«ΣΠΟΥΔΑΙ», Τόμος 44, Τεύχος 1ο-2ο, Πανεπιστήμιο Πειραιώς / «SPOUDAI», Vol. 44, No 1-2, University of Piraeus

EXTERNALITIES, ENDOGENOUS GROWTH AND THE INVESTMENT ACCELERATOR. SOME ESTIMATES FOR THE GREEK MANUFACTURING

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Abstract

This paper attempts to provide a brief survey on macroeconomic theories which deal with externalities, refer to the empirical testing of these theories and investigates the existence of investment accelerator in Greek manufacturing industry. Investment accelerator could arise as a learning process in the economy, which implies that agents learn about the state of the economy from the realisation of output and invest (and probably decide about employment) accordingly. Our aggregate data supports the existence of investment accelerator but not that of the employment one. (JEL 04, E2, C2)

1. Introduction

An externality exists when the action of an agent has an impact on the pay-off of another agent and there does not exist a market in which the former agent can be paid by the latter for her action. The micro-economics literature is full of examples of externalities. However, the arrival of externalities into the macro-economics literature is relatively recent. There are two approaches of explaining technological externalities. (a) *the first* considers that these are internal to firms arising from the spill-over effect of training, learning-by-doing and innovations where the firm that takes the action will not be able to exploit them fully, and which consists the so-called endogenous growth theories. (b) *the second* argues that technological externalities are actually external economies, where the output of each firm could be among other things a function of some aggregate variables and this could reveal the existence of the accelerator for the economy.

* I am indebted to an anonymous referee whose stimulating comments and suggestions, considerably improved this paper. Any errors remain mine.

2. Mainstreams in Macroeconomic Literature

Endogenous Growth literature tries to reconcile indefinite increases in incomes per head with diminishing returns to factors of production without resort to exogenous technical progress. The common idea is that knowledge is taken as an input in the production function, which depends upon past levels of investment. Moreover each firm learns from the investment activity of other firms as well as from its own investment behaviour. This renders increasing returns to scale, even if each firm is assumed to produce at constant returns to scale (see eg. the learning-by-doing model of Arrow, 1962).

A striking variant is Romer's (1986) model in which although new knowledge is assumed to be produced under diminishing returns (as previously), the production of goods with new knowledge is assumed to result in increasing returns. Romer demonstrates that the key variables externalities, increasing returns in the production of output, and decreasing returns in the production of knowledge are consistent with competitive equilibrium. Thus, endogenous technical change is explained in terms of the acquisition of knowledge by rational profit maximizing agents.

An alternative attempt to explain technological change endogeneously are the R&D models (see Uzawa, 1965; Lucas, 1988; Romer, 1990). The characteristic of these models lies in identifying a sector specializing in the production of ideas, which invokes human capital together with the existing stock of knowledge to produce new knowledge. New knowledge enhances productivity and is available to other sectors at virtually zero marginal cost.

The essence of modern statements of endogenous growth (see Shaw, 1992) is that the technical progress residual is accounted for by endogenous human capital formation. Thus, they can explain why per capita incomes may grow without bound and furthermore why, the rate of return to capital may actually increase with rising incomes. However the question is whether catching-up and convergence as suggested by the constant returns to scale model, or persistent differences in per capita incomes, as a possible outcome of the refered to previously models, are adequate description of the real world. Empirical researches examining cross-country data among poor and rich countries, have given conflicting results on their way to investigate conditional convergence. Support to the new models was only given by evidences which refer to a small number of industrialized countries which are not too different with respect to their population growth, production technologies and institutional framework and therefore, the concept of conditional convergence should apply (see Gundlach, 1993).

The second important class of technological externalities could be external economies (see recently Caballero and Lyons, 1990 or Acemoglu, 1993). The sources for such external effects could be advantages of within-industry specialization, conglomeration, indivisibilities and public intermediate inputs such as roads. These models assume that the marginal product of investment for a typical firm depends on the total investment in the economy. Scott (1992) described two ways that this could be justified (a) There are the learning externalities, ie. investment creates and reveals further investment opportunities, which implies that there may be a social benefit from it, not entirely captured by the investor. These sorts of technological εxternalities will usually increase the persistence of economic fluctuations since a shock which leads to a rise in aggregate investment will increase the marginal productivity of future investments. (b) Market externalities, which could depend on the existence of imperfect markets. For example, if a firm wants to increase its sales must incur extra selling costs. The more imperfect the markets it sells, the more marginal returns to investment (which increases output and sales) will fall below average returns. If now all firms were to expand investment together, all would find their demand curves shifting faster to the right, which brings us closer to an accelerator/ locomotive effect.

Consider now the case that agents (firms) learn about the other firms' current investment activities only through future increases in others's production capacity and then react accordingly. Thus, assuming that the level of last period's aggregate investment is not in the information set of the agents but aggregate output is observable, agents will try to deduce aggregate investment from the aggregate output figures. This implies that output may lead (Granger causes) investment, which implies the investment accelarator. Furthermore, Acemoglu's (1993) model predicts that the higher the variance of output (due to further sources of shocks besides investment), the less responsive investment should be to changes in output. However, increased output variability may results in efficiency losses. Hence, the mechanism that gives rise to the investment accelerator is that agents learn about the state of the economy from the realisations of output and invest accordingly. This may also imply that an "employment accelerator" exists if firms make their employment decisions conditional upon the information they obtain from the realization of output. Therefore accelerators arise as the outcome of learning in the economy.

On the empirical ground, using dissaggregated manufacturing data from four European countries, Caballero and Lyons (1990) found that external economies are more important than internal returns to scale (as endogenous growth models pretend). They then conclude that opportunities for unexploited increasing returns in European manufacturing are not much widespread, while on the other hand the relatively neglected dimension of external economies appears to be quite important. Using the accelerator approach we discussed previously, Acemoglu (1993) showed that output have some predictive power for employment and investment in the USA and the UK respectively and also that output variability is detrimental to the UK investment activities. This last evidence discriminates his model from the other explanations about the accelerator's existence when tested against UK data but fails when tested for the USA.

3. Empirical Findings for Greek Manufacturing

There are some obstacles that prevented me from testing some of the models refered to previously against Greek data. These are the following: (a) Endogenous growth theories' empirical investigation confronts insuperable methodological problems (see Barro, 1991), especially when countries of different structures and development processes are included. Greece obviously has not the similarities (with the big European countries) that Gundlach (1993) defined as prerequisities in order to select the countries to be included in his study. (b) Lack of sufficiently long-spanning dissaggregated data for Greek manufacturing prevents me (as had also prevented Caballero and Lyons, 1990) from testing their model for the Greek case.

In this last and empirical part of the paper, I am going to examine the existence of the investment (and employment) accelerator for the Greek manufacturing, running a series of Vector Autoregressions (VAR) and then test for Granger causality by carrying out block exogeneity tests. These are applied upon aggregate annual data for output (y: log of index of industrial production), investment (i: log of real gross capital formation in manufacturing), and employment (n: log of manhours in manufacturing), all from OECD data sources, during the period 1954-90.

However, before specifying VAR equations we should discuss the following:

(i) We have to decide about the form variables will be introduced into the regressions. Dickey-Fuller (1979) tests for unit roots presented in Table 1 indicate that all series are difference stationary, integrated of order one. Hence their first differences Δy, Δi, Δn should be the variables' transformation to be used.

(ii) Which would be the lag length of each variable's lag polymonial. In the case of univariate and later multivariate equations I will follow the procedure proposed by several authors, and presented in Fuckler (1985). This implies that the lag length for each VAR equation separately should be chosen according to Akaike's Final Prediction Error (FRE) Creterion. This suggests that the reduction of the estimated sum of squared residuals has to be sufficiently large to outweight the "penalty" of an increase in the number of estimated coefficients by the addition of another lag. As a result, overly generous lag lenghts are avoided thus preserving degrees of freedom, while biased estimates of lag parameters are avoided by including lags of a sufficient length. Table 2 reports the optium lag length and the corresponding FPE for each univariate case. In all equations the Box-Pierce tests are favourable to the hypothesis of white noise processes.

(iii) Before proceeding to the construction of the bi -or multi-- variate VAR models, we must be sure that important error correction terms are not erroneously excluded from the regressions. This detects the importance of long run components in regressions among difference stationary variables, and is connected with the rapidly expanding literature on cointegration (see Engle and Granger, 1987). Nevertheless, our relatively small sample (37 observations) could result in biases in the results which may also decline slowly, and this should be a subject for investigation. Banerjee et al (1986) suggested that the coefficent of determination R^2 offers a good guidance as to the potential the unreliability of estimates from such static cointegrating regressions, although in multivariate models a high R^2 does not imply that each element in the cointegrating vector is estimated with negligible bias. Table 3 presents the cointegrating coefficients, R^2 and Durbin-Watson statistic from the cointegrating regression (CRDW) and also the two Dickey-Fuller tests for difference stationarity (non-cointegrating) in the residuals. Tests show that the null non-cointegration hypothesis can not be rejected at 5% sl. in all cases. In the first two cointegrating regressions we rely on Dickey-Fuller tests on residuals rather than the CRDW, which indicate the existence of a cointegrating vector. Banerjee et al. (1986) support that its power as a test to reject the null of non-cointegration against alternatives close to the unit circle is low. Furthermore, R^2 statistic indicates that estimation bias due to our small sample is relatively small (around 4%) but rises to 12% at the employment-investment relations.

We are now ready to discuss the results of the Granger causality tests reported in Table 4. Equations have also been estimated as Seemingly Unrelated Regressions, in order cross correlation functions for all equations residuals to be inspected and their significance to be weighted to the outcome of causality tests.

However, no changes in causality results were observed in comparison to the least squares estimates of Table 4.

Investment is Granger caused by output but on the other hand it does not cause output, which means that the 2x2 system supports the existence of investment accelerator. However if we accept the notion of employment accelerator this can not be empirically supported by the data, which depict that output is Granger caused by employment but it does not cause it. Another interesting outcome (not directly connected to accelerator) is that employment causes (at the limit) investment. This could mean that higher employment stirs up investment activities, or better human capital incorporated in manhours (labour) data improves efficiency and triggers investment.

Results do not alter in the 3x3 systems. Output Granger causes investment despite the inclusion of employment into the system. However, investment does not cause the output-employment equation. Furthermore, results on employment show that causality does not run in any direction between employment and the output-investment systems. Finally, in order to include a noise term for output (which according to Acemoglu (1993) is detrimental to investment) I inserted in the [Δi; Δn, Δy] system the squared residuals of the system [Ay; $\Delta \eta$, Δi]. ARCH effects in output is generally insignificant for the Greek case, the same appeared here as well. Therefore, this term failed in causing investment, it was insignificant (in any lag length) but its overall effect was correctly signed (negative).

4. Conclusions

This paper attempts to provide a brief survey on the recent approaches to externalities, refer to the empirical testing of these theories and investigates the existence of investment accelerator in Greek manufacturing industry. Investment accelerator could arise as a learning process in the economy, which implies that agents learn about the state of the economy from the realisation of output and invest (and probably decide about employment) accordingly. Our aggregate data supports the existence of investment accelerator but not that of the employment one.

Appendix

TABLE 1

Integration Tests

(i) Dickey-Fuller: $\Delta x = \alpha + \beta * time + \rho * x_{-1}$						
Series	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\rho}$	Q-stat.	s	DW
y	0.039 (0.2)	-0.005 (1.7)	0.025 (0.6)	2.60	0.045	1.73
i	0.488 (1.8)	0.002 (0.6)	-0.110 (1.4)	1.55	0.116	1.70
n	0.394 (1.1)	0.001 (0.9)	-0.091 (1.1)	12.89	0.023	1.05
(ii) Augmented Dickey-Fuller: $\Delta x = \alpha + \beta * time + \rho * x_{-1} + \delta * \Delta x_{-1}$						
Series	$\hat{\rho}$	Φ_2	Φ_3	Q-stat.	s	DW
y	0.015 (0.3)	5.49*	4.39	2.8	0.046	1.85
i	-0.111 (1.4)	2.97	2.66	1.0	0.118	1.70
n	-0.154 (2.0)	4.19	4.31	2.5	0.020	2.01

Notes: Computed absolute t-statistics in parentheses. Q-stat. is the Box-Pierce statistic for 4 lags (asymptotically distributed by $x^2(4)$), s is the standard error of the regression and DW is the Durbin-Watson statistic. Φ_2 and Φ_3 are likelihood ratio tests for the null joint hypothesses $(\alpha, \beta, \rho) = (0, 0, 0)$ and $(\alpha, \beta, \rho) = (\alpha, 0, 0)$ respectively. Critical values at 5% s.l. are $\tau(\hat{\rho}) = 2.79$, $\Phi_2 = 4.88$ and $\Phi_3 = 6.49$.

TABLE 2

Optimal Lag Length for the Univariate Autoregressions

Series	Length	FPE*10^3	Q-stat.
Δy	3	2.38	1.66
Δi	2	15.07	0.67
Δn	1	0.43	5.36

TABLE 3
Cointegration Tests

VAR system	Coint coeff.	R^2	CRDW	DF	ADF
[y;i]	1.02	0.95	0.46	1.99	2.01
[i;y]	0.89	0.95	0.50	2.10	2.29
[y;N]	2.82	0.96	0.30	1.45	1.56
[n;y]	0.34	0.96	0.30	1.23	1.41
[i;n]	2.47	0.88	0.26	1.73	2.16
[n;i]	0.34	0.88	0.22	1.35	1.72
(critical values at	5% s.l.		0.39	3.37	3.17)
[y;i, n]	0.34/ 1.98	0.98	0.66	2.06	1.97
[i;y. n]	1.21/-0.96	0.95	0.67	2.23	2.36
[n;y, i]	0.39/-0.05	0.96	0.37	1.43	1.48
(critical values at	5% s.l.		—	4.22	4.02)

Note: *Semi-colon separates the dependent from the independent variables.*

TABLE 4
Granger Causality tests for the VAR Systems

VAR System	length	FPE*10^3	Cause?	Q-stat.
[Δy;Δi]	3;1	2.43	no	2.77
[Δy;Δn]	3;1	2.41	yes	0.45
[Δi;Δy]	2;1	13.66	yes	1.04
[Δi;Δn]	2;1	15.05	yes	1.28
[Δn;Δy]	1;1	0.44	no	7.95
[Δn;Δi]	1;1	0.45	no	4.53
[Δy;Δi, Δn]	3;1, 1	2.51	no	1.35
[Δy;Δn, Δi]	3;1, 1	2.51	no	1.35
[Δi;Δy, Δn]	2;1, 1	14.33	no	1.09
[Δi;Δn, Δy]	2;1, 1	14.33	yes	1.09
[Δn;Δy, Δi]	1;1, 1	0.45	no	7.70
[Δn;Δi, Δy]	1;1, 1	0.45	no	4.10

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