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Notes and Comments

A Note on the Sectoral Employment Pattern

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Précis: The theory proposed by Cogan (1978) that the sectoral employment pattern is likely to reach a "steady state" is re-examined. It is suggested that there is no theoretical basis for such a state and that there is a considerable weight of opinion against it. It is shown that the statistical evidence advanced by Cogan is not conclusive. The theory is, accordingly, rejected.

In a recent study mainly concerned with the productivity of the service sector in Ireland, Cogan (1978) deals with the concept of a "steady state" in the sectoral employment pattern and it is argued here that there is no evidence that such a state exists.

This "steady state" or "equilibrium" is referred to repeatedly (for example, p. 60, paragraph 2; p. 68, paragraph 3). It is defined as a condition in which the percentages of the total workforce employed in each of the three main economic sectors (agriculture, industry and services) remain constant as income per head rises. Cogan's argument is mainly statistical (though some justification is given on p. 57) and rests chiefly on the results of regressions in the form:—

$$Y_i = b_{oi} + b_{ii} \frac{1}{X} + u_i$$

where Y_i is the percentage of total employment engaged in sector i and X is GDP *per capita.* Three sets of regressions are run using data from Ireland 1956/75, from a sample of 19 OECD countries for 1973 and from a sample of 27 UN countries for 1960. Since Cogan rejects his OECD sample as being "biased" (p. 63) we will not consider it further here. The "equilibrium

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values" found in the other two sets of regressions are as follows:—

Ireland (1956/75): Agriculture 21.3 per cent; Industry 32.7 per cent; Services 46.0 per cent
UN (1960) Agriculture 10.0 per cent; Industry 41.5 per cent; Services 48.5 per cent
(Source: Table 16, p. 68).

If such a steady state could be proved to exist it would be a matter of considerable practical importance and also of great theoretical interest. Once a country had reached the equilibrium, employment in the three sectors could only expand in the same proportion. This would have important implications for manpower policy, industrial development and education. Unfortunately, the evidence proves, on examination, to be less than convincing.

There does not seem to be any firmly established economic theory which relates to the matter of sectoral employment shares. However, it is clear that the percentage of the workforce employed in any sector must depend on the productivity of labour in that sector and on the ability of the economy to generate demand for the sector's output. The demand need not necessarily be internal; export demand will do just as well. To maintain an equilibrium, productivity and demand in each sector would have to change at the same rate.

Increases in labour productivity play a double role in the matter. On the one hand, they generate extra income and so change the demand for the output of the various sectors. On the other hand, they alter the amount of labour required to produce a given output. To maintain a "steady state" the two processes would have to balance each other. However, this is unlikely because, while the income elasticity of demand for the output of agriculture is generally believed to be low and that for the services much higher, the changes in productivity seem to be highest in agriculture and lowest in the services (Cogan, Table 17, p. 75). Changes in exports could, of course, help to maintain the balance, as could changes in relative prices. However, there is no obvious reason why all these influences should balance each other exactly, so as to produce a "steady state". Even if an equilibrium were established temporarily, only the strongest coincidence or the most rigorous planning could maintain it for an extended period.

It is not surprising, then, to find that writers who have considered the matter believe that continual change is more likely than sectoral employment equilibrium. The following are typical of the opinions they express: Kuznets (1966, p. 154) "Some conclusions have been suggested with respect to the downward trend in the share of the agricultural sector in the labour force and . . . a distinct rise in the share of the labour force (in the service

sector)". Gershuny (1978, p. 138) "We find that employment in primary industry falls over time, secondary industry first rises and then falls, tertiary service employment rises continually. In fact, the evidence emboldens us to generalise a quite determinist sequence of development for employment sectors". Maddock (1978, p. 595) "The future pattern is likely to be a steep decline in the proportion of the workforce engaged in the manufacturing industries and a corresponding increase in employment in the tertiary industries".

The European Trade Union Institute (1979, p. 104) forecasts that in the 1980s employment in agriculture and mining will drop, industrial employment will level off in some sectors and drop in others and the majority of the services will expand their employment. Keenan (1978, p. 200) forecast that between 1976 and 1986 agricultural employment in Ireland will fall from 23.5 per cent of the total employed to 17.4 per cent. Not only do these writers reject the idea of an equilibrium but they all tend to forecast a decrease in employment in agriculture and the primary industries and an increase in the numbers at work in the services.

The empirical evidence supports these ideas very strongly. If we take the 27 UN countries in Cogan's sample (OECD 1977) and examine their performance in the period 1960-75, we find only one of them in which the sectoral employment pattern remained stable to within one per cent. This was India with 73 per cent in agriculture, 11 per cent in industry and 16 per cent in services. In *all* the others, the percentage in agriculture fell and in all except one the percentage in the services rose. The exception was South Africa where service employment fell from 42 per cent to 41.3 per cent. The changes in most cases were quite substantial – the average fall in agriculture was 10.0 per cent and the average rise in the services was 8.2 per cent. If equilibrium were possible in Ireland at the relatively low levels of income suggested by Cogan's Chart 7 (p. 59), then one would expect to find at least one advanced country which had reached the stable situation.

The results of the UN cross-section regressions are also inconsistent with the evidence. Chart 9 (p. 65) suggests that, for the sample, the lower asymptote for agricultural employment is 10 per cent, and for service employment the upper asymptote is 48.5 per cent. Yet in 1975 one finds that 11 of these countries had less than 9 per cent employed in agriculture and 13 had more than 50 per cent employed in the services. Thus, the upper and lower "limits" do not seem to be valid. One could, of course, argue that the function shifts over time, but Cogan does not mention this and, in any case, a function with such a time shift would need to be interpreted in a very different way.

Thus, there is a considerable mass of opinion and evidence against the existence of a steady state, and to prove its existence by statistical means would require very strong results indeed. However, on examination, Cogan's

results seem less than strong. In the first place, the emergence of an asymptote in regressions of the kind used by Cogan is no proof that an asymptote exists. Consider the following data which are generated by the function

$$Y = 5 + \ln X$$

X:	1.00	1.25	1.50	1.75	.....	6.00
Y:	5.00	5.22	5.41	5.56	.....	6.79

Clearly, Y does not have an upper asymptote; we can make it arbitrarily big by increasing X sufficiently. However, if we use OLS to fit the function $Y = b_o + b_1 \frac{1}{X}$ to the data above, we get:—

$$Y = \underset{(122.1)}{6.97} - \underset{(17.0)}{2.26}\frac{1}{X} \quad R = .969$$

(the figures in parentheses are t-values)

This regression produces an asymptote with a very high degree of confidence where none exists. Thus, the reasonably good fit which Cogan achieves in his regressions provides no basis for believing that a "steady state" exists.

A more detailed examination of Cogan's results weakens his case still further. It will be recalled that his theory takes the form

$$Y_i = b_{oi} + b_{ii}\frac{1}{X}$$

(the variables are explained at the beginning of this paper). However, we find (Chart 7, p. 59) that he uses *current price* GDP *per capita* as the independent variable in his regressions on the Irish data. It is difficult to see how this can be defended, since it implies that a change in the general price level has the same effect on the sectoral employment pattern as a change in real income. However, if we run the same regressions using constant price GNP per head (a constant series for which is available in the Central Bank Data Bank 1977) the results are still good, as the top half of Table 1 shows.

It is interesting to see, by comparison with Cogan's Chart 7, that the use of real income instead of money income makes a substantial change in the asymptotes, lowering that for agriculture and raising that for the services. However, the main point to be made is that the inverse form used by Cogan is not by any means clearly superior to all others. The second part of Table 1 shows the results of regressions where $(\frac{1}{X})$ is replaced by (lnX) and where, of course, no asymptotes or "steady state" exist. It will be seen that in this alternative form the overall fit (as measured by either the coefficient of

Table 1: *Relation between sectoral employment shares and* per capita *GNP (constant prices) Ireland 1956/75*

	R^2	LLF	b_0	b_1
(a) Form $Y = b_0 + b_1 (\frac{1}{X})$				
Agriculture	.975	−24.0	6.65 (6.9)	11.493 (26.2)
Industry	.965	−15.2	40.68 (65.4)	−6,318 (22.4)
Services	.872	−25.3	52.67 (51.4)	−5,175 (11.1)
(b) Form $Y = b_0 + b_1 \ln X$				
Agriculture	.990	−14.7	185.33 (50.7)	−24.99 (42.2)
Industry	.958	−17.1	−56.56 (13.7)	13.58 (20.3)
Services	.911	−21.6	−28.76 (5.6)	11.41 (13.6)

(LLF is the logarithm of the likelihood function: the figures in parentheses are t-values.)

determination or the log of the likelihood function) improves in two of the three cases and that the t-values of the coefficients improve in three of the six cases and disimprove in the other three. The logarithmic form will generate realistic values for all Y_i (that is, values between 0 per cent and 100 per cent) in the income range £65 per head to £1,600 per head at 1970 prices. The lowest observed value for incomes per head is £352 and the highest £617. It is not claimed here that the logarithmic form is necessarily the correct one, but merely that the statistical superiority of the inverse form used by Cogan is demonstrably questionable.

The same applies to Cogan's findings on the UN cross-section data. The results of his regressions are given in the top half of Table 2 below. It will be seen that, as one would expect, the fit is less good than in the case of the Irish data, presumably because the development pattern varies substantially from country to country. However, a double-log regression will give results whose goodness-of-fit statistics are almost identical to those given by the inverse regression. More interesting, perhaps, are the results shown in the second part of Table 2. These are derived from a low-degree polynomial in the form

$$Y_i = b_{oi} + b_{ii} X + b_{2i} X^{1.5}$$

This gives, over a wide range of income, results which are consistent with the sectoral employment pattern suggested by Gershuny above, namely, a decline

in agriculture, a rise followed by a fall in industry and a rise in the services. This pattern is also observable if one plots the data. It will be seen that the polynomial provides a better fit in all three cases at the cost of some deterioration in the t-values. Once again, it is not claimed that the polynomial is the correct form. It is merely asserted that the inverse form has no particular pre-eminence.

Table 2: *Relation between sectoral employment shares and* per capita *GNP 27 UN countries 1960*

(a) Form $Y = b_0 + b_1 (\frac{1}{X})$

	R^2	LLF	b_0	b_1
Agriculture	.753	−99.9	10.1 (3.4)	12,224 (8.7)
Industry	.683	−87.4	41.5 (21.9)	−6,474 (7.3)
Services	.553	−91.7	48.4 (21.9)	−5,750 (5.6)

(b) Form $Y = b_0 + b_1 X + b_2 X^{1.5}$

	R^2	LLF	b_0	b_1	b_2
Agriculture	.845	−93.6	82.7 (6.4)	−.1150 (5.5)	.0018 (4.0)
Industry	.809	−80.6	−1.8 (0.5)	.0821 (6.4)	.0014 (5.2)
Services	.631	−89.1	19.1 (3.6)	.0329 (1.9)	.0004 (1.0)

To summarise:—

(1) While there is no well-established body of economic theory on the matter, such knowledge as we posess indicates that sectoral employment equilibrium is unlikely.

(2) There are many authors who believe that there will be a continuous decline in agricultural employment and a continuous rise in service employment. There does not seem to be anyone else who foresees a sectoral equilibrium.

(3) The observable evidence (even Cogan's own UN data) support the ideas in (2) above.

(4) The fit of the inverse function used by Cogan is by no means uniquely good. Other forms (which do not imply the existence of asymptotes) will fit the data just as well.

(5) In view of all this, there does not seem to be any reason to expect that the sectoral employment pattern will reach a "steady state". It seems far more likely that the percentage employed in agriculture will continue to contract and the percentage in the services to expand. The main source of employment in the future is very likely to be found in the services sector.

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