which are vastly different from simple averages of firm behavior.

The resulting correlograms fall into two main groups: the first one is employment, capital stock, and labor compensation, which display autocorrelation typical of a low-order autoregressive process with a firm-specific random growth rate (equal and postive autocorrelations at long lags). If there is serially uncorrelated measurement error here, it would depress the first autocorrelation, and if the autoregressive process is of order less than 2, we can easily identify the magnitude of the error from the first three covariances and the variances, even if there are random growth rates. All three series have correlograms with little or no room for measurement error, because of the size of the first autocorrelation relative to the next two. Therefore either the process is a more complex higher order one, or we must conclude once again that there is no observable measurement error in these variables.

The other three variables, sales, inventory stocks, and materials purchased, follow a quite different pattern: for these variables, the first couple of lags have negative autocorrelations followed by correlations which tend to oscillate more in sign, although on the whole they are positive, suggesting some longrun differences across firms in the growth of output. The autocorrelations of sales and materials purchased track each other quite closely; this is not too surprising and does suggest that something like a constant ratio per firm might exist.

These three series also have variances which are much larger than that of the others, and would probably require at least an AR(2) process plus random growth rates to be adequately modelled.

The contrast between the two groups of series is basically a contrast between the growth rates of stocks, and the growth rates of flows, which fluctuate far more, and display less inertia. This is obvious, except for one interesting result of the classification: both the number of employees and the total wage bill look more like stocks than flows, underlining the fact that labor in the large modern manufacturing firm is not an instantaneously adjustable factor, but looks more like the capital stock. There are many reasons for this, of which the most important are probably the fact that the labor of the firm embodies some of its (human) capital, and the long term nature of the typical employment contract, implicit or explicit. I leave to future investigation the question of whether the apparent strength of this result in France relative to the United States is a measurement difference or a real difference. The dominant fact remains, however, that for all these series, all autocorrelations are small, which means that random year-to-year changes account for most of the growth of these firms.

4. The Dynamics of French and U.S. Manufacturing Growth Compared

Plots of the autocorrelation estimates which I obtained above are shown in Figure 1 for both France and the U.S. Those for capital (K) and sales (S) for the U.S. are averages over two samples of firms: one from 1972 to 1979 containing 352 firms and one from 1978 to 1985 containing 580 firms.[4] The correlation coefficients were very similar for the two periods. We can note several things from the plots: first, the difference between the first autocorrelation for employment between the two countries is undoubtedly due to the way the French data was constructed. When I break the French sample into two parts, one which averaged and one which did not, the first sample has a first order correlation coefficient of 0.19 and the second sample one of 0.03, while the higher order correlation coefficients are the same for both samples. This is vaguely consistent with the type of moving average error structure induced by averaging, but inconsistent with the most simple model. If the employment reported is simply last year's plus this year's over two, and the true correlation is greater than or equal to zero (as suggested by the part of the sample which does not average), then the correlation of adjacent years must be at least one half.

To show this, denote the log employment in firm i at a point in time (say the end of the year) as y_{it}, but assume that we measure instead E_{it}, which is given by

$$(7) \quad E_{it} = (y_{it} + y_{it-1})/2$$

The growth rate of E_{it} is given by a similar expression:

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4. The results for employment throughout this paper are based on a much larger sample of U.S. firms (approximately 1000) which were analyzed in my previous paper. Because I do not have this sample with me, I used a smaller subset (roughly the same size as the French sample) to obtain the results for sales and capital stock. This sample consists of the larger and more technologically oriented firms since all the firms in it are R&D performers.

$$\Delta E_{it} = (\Delta y_{it} + \Delta y_{it-1})/2$$

Then if I denote the covariances of Δy_{it} as σ_0^2, σ_1^2, σ_2^2, ... and those of ΔE_{it} as s_0^2, s_1^2, s_2^2, ..., the following identities hold:

$$(8) \quad \begin{aligned} s_0^2 &= 0.5\ \sigma_0^2 + 0.5\ \sigma_1^2 \\ s_1^2 &= 0.5\ \sigma_1^2 + 0.25\ \sigma_0^2 + 0.25\ \sigma_2^2 \\ s_2^2 &= 0.5\ \sigma_2^2 + 0.25\ \sigma_1^2 + 0.25\ \sigma_3^2 \end{aligned}$$

and so forth. Denoting the correlation coefficients of Δy_{it} and ΔE_{it} by ρ_s and r_s respectively, this implies that

$$(9) \quad \begin{aligned} r_0 &= \rho_0 = 1 \\ r_1 &= (\rho_1 + 0.5\ (1 + \rho_2\ ))/(1+r_1) \\ r_2 &= (\rho_2 + 0.5\ (\rho_1 + \rho_3\ ))/(1+r_1) \\ r_3 &= (\rho_3 + 0.5\ (\rho_2 + \rho_4\ ))/(1+r_1) \end{aligned}$$

We note immediately that if ρ_1 and ρ_2 are both greater than or equal to zero, r_1 must be greater than one half. Now assume that the high order ρ's are equal (as is approximately true in the data), so that the equations may be solved. For example, let $\rho_3 = \rho_4 = \rho$. Then some manipulation will show that the observed values of the first three correlations, r = (0.19, 0.07, 0.09), imply true values of ρ = (-0.63, 0.40, -0.11), which is quite unreasonable when compared either with the U.S. sample or with the part of the French sample that did not average. The most likely explanation is that the employment measured at the end of one year is not exactly the same as that measured at the beginning of the next year (the y_{it} which appears in E_{it} is not the same as that which appears in E_{it+1}), but this awaits further work exploring the data collection methodology. In the interim, the interpretation of the

French time series for employment is clouded by the measurement problem and the differences from the U.S. data may be merely spurious.

Second, the capital stock variable for the two countries shows a remarkably similar pattern, one which suggests both adjustment costs in capital (a smoothing of changes from year to year) and longrun permanent differences in the growth of capital across firms. For both countries, the implied variance in growth rates across firms accounts for about seven percent of the total year-to-year variance in growth rates. In France, this same pattern exists for employment, but not for sales, while for the United States it is difficult to tell owing to the limited number of lags available.

Now return to the model outlined in equations (3)-(5), with the additional assumption that the shocks ε_{it} are serially uncorrelated. For this model, the first few covariances of the differenced data are the following:

$$\text{(10)} \quad \begin{aligned} V(\Delta Y) &= \sigma_a^2 + \sigma_\varepsilon^2 + 2\,\sigma_w^2 \\ E(\Delta Y, \Delta Y_{-1}) &= \sigma_a^2 - \sigma_w^2 \\ E(\Delta Y, \Delta Y_{-2}) &= \sigma_a^2 \\ E(\Delta Y, \Delta Y_{-3}) &= \sigma_a^2 \end{aligned}$$

A similar pattern will occur for any kind of moving average error structure of low order: after the first few covariances, the covariances should be constant and equal to the variance of the random growth rates. Even if the structure is autoregressive, if the AR parameter is sufficiently near zero (around 0.3 or less), after a very few lags all that will be left is the correlation due to the random effect. This type of model (with autoregressive ε's) would fit the

French employment and capital stock data quite well, and would imply a standard deviation of the random growth rates of around 2.4 percent. In the U.S. data it is difficult to tell, given the shortness of the panel, but it appears that the variance of the capital stock growth rates are about the same as in France, whereas that of employment is higher.

5. Conclusion and Suggestions for Future Work

Like many papers, and perhaps more than most, this report has raised more questions than it answers. They fall into roughly three groups. First, there are basic measurement issues: what changes if we deflate the data correctly, why does the French employment data not behave the way we expect it to given the measurement methodology, can we get the samples to be somewhat more comparable, perhaps by some work on the U.S. side? Are the capital stock measures comparable between the two countries?

Second, there are estimation issues: How can we best summarize the univariate time series nature of the data, while keeping in mind that variances may not be constant either across time or across firms. At a minimum, it would be desirable to estimate the parameters of some simple time series models of the processes along with their standard errors (preferably robust estimates). The software for this exists, but I have not yet obtained estimates.

Finally, there is the substantive topic which I discussed in the introduction: can we use data in this form to describe the reponse of firms to changes in their environment and gain some insight into the role that the speed of adjustment and firm heterogeneity play over the business cycle? We can ask, for example, how many and what kind of unobservable factors could explain the observed fluctuations in the growth rates of the various variables and how are these factors connected across variables. In other words, an ambitious but interesting research program would be the estimation and interpretation (a nontrivial task, given the identification problems of such models) of a multivariate dynamic factor model for these data with an emphasis on the cross-country comparison. The groundwork for such an endeavor has been laid here.

Table 1

Comparison of Samples: U.S. and French Manufacturing

	France (427 Firms)			U.S. (1349 Firms)			Ratio
	# of Firms	Size (empl)	Growth (percent)	# of Firms	Size (empl)	Growth (percent)	of Avg. Sizes
Food	13	490	1.4	112	4092	2.2	.12
Textiles	31	499	-2.9	101	2971	-0.02	.17
Chemicals	13	359	0.0	72	4019	3.8	.09
Drugs	17	506	0.4	66	2812	5.3	.18
Petroleum	-	-	-	37	9034	4.4	-
Rubb&Plastics	23	613	-1.1	33	2423	1.6	.25
Stone,Clay,Glass	59	460	-1.7	46	2912	-0.8	.16
Primary metals	22	784	-0.5	66	3235	2.2	.24
Fab. metals	39	458	-0.9	103	1606	2.5	.29
Engines, mach.	84	627	-0.5	207	1966	5.2	.32
Elec, comp. mach.	54	1047	1.4	194	1640	5.7	.64
Autos	22	1880	0.7	61	5018	0.2	.37
Aircraft & trans.	10	1604	1.6	27	.4393	2.8	.37
Misc (incl wood)	23	1010	-1.7	208	2555	3.4	.40
Conglomerates	-	-	-	16	33852	2.1	-
Total	427	658	-0.4	1349	2841	2.9	.23

Notes:

Size is the geometric mean of the number of employees per firm.

Growth is the average growth rate of the number of employees between 1972 and 1979 on an annual basis.

Table 2

Sales, Employment, and Capital Stock

Comparison of Growth Rates

Year	France All Mfg. Mean	France All Mfg. S.D.	France Tech. Sector Mean	France Tech. Sector S.D.	United States Mean	United States S.D.
			Sales			
Number of Firms	427		200		352	
72-73	15.3	12.3	15.6	11.1	17.4	11.9
73-74	22.0	13.9	21.2	12.9	16.9	15.1
74-75	2.9	18.0	7.7	17.4	1.9	14.9
75-76	15.2	14.4	15.0	15.2	11.7	11.4
76-77	8.6	12.6	9.0	11.7	11.5	11.8
77-78	9.6	11.7	8.8	12.1	13.5	9.6
78-79	13.8	7.8	13.2	14.5	16.3	11.6
			Employment			
Number of Firms	427				1349	
72-73	3.2	11.1			8.8	16.4
73-74	0.9	9.4			0.5	18.5
74-75	-2.3	9.8			-4.2	15.9
75-76	0.0	8.3			5.3	18.3
76-77	-1.0	7.9			4.6	17.1
77-78	-2.0	7.9			6.7	14.4
78-79	-1.8	7.4			4.4	17.1
			Capital Stock			
Number of Firms	427		200		352	
72-73	10.2	9.7	10.2	9.7	8.3	12.8
73-74	9.4	9.1	10.5	9.1	11.3	14.3
74-75	6.5	9.9	7.7	9.9	17.6	13.5
75-76	6.8	10.4	7.1	10.4	17.1	12.3
76-77	7.4	11.6	8.5	11.6	7.9	10.7
77-78	17.3	16.7	18.7	16.7	10.8	12.8
78-79	10.9	14.3	11.3	14.2	14.7	12.9

Table 3

The Size-Growth Relationship in U.S. and French Manufacturing

1972-1979

Dep. Var.	Annual Growth Rate in Percentage Terms 72-79 OLS	73-79 OLS	73-79 OLS	73-79 IV
	United States: 1349 Firms			
Intercept	4.0 (0.2)	2.9 (0.3)	2.9 (0.3)	3.0 (0.3)
Log of size	-1.14 (.15)	-0.98 (.14)	-0.92 (.14)	-0.99 (.14)
in year	72	72	73	73
Std. error	8.4	9.4	9.5	9.5
	France: 427 Firms			
Intercept	3.0 (1.1)	3.0 (1.1)	2.7 (1.1)	3.0 (1.1)
Log of size	-0.53 (.16)	-0.62 (.17)	-0.58 (.16)	-0.62 (.17)
in year	72	72	73	73
Std. error	4.1	4.2	4.2	4.2

	France	United States
Total Number of employees	0.6 million	15 million
Average log of employment	6.47	9.61
Geometric mean	645	14,913
Range (min-max)	17-16,600	18-735,000
Var (72-79 growth rate in annual terms)	16.94	73.58
Average of Var (yearly growth) 72-79	79.03	339.00

Table 4

Correlogram Estimates - French Manufacturing

427 Firms 1967-1979

Lag	Test*	Sales Robust	Sales Avg. Firm	Test	Employment Robust	Employment Avg. Firm
0(Var)**		.0172(.0020)	.0194(.0009)		.0084(.0015)	.0100(.0010)
1		-.017(.07)	-.011(.014)	X	.146(.08)	.172(.015)
2	X	-.070(.06)	-.054(.015)	X	.089(.07)	.069(.015)
3	X	.041(.06)	.041(.015)	X	.061(.06)	.075(.015)
4		.100(.06)	.101(.016)	X	.075(.05)	.109(.016)
5	X	.034(.06)	.036(.018)	X	.063(.05)	.061(.017)
6	X	-.017(.06)	-.035(.018)	X	.045(.05)	.028(.019)
7	X	.020(.06)	.049(.019)	X	.063(.05)	.069(.020)
8		.056(.06)	.083(.022)	X	.065(.06)	.062(.022)
9	X	-.003(.06)	.007(.024)	X	.052(.05)	.037(.025)
10	X	.055(.06)	.055(.029)	X	.034(.05)	.056(.029)
11	X	.005(.06)	.085(.034)	X	.043(.06)	.069(.034)

Lag	Test*	Capital Stock Robust	Capital Stock Avg. Firm	Test	Inventories Robust	Inventories Avg. Firm
0(Var)**		.0119(.0017)	.0133(.0005)		.0438(.0068)	.0546(.0032)
1		.191(.07)	.178(.015)		-.103(.07)	-.066(.013)
2	X	.082(.05)	.101(.015)	X	-.112(.07)	-.088(.014)
3		.076(.05)	.088(.015)	X	-.018(.07)	-.001(.015)
4	X	.075(.05)	.087(.016)		.053(.07)	.047(.016)
5	X	.075(.05)	.072(.017)	X	.025(.07)	.025(.017)
6	X	.063(.05)	.054(.019)	X	.018(.07)	.004(.019)
7	X	.076(.05)	.065(.020)	X	.053(.07)	.026(.020)
8	X	.056(.05)	.052(.022)	X	-.006(.07)	.035(.021)
9	X	.099(.05)	.093(.025)	X	-.003(.07)	-.025(.025)
10	X	.065(.06)	.071(.028)	X	.013(.07)	.060(.027)
11	X	.030(.07)	.080(.034)	X	.016(.07)	.046(.034)

Table 4 (continued).

Lag	Test*	Materials Robust	Materials Avg. Firm	Test	Labor Compensation Robust	Labor Compensation Avg. Firm
0(Var)**		.0280(.0025)	.0370(.0046)	X	.0101(.0015)	.0112(.0006)
1		-.096(.08)	-.107(.013)	X	.077(.07)	.162(.015)
2	X	-.143(.07)	-.089(.015)	X	.043(.06)	.035(.014)
3		.050(.06)	.036(.013)	X	.068(.06)	.068(.015)
4		.128(.06)	.093(.016)		.085(.06)	.106(.015)
5	X	.028(.06)	.016(.016)	X	.025(.06)	.043(.017)
6	X	-.062(.06)	-.057(.018)	X	.050(.06)	.005(.019)
7	X	.024(.06)	.037(.019)	X	.065(.06)	.056(.019)
8	X	.093(.05)	.076(.022)	X	.090(.05)	.085(.022)
9	X	-.039(.05)	-.029(.024)	X	.045(.05)	.055(.024)
10	X	-.015(.05)	-.004(.028)	X	.033(.05)	.081(.028)
11	X	.038(.05)	.036(.034)	X	.061(.06)	.090(.035)

Estimated correlograms for the growth rates of six variables using panel data. See the text for a description of the methods used to obtain these estimates.

Notes:

*This column contains an X if the test for equality of the covariances at this lag over time was accepted at a one percent level.

**This row contains an estimate of the average variance of the growth rates across firm and time. The first estimate is based on the Macurdy methodology, while the second is a simple average.

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