



UNIVERSITÀ DEGLI STUDI DI ANCONA
DIPARTIMENTO DI ECONOMIA

**INCREASING RETURNS
VERSUS EXTERNALITIES:
PRO-CYCLICAL PRODUCTIVITY
IN US AND JAPAN**

MICHELA VECCHI

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Increasing Returns versus Externalities:

Pro-cyclical Productivity in US and Japan

by
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Abstract

This paper investigates the phenomenon of pro-cyclical productivity and attempts to discriminate among several competing explanations given in the literature. The study focuses on the United States and Japan. The different industrial relations in these two economies cast a sharper light on the pro-cyclical productivity debate. Although the labour hoarding hypothesis has proved to be quite robust, my results suggest that the role of external economies should not be underestimated, especially in the case of Japan.

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1) Introduction

The phenomenon of pro-cyclical movements in labour productivity has given rise to a large number of studies. Among the different economic explanations, the labour hoarding hypothesis has gained prominence. Since Walter Oi's seminal 1962 paper, theoretical and empirical studies have continued to place particular emphasis on labour hoarding (Fair, 1985, Fay and Medoff, 1985, Hart and Malley, 1996). However, there has recently been an increasing interest in stressing the importance of alternative explanations of pro-cyclical productivity. Subsequently, this has given rise to a literature that has attempted to discriminate among competing theories of the business cycle. Three main approaches to the analysis of cyclical productivity movements have stimulated particular interest: the Real Business Cycle view (Prescott 1986, King and Plosser 1983), the increasing returns and market power hypothesis (Hall 1989, Bernanke and Parkinson 1990), and the presence of externalities (Caballero and Lyons 1990, 1992). The purpose of this paper is to examine these alternative explanations in a comparative international framework. In particular I concentrate on the presence of increasing returns and positive spillovers.

Most of the above mentioned studies have focused on the United States economy. A main motivation of this paper is to show that a comparison between Japan and the US allows us to cast a sharper light on the pro-cyclical productivity debate. *A priori*, the particular set-up of the Japanese system makes it a comparatively important economy for the study of pro-cyclical productivity in general, and the role of externality effects in particular. In this latter respect, information exchange, joint ventures and mutual insurance within firms and sectors is a relative important feature of the Japanese economy (Odagiri, 1992). The coalitional structure of the Japanese economic system, combined with a preference towards long term commitments, allow firms to gain mutual advantage from their activity (Hashimoto 1990, Hart and Malley 1996). The *quasi rent* originating from each firm's specific investments in these long-term relationships is the essence of the externality (or spillover) effect. This can make labour productivity to move pro-cyclically even in presence of constant or decreasing internal returns.

Industrial relations in the United States are characterised by a less co-operational milieu. Highly vertically integrated firms, rather than network of firms, portrays one of the salient features of the US industrial structure (Odagiri 1992)¹. Comparatively, this is more likely to give rise to internal increasing returns rather than strong spillover effects. In fact, empirical evidence on the presence of externalities in the US economy has led to less than clear-cut results².

According to Coase (1937), a firm will expand until the cost of organising an extra transaction within its organisation becomes equal to the cost of carrying out the same transaction by means of an exchange in the open market. Hence, the preponderance towards vertically integrated firms in the United States can be considered as consistent with the presence of high transaction costs. On the other hand, a low transaction cost environment in

¹ While in the US a higher number of employees and a greater proportion of production phases are concentrated in the same production unit, the Japanese enterprise system is characterised by a very high interdependency of multi-function factories, each producing highly specialised components. For example, Toyota buys about 75% of sales value of its cars in the form of parts, components and services supplied by other companies while General Motors purchase-to-sales ratio is about 50% (Fruin 1992).

² While Caballero and Lyons (1992) provide evidence for the presence of externalities in the US economy, both Marchetti (1994) and Basu and Fernard (1995) argue that the claim for spillover effects, in some earlier studies, result from misspecification. Hence they argue that externalities have not been established as major factors driving the business cycle.

Japan has reduced the risk of asymmetric information and it has nurtured a different industry structure, based on co-operation³ (Nakatani 1984, Odagiri 1992, Kawasaki and McMillan 1987).

Given these observations, we might expect internal returns to scale to be larger in the United States than in Japan, while spillover effects should have a stronger impact in the opposite direction.

In the following section, I present the model on which I base my empirical analysis, and discuss its main implications. Section 3 provides a brief description of the data set and the methodology followed in the estimation. Section 4 presents the results for the two countries. The major differences are underlined and discussed. A conclusive section will follow.

³ For a comparative study of transaction costs in United States and Japan see Hashimoto 1990.

2) The model

The theory underlying the present analysis follows the approaches of Hall (1989) and Caballero and Lyons (1992). As a starting point, the production function for firm i is expressed as:

$$Y_{it} = A(t)F(L_{it}, K_{it}, M_{it}) \quad (1)$$

where Y is gross output, L is hours worked, K is capital, M is the value of intermediate materials, and $A(t)$ is Hick's neutral technical change. Taking logs and totally differentiating (1), we obtain:

$$dy_{it} = \eta_{il} dl_{it} + \eta_{ik} dk_{it} + \eta_{im} dm_{it} + \Theta_{it} \quad (2)$$

where Θ_{it} is the Solow's residual and the η_{it} are input-output elasticity. It is possible to show that in presence of increasing returns and monopoly power, these elasticities are equal to $\eta_{it} = \gamma\alpha_{it}$ where γ is the degree of homogeneity and α is the factor's cost share (see Hall 1989, Caballero and Lyons 1990, 1992, Basu and Fernard 1995). Hence, incorporating these assumptions, equation (2) can be written as:

$$dy_{it} = \gamma dz_{it} + \Theta_{it} \quad (3)$$

where $dz_{it} = \gamma(\alpha_{il} dl_{it} + \alpha_{ik} dk_{it} + \alpha_{im} dm_{it})$.

Concentrating on the productivity residual, a source of exogenous productivity growth can be reasonably represented by the production activity undertaken in the manufacturing sector, that is:

$$\Theta_t = \beta dY_t^* + \varepsilon_{it} \quad (4)$$

where Y_t^* is equal to the rate of growth of total manufacturing output minus each industry's own output:

$$Y_t^* = \sum y_{it} - y_{it} \quad i = 1, 2, \dots, n. \quad (5)$$

In previous studies, total manufacturing output was used (see Caballero and Lyons 1992). The correction adopted here is aimed at eliminating a possible source of bias in the empirical analysis. Assuming, for illustration purposes, that there are only two firms in the economic system, industry 1 and 2. The production function of firm 1 will be equal to:

$$dy_1 = \gamma dz_{1t} + \beta d(y_1 + y_2) \quad (6)$$

that is

$$dy_1 = \frac{\gamma}{(1-\beta)} dz_{1t} + \frac{\beta}{1-\beta} dy_2 \quad (7)$$

Hence, assuming that $\beta < 1$, our parameter estimates will be upward biased.

This spillover effect is mirrored by the β term. If there are no spillover effects β will not be significantly different from zero. On the other hand, if

there is a good matching between different firms in the economic system, which implies the possibility of efficient communication and co-operation, there will likely be important spillovers effects, even in firms operating in different industries ($\beta > 0$). The hypothesis that "an increase in the activity of the automobile industry will somehow increase the productivity - that is, shifts the production function- of, say a chemical factory" (Basu and Fernard 1995) is not unreasonable. Sustained inter-firm relationships, which are particularly important in the Japanese economy, can be a key factor for the development of this type of external effect.

In general, the possibility of gaining benefits from co-operation with other firms is constrained by the presence of transaction costs. Hence, assuming that β is a convex function of such costs, we can write

$$\beta = \beta(\tau), \quad \beta'(\cdot) < 0, \quad \beta''(\cdot) > 0 \quad (8)$$

where τ represents transaction costs.

Equation (3) can then be written as:

$$dy_{it} = \gamma dz_{it} + \beta(\tau) Y_t^* + \varepsilon_{it} \quad (9)$$

Another modification of the production function is incorporated to capture labour market flexibility. Three different indices are considered: the ratio of

production workers to total workers (pw/tw), average number of hours per production worker (hpw) and average overtime (ov)⁴. The first measures flexibility in the number of workers while the latter two account for flexibility in the number of hours. Hence the final specification, that forms the basis of the empirical work, takes the form:

$$dy_{it} = \gamma dz_{it} + \beta(\tau)Y_t^* + \sum \phi_i q_{it} + \varepsilon_{it} \quad (10)$$

where the q s are the indices.

⁴ In previous studies (Caballero and Lyons 1992, Marchetti 1994) the same indices were used as proxies for effort. The reason for using these indices is their high correlation with another proxy for effort, which is not so easily available, the accident rates. Shea (1992) shows that accident rates, considered as a better proxy for effort, have important explanatory power in production function estimates and that average overtime hours, average number of hours per production workers and the ratio of production workers to total workers are highly correlated with accident rates. The problem lies in the economic interpretation of this proxy. When people work longer hours the probability of an accident gets higher. Moreover, during a period of high demand more workers are hired. Hence, more employees will work together in the same factory, given that in the short run it is difficult to modify the structure of the firm. This will inevitably increase the number of accidents. This does not necessarily mean that labour productivity increases; on the contrary, if people work in worse condition their productivity can easily decrease (Akerlof, 1982). Another consideration concerns the definition of production workers. In NBER data: "...this excludes supervisors above the line-supervisor level, clerical, sales office, professional and technical workers." Stated differently, the definition of production workers is based towards the coverage of lower skilled workers. The theory of human capital shows that low skilled workers can be varied with higher flexibility than higher skilled counterparts. As a consequence, when production increases, more low-skilled workers will be hired and the ratio of production workers to total workers, together with the average number of hours per production worker, will move procyclically. Finally, it is implicitly assumed that effort variation is procyclical. However, this might not be always the case. In fact, there can be a "discipline effect" of recessions which makes effort to increase in periods of slack demand because of the higher probability of being fired (Saint-Paul, 1993).

3) Data and methodology

For each country I have collected data for 9 manufacturing industries. The industry breakdown is listed in table A1 in the appendix and it is the same for Japan and the United States. The sample periods covered are 1961-1984 for Japan and 1959-1991 for the United States. Changes to the data definitions for Japan after 1984 precluded further extension of the time period. A full description of the data can be found in the appendix.

The estimation of equation (10) requires the computation of input cost shares in order to obtain the composite dz variable. To obtain a measure of the capital cost share, I follow the method developed by Bean (1990). I take the predicted value from a second-order autoregression of the *ex-post* real short-term interest rate, plus a 10 percent allowance to capture depreciation⁵. I then multiply this by the real capital stock. Appendix table 2, shows the mean values and the coefficient of variation of the capital cost share, together with the other input cost shares.

⁵ The reason for using the predicted value rather than the *ex-post* real rate, is that the *ex-post* rate is very volatile, mainly due to inflation movements. Arguably, these were unanticipated, and in any case theory would suggest that expected real rates matter. Since 0.1 is supposed to reflect depreciation, the overall calculation provides an estimate of the sum of the *ex-ante* real rate and the depreciation rate.

Equation (10) is estimated simultaneously for all 9 industries, using Seemingly Unrelated Regressions (SUR) technique. System estimation allows us to account for the cross correlation among the different equation disturbances, under the hypothesis that exogenous shocks within different industries are correlated. Three-stages-least-squares (3SLS) has also been used in related works. In the present study, however, 3SLS does not provide qualitatively different estimates⁶. Hence the uninstrumented results are shown.

4) Empirical Results

The estimation is carried on the following two model specifications. In the first of these (the fixed effect model - see table 1), equal coefficients are imposed in all industries and only the intercept is allowed to vary across industries in order to catch industry-specific characteristics. Although this specification has been used in previous studies, the hypothesis of equal coefficients across industries is rejected at 5%⁷ confidence level for both countries. Accordingly, in the second specification, I show the

⁶ The instruments used in the 3SLS estimation were: the rate of change of military expenditure, the rate of change of the world price of oil and its lagged value. These results will be provided on request.

⁷ Appendix table 3 shows the Wald test of restriction on parameters.

unconstrained version of the model (see table 2 for the United States and table 3 and 4 for Japan).

Table 1

$$dy_{it} = \gamma dz_{it} + \beta(\tau)Y_t^* + \phi q_{it} + \varepsilon_{it}$$

(t statistics in parentheses)

	Japan	USA
Internal returns to scale	0.71 (9.14)	0.93 (37.19)
Externality	0.57 (10.42)	0.09 (3.82)
Hpw	-6.62E-05 (-0.02)	0.32 (5.05)
pw/tw	0.09 (1.60)	0.11 (1.19)
overtime	0.09 (5.14)	na

Focusing first on the constrained specification in table 1, the estimates reveal decreasing returns to scale for both countries. These are somewhat higher in the United States. Externality effects are relatively very

significant for Japan; they display almost a six-fold larger coefficient than the USA equivalent. This result is in line with our *a priori* expectations. The coalitional structure of the Japanese industrial system allows firms to obtain a quasi rent and this is captured by the externality effect parameter. In the US, the smaller size of the spillover effect is consistent with our earlier suggestion of relatively high inter-sector transaction costs in this economy.

As for the flexibility indices, the change in the number of hours per production worker appears relatively important in the US, while in Japan only the change in overtime displays a significant effect on productivity growth. This conforms with what Tachibanaki (1987) and other studies have underlined about the widespread use of overtime in Japanese firms⁸.

More insights can be obtained by looking at the unconstrained results, recorded in table 2, for the United States, and in table 3 and 4 for Japan.

⁸ According to Tachibanaki (1987) the contribution of overtime hours in Japanese firms is as strong as the contribution of regular hours.

Table 2
United States: unconstrained specification
(t statistics in parentheses)

Industry (SIC)	Internal returns	Externality	Hpw	pw/tw
20	0.78 (10.13)	0.06 (1.60)	-0.15 (-0.74)	-0.40 (-1.30)
22	0.86 (8.53)	0.01 (0.14)	0.51 (3.04)	0.32 (0.59)
26	0.96 (8.49)	0.27 (3.02)	0.39 (1.57)	-0.53 (-1.09)
28	0.50 (4.26)	0.59 (5.04)	0.30 (0.78)	0.27 (0.57)
33	0.98 (14.32)	0.24 (1.97)	0.30 (1.22)	0.34 (0.72)
34	0.94 (8.35)	0.24 (1.45)	0.57 (1.76)	-0.11 (-0.24)
35	0.84 (12.08)	0.04 (0.46)	0.35 (1.40)	0.62 (2.02)
36	0.85 (13.42)	0.19 (1.85)	-0.09 (-0.41)	-0.02 (-0.12)
37	1.10 (23.06)	-0.04 (-0.48)	-0.15 (-1.14)	-0.26 (-1.66)

With the exception of chemical industry, the returns to scale coefficients in the United States are reasonably uniform, varying between 0.78 and 1.10⁹.

⁹ The chemical industry, by contrast, shows internal returns equal to 0.50. However, the low internal returns are compensated by a high externality effect, 0.59.

Moreover, chemical is the only industry where the externality effect displays an important role. In sector 26 (Pulp and Paper products) the externality effect is around 0.25 and for the rest of the industries it is not statistically different from zero.

Generally, the flexibility indices do not appear to have significant effect. Even the rate of change in the number of hours - which was an important addition to the constrained model - displays an important effect only in industry 35 (General machinery). In fact, the results concerning the returns to scale and the externalities are virtually unaffected by dropping the flexibility indices.

Table 3 shows the unconstrained results for Japan. By contrast to the United States, the externality effect is very high in almost all industries (the only exception is industry 37 - Transportation Equipment). It ranges from 0.48 (industry 20 - Food and Tobacco) to 1.05 (industry 34 - Fabricated Metal Products). As for the returns to scale, in some industries they are higher than we would have expected from the constrained model, ranging in size from 0.78 to 1.10. On the other hand, in industry 20, 22 and 28 the internal returns are not significantly different from zero, while the

externality effect is very high. This is probably due to the different structure of these three sectors. Hence, either the empirical model does not fit these three particular industries, for reasons which are beyond the scope of this paper, or their structure is so highly fragmented that they rely much more on external quasi rent rather than internal inputs. Table 3 also shows that the flexibility indices in the unconstrained version of the model also perform poorly in Japan. This may be due to a collinearity problem among the three indices. With this in mind, and following Tachibanaki (1987), I re-estimate the unconstrained model including only overtime as a flexibility index. The results are in table 4.

Table 3
Japan: unconstrained specification
(t statistics in parentheses)

Industry (SIC)	Internal returns	Externality	Hp _w	pw/tw	overtime
20	0.17 (1.18)	0.48 (5.81)	-0.07 (-0.75)	0.13 (1.53)	-0.76 (-1.77)
22	-0.17 (-0.63)	0.62 (5.05)	-0.26 (-2.75)	-0.13 (-0.74)	1.55 (1.93)
26	0.82 (3.98)	0.54 (5.44)	0.14 (1.29)	-0.32 (-2.05)	0.91 (1.13)
28	0.23 (1.50)	0.85 (7.82)	0.01 (0.16)	0.16 (0.87)	0.61 (0.66)
33	0.86 (2.54)	0.74 (2.75)	-0.23 (-0.74)	1.31 (3.83)	2.01 (0.94)
34	0.49 (2.00)	1.05 (4.36)	0.18 (0.74)	-0.04 (-0.30)	-0.83 (-0.48)
35	1.21 (4.62)	0.51 (1.98)	0.19 (3.96)	-0.10 (-0.48)	0.00 (1.16)
36	0.97 (5.60)	0.80 (4.80)	0.04 (1.55)	-0.17 (-1.28)	2.30 (6.48)
37	1.37 (8.20)	-0.12 (-0.92)	-0.10 (-0.91)	0.27 (2.46)	2.27 (2.61)

Table 4
Japan: unconstrained specification
(t statistics in parentheses)

Industry (SIC)	Internal returns	Externality	overtime
20	0.00 (0.03)	0.52 (6.01)	-0.18 (-3.45)
22	-0.05 (-0.23)	0.56 (4.96)	-0.09 (-1.69)
26	0.68 (3.93)	0.54 (5.07)	0.22 (5.21)
28	0.23 (1.78)	0.83 (7.45)	0.10 (2.10)
33	0.91 (2.82)	0.54 (1.96)	0.14 (1.93)
34	0.70 (3.40)	0.95 (4.87)	0.03 (0.67)
35	1.12 (5.11)	0.58 (2.45)	0.18 (3.96)
36	1.21 (5.04)	0.58 (2.44)	0.06 (1.92)
37	1.35 (7.56)	-0.11 (-0.75)	0.17 (4.29)

Leaving only the overtime variable as a flexibility index leads to an improvement of the parameter estimates, without major changes in the estimates of the internal returns and the externality parameters.

To summarise, it appears that the externality effect plays a very important part in explaining pro-cyclical productivity in Japan. In the USA, while the effect is significant in some industries, it is not nearly as strong as in the Japanese economy. No strong evidence of increasing returns can be found in the United States¹⁰.

5) Discussion and conclusion

This analysis has provided empirical evidence of the relative importance of increasing returns to scale and positive spillovers in explaining pro-cyclical productivity in the United States and Japan. I argue that the different industrial structure and transaction costs environment in the two countries is at the root of the different empirical results obtained.

In Japan, The coalitional structure of the economic system provides a source of co-operation and reliable information exchange that make spillover effects particularly important in fostering productivity. In the

¹⁰ The hypothesis of constant returns to scale in sector 37 in the United States cannot be rejected at 5% significance level.

empirical framework used in this study, this phenomenon is reflected in the high externality effect. This finding goes beyond the traditional approach to the analysis of externalities, which mainly refers to spillover effects among firms belonging to the same industry. Spillover in Japan appear as an economy-wide phenomenon, operating via the multiple inter-industry connections.

By contrast, in the United States positive spillovers among different industries do not have an important effect. This is in contrast with Caballero and Lyons (1992). Their finding of high externality effect in the United States has been criticised on the grounds of a miss-specification problem (Basu and Fernald 1995). The miss-specification lies in the use of value added data, instead of output data, as the left hand side variable and the consequent exclusion of material inputs on the right hand side. Intermediate materials affect the rate of growth of value added if competition is not perfect and their exclusion leads to a downward biased returns to scale coefficient and an upward biased externality effect (see Basu and Fernald for a complete theoretical proof of this point). Table 5

compares my results together with Caballero and Lyons and Basu and Fernard.

Table 5
A cross-study comparison
(t Statistics in parentheses)

Coefficient	Vecchi	Caballero and Lyons	Basu and Fernard
Internal returns to scale	0.93 (37.19)	Ranges from 0.92 to 1.05	1.00 (111.11)
Externality	0.09 (3.82)	Ranges from 0.16 to 0.26	-0.02 (1.81)

In the present study intermediate inputs are included in the model specification and, although the externality coefficient is significantly different from zero; its addition to the overall result is quite small. Hence, the cross-study comparison provides a further evidence of the little importance of externalities in the United States.

In conclusion, this paper has offered a contribution to the pro-cyclical productivity debate, extending the analysis to the Japanese experience and

In conclusion, this paper has offered a contribution to the pro-cyclical productivity debate, extending the analysis to the Japanese experience and evaluation the role of external economies. This is the main distinctive feature of the pro-cyclical productivity phenomenon in the two countries. In fact, as for internal returns, no major differences have been found. Further developments on this line of research will entail the investigation of the link between externalities, transaction costs and labour hoarding.

On one hand, low transaction costs allow external quasi rents to develop among different firms. On the other hand, low transaction costs foster firm's investments in human capital (Hashimoto 1990) and has a direct impact on labour productivity. At the same time, higher human capital investments determine a high level of hoarding. Hence, more labour hoarding and stronger spillover effect will be observed in those countries where transaction costs are lower. This line of reasoning will also offer a unifying framework to the analysis of pro-cyclical productivity.

Appendix

This appendix contains details of the data used in the empirical analysis.

Table A1 presents the 9 manufacturing industries incorporated in the empirical analysis:

Table A1
Manufacturing industries
incorporated in the empirical analysis

SIC	INDUSTRY
20,21	Food, Beverage, Feed and Tobacco
22	Textile Mill Products
26	Pulp and Paper Products
28	Chemical and Allied Products
33	Iron, Steel, Non-ferrous Metal Products
34	Fabricated Metal Products
35	General Machinery
36	Electrical Machinery, Equipment and Supplies
37	Transportation Equipment

Table A2 shows, for each of the above industries, the mean values and the coefficient of variations of each input cost share:

Table A2
Input cost shares
Mean values 1961-1984
(coefficient of variation in parentheses)

SIC	Labour		Capital		Raw Materials	
	Japan	USA	Japan	USA	Japan	USA
20	0.42 (10.15)	0.09 (9.06)	0.37 (15.09)	0.06 (22.51)	0.21 (7.73)	0.85 (1.09)
22	0.36 (9.48)	0.20 (10.04)	0.51 (6.59)	0.10 (14.78)	0.13 (14.91)	0.71 (2.39)
26	0.30 (11.40)	0.16 (12.32)	0.54 (8.45)	0.11 (25.17)	0.15 (9.77)	0.72 (2.25)
28	0.20 (9.56)	0.11 (16.48)	0.67 (3.04)	0.13 (16.06)	0.13 (4.82)	0.76 (2.42)
33	0.20 (9.68)	0.16 (15.26)	0.64 (5.42)	0.12 (29.35)	0.15 (11.85)	0.71 (3.39)
34	0.50 (11.72)	0.23 (8.26)	0.37 (21.88)	0.08 (31.57)	0.13 (19.19)	0.69 (1.95)
35	0.44 (3.37)	0.24 (18.69)	0.43 (5.30)	0.08 (33.85)	0.13 (11.11)	0.67 (3.74)
36	0.40 (17.72)	0.22 (10.51)	0.45 (18.11)	0.08 (30.51)	0.15 (10.36)	0.69 (1.54)
37	0.30 (6.38)	0.16 (11.77)	0.53 (5.23)	0.06 (24.12)	0.16 (8.11)	0.77 (1.96)

Table A3 shows the results of the Wald test of restrictions on parameters:

Table A3
Wald test results

	Japan	USA
Value of the test	197	115
χ^2 critical values	61.60	53.00

Table A4 and A5 provide a description of the data sources, respectively for Japan and the United States:

Table A4
Data source: Japan

y	Value of Production	Historical Statistics of Japan (1956-1984), Japanese Statistical Yearbook (1985-1991)
N	Persons Engaged	"
H	Working Hours	"
M	Value of Raw Materials	"
D	Domestic Wholesale Price Index Industrial production indexes (weights of value added)	"
i	Interest Rate on Bank Loan	"
pw	Production Workers	Japanese Yearbook of Labour Statistics
w	Total Cash Earnings paid on the basis of methods and conditions previously determined by labour contracts, collective agreements or wage regulations of establishments (contractual cash earnings), plus Special Cash Payments. The latter includes: the amount actually paid to the employee during survey period for extraordinary or emergent cases without any previous agreement, contract or rule; retroactive payment of wages for past months as a result of a new agreement; payments such as summer and year-end bonuses which are paid for each period longer than 3 months and allowance such as marriage allowance which are paid for unforeseen events.	"
k	Gross Capital of Private Enterprise	Economic Planning Agency - Japanese Government

Table A5
Data source: United States

y	Value of shipments	NBER Productivity Database
N	Persons Engaged	"
M	Value of Raw Materials (including cost of material input and energy expenditure	"
D	Shipment deflator, deflator for investment, energy deflator, material deflator	"
pw	Production Workers	"
w	Total compensation of employees	"
i	Prime commercial paper, 4 to 6 months	Statistical abstract of the United States
H	Working Hours	Ehrensa database (Employment Hours Earnings, Not Seasonally adjusted), Bureau of Labour Statistics
k	Real capital stock (start of year), real stock of equipment, real stock of plant	NBER Productivity Database

References

- Akerlof, G., 1982, Labour contracts as partial gift exchange, *Quarterly Journal of economics*, 97, 543-569.
- Aoki, M., 1988, *Information, incentives and bargaining in the Japanese economy*, Cambridge University Press.
- Aoki, M., 1984, *The Co-operative game theory of the firm*, Clarendon Press, Oxford.
- Aoki, M. and R. Dore, 1994, *The Japanese firm: sources of competitive strength*, (Oxford University Press).
- Bartelsman, E. and W. Gray (forthcoming), *Manufacturing productivity database*, NBER technical working paper, Cambridge, MA.
- Basu S. and J.G. Fernald 1995, Are apparent productive spillovers a figment of specification error?, *Journal of Monetary Economics*, 36, pp. 165-188.
- Bean, C.R., 1990, Endogenous growth and the pro-cyclical behaviour of productivity, *European Economic Review* 34, 355-363.
- Blanchard, O. and S. Fisher, 1989, *Lectures on macroeconomics*, (MIT Press, Cambridge, Massachusetts).

- Bernanke, B.S. and M.L. Parkinson, 1991, Pro-cyclical labour productivity and competing theories of the business cycle: some evidence from interwar U.S. manufacturing industries, *Journal of Political Economy*.
- Caballero, R.J. and R.K. Lyons, 1989, Internal and external economies in European industries, *European Economic Review* 34, 805-830.
- Caballero, R.J. and R.K. Lyons, 1992, External effects in U.S. pro-cyclical productivity, *Journal of Monetary Economy*, 29, 209-25.
- Coase, R.H., 1937, The nature of the firm, *Economica*, 3, 386-405.
- Eliasson, G., 1996, Spillovers, integrated production and the theory of the firm, *Journal of Evolutionary Economics*, 6, 125-140
- Fair, R.C., 1969, The short-run demand for workers and hours, North Holland, Amsterdam.
- Fair, R.C., 1985, Excess labour and the business cycle, *American Economic Review*, 75, 239-45.
- Fay, J. A. and J. L. Medoff, 1985, Labour and output over the business cycle, *American Economic Review*, 75, 638-55.

- Fruin, W.M., 1992, The Japanese enterprise system, Claredon Press, Oxford University Press, New York.
- Gordon, R.J., 1987, Productivity, wages and prices inside and outside of manufacturing in the U.S., Japan and Europe, *European Economic Review*, 31, 685-739.
- Hall, R.E., 1989, Invariance property of the Solow's productivity residual, in P. Diamond (ed.), *Growth, Productivity, Unemployment*, Cambridge, Mass: MIT Press.
- Hamermesh, D., 1993, *Labour demand*, Princeton NJ: Princeton University Press.
- Hart, R.A. and J. Malley, 1996, Excess labour and the business cycle: a comparative study of Japan, Germany, the United Kingdom and the United States, *Economica* 63, 325-42.
- Hashimoto, M., 1993, Aspects of labour market adjustments in Japan, *Journal of Labour Economics*, 11.
- Hashimoto, M., 1990, The Japanese labour market in a comparative perspective with the United States, W.E. Upjohn Institute for Employment Research, Michigan.

Hashimoto, M. and J. Raisian, 1985, Employment tenure and earning profiles in Japan and the USA, *American Economic Review*, 75.

Itoh, H., 1993 Coalition, incentives, and risk sharing, *Journal of Economic Theory*, 60:410-27.

Kawasaki, S. and J. McMillan, 1987, The design of contracts: evidence from Japanese subcontracting, *Journal of the Japanese and International Economies* 1, 327-349.

King, R.G. and C.I. Plosser, 1984, Money, credit , and prices in a real business cycle, *American Economic Review* 74, 363-380.

Marchetti, D., 1994, Pro-cyclical productivity, externalities and labour hoarding: a re-examination of evidence from U.S. manufacturing, *European University Institute Working Papers in Economics*, 94/13.

Nakatani, I., 1984, The economic role of financial corporate grouping, in: M Aoki, ed., *The economic analysis of the Japanese firm* (North-Holland, Amsterdam) 227-257.

Odagiri H., 1992, *Growth through competition, competition through growth*, Claredon Press, Oxford.

Oi, W., 1962, Labour as a quasi-fixed input, *Journal of Political Economy*, 70.

Plosser, C.L., 1989, Understanding real business cycle, *Journal of Economic Perspectives*, 3: 51-77.

Prescott, E.C., 1986, Theory ahead of business cycle measurement, *Federal Reserve Bank of Minneapolis Quarterly Review*, 10.

Ramey, V.A., 1991, Non-convex costs and the behaviour of inventories, *Journal of Political Economy* 99, n. 2, 307-334.

Saint-Paul, G., 1993, Productivity growth and the structure of the business cycle, *European Economic Review* 37, n.4, 861-890.

Sargan, J.D., 1959, The Estimation of relationship with autocorrelated residuals by the use of instrumental variables, *Journal of the Royal Statistical Society*, 21: 91-105.

Shea, J., 1992, Accident rates, labour effort and the business cycle, Manuscript, University of Wisconsin, Madison, WI.

Solow, R.M., 1957, Technical change and the aggregate production function, *Review of Economics and Statistics*, 39.

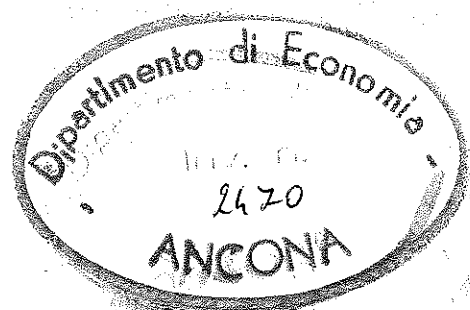
Solow, R.M., 1964, Draft of the presidential address to the Econometric

Society on the short-run relation between employment and output.

Tachibanaki, T., 1987, Labour market flexibility in Japan in comparison

with Europe and the U.S., *European Economic Review*, 31: 647-

684.



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