The Development of Verdoorn's Law

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Since Kaldor gave his Inaugural Lecture in 1966, presenting the Verdoorn law (the empirical relationship between the rate of growth of total manufacturing labour productivity and that of output) as evidence of substantial economies of scale, it has been the object of considerable investigation, criticism and controversy. The main area of application of the Verdoorn Law to date, has been to provide empirical support for cumulative models of growth initially proposed by Allyn Young (1928). Young outlined his growth model for an advanced economy incorporating as its central theme, the notion of "dynamic increasing returns to scale" in manufacturing. The Verdoorn Law forms the core of cumulative causation models, of which a succinct formalisation is that of Dixon and Thirlwall (1975, 1979).

The positive correlation between productivity and output was initially identified by Dr. P. J. Verdoorn in his paper; "Factors that determine the Growth of Labour Productivity"which appeared in the Italian journal *L'Industria* in 1949. Verdoorn, from an analysis of sectoral and international industry data observed the relative constancy of the average value of the elasticity of labour productivity with respect to output at about 0.45. He derived the conditions for a stable relation between the logarithms of labour productivity and output within the context of the general equilibrium model of Tinbergen (1942). In this framework, Verdoorn has the productivity elasticity dependent upon the growth of the capital to labour ratio in an assumed Cobb-Douglas aggregate production function.

Verdoorn also incorporates a labour supply function into his model, where the growth of employment is a function of the growth of wages. Since the growth of wages is equal to the growth of productivity (through marginal productivity assumptions), there is a labour supply relationship between labour productivity growth and employment growth (and hence output growth). Consequently the "Verdoorn elasticity"; (productivity growth/output growth) contains parameters of both the production function and the labour supply relationship. Kaldorian economists however do not accept that there is a systematic relationship between the growth of manufacturing wages and the supply of labour to that sector. The Verdoorn Law is seen simply as an empirical relationship. Kaldor (1966) proposed that the law reflects three phenomena; namely economies of scale, technical progress and learning by doing. However, recalling the earlier work of Allyn Young (1928), Kaldor emphasised the role of the division of labour and increasing returns as the

chief explanation for the causal relationship running from output to productivity growth particularly in the manufacturing sector.

The Verdoorn Law was brought to the wider attention of economists in 1966 by Kaldor, however, he was preceded by other economists in investigating the Verdoorn relationship. Colin Clark (1961) in his third edition of *Conditions for Economic Progress*, discusses Verdoorn's work and identifies the positive linear relationship for many industries internationally. In relation to the field of study regarding productivity growth and industrial output growth, Clark boldy predicted; "Dr. Verdoorn, in this field, may prove to have played much the same role as Pareto in the field of income distribution" (Clark, 1961, 359). It is of some significance that both Clark and Kaldor share a common link, i.e. their association with Allyn Young. Kaldor was an undergraduate at the London School of Economics between 1927 and 1930. His teachers, with whom he attributed having much influence on him were Lionel Robbins, Friedrich von Hayek and most of all, Allyn Young, the Harvard economist. Among Kaldor's contemporaries were Hicks, Rothbarth and Scitovsky (Pasinetti, 1983, 335).

In 1928, Clark, a student of chemistry, graduated at Oxford. However, his growing interest in politics and economics brought him into acquaintence with Robbins and William Beveridge at the L.S.E. In the same year he was offered a part time job as a research assistant by Beveridge. Clark also worked for Allyn Young on a short-term contract. In 1930 Clark's rapidly growing skills in statistics led him to investigatory work for the Economic Advisory Council, where he met Keynes. In 1931 Keynes secured for Clark a lectureship in statistics at Cambridge; a post he would hold until he moved to Australia in 1937 (Groenewegen, McFarlane, 1990, 109-110).

Kaldor and Clark were both heavily influenced by the Keynesian revolution. However, the single most striking feature of their respective work on the Verdoorn Law is the pervading influence of Allyn Young's famous 1928 address on increasing returns and economic progress. Young delivered his presidential address on September 10, 1928 at Glasgow University (Blitch, 1983, 364). This was to be an appropriate place, for the paper was basically an extension and refinement of Adam Smith's theory of economic progress. Smith's theorem that the division of labour is limited by the extent of the market was the central theme of Young's paper. As Young stated; "That theorem, I have always thought, is one of the most illuminating and fruitful generalisations which can be found anywhere in the whole literature of economics" (Young, 1928, 529). Like Marshall and Smith, Young regarded the division of labour as the prime source of increasing returns and economic progress.

Young believed as did Smith, that agriculture did not offer as many opportunities for the division of labour as did manufacturing. The data on the US economy for the 1920's supported Young's belief for it showed startling gains in industrial productivity with only moderate gains in that of the farm sector (Blitch, 1983, 365). According to Young, the division of labour in its modern form is more far reaching than the specialisation in a single craft, such as Smith's pin making example. It manifests itself in two related aspects: the growth of indirect or roundabout methods of production and specialisation among industries. "Roundaboutness" involves the breaking up of a complicated process into a succession of simpler processes, many of which lend themselves to the use of machinery.

The Specialisation of industries was seen by Young to be the most important source of increasing returns: "the progressive division and specialisation of industries is an essential part of the process by which increasing returns are realised" (Young, 1928, 439). Young's argument that "industrial differentiation, has been and remains the type of change characteristically associated with the growth of production" (Young, 1928, 537), has been supported both by empirical and historical evidence (Blitch, 1983, 365). With economic advance there is continual structural change in the manufacturing region of the economy leading to greater specialisation and interdependence. External economies are related not so much to the growth of a single industry but more to the volume of output of allied industries. Young argued: "the mechanism of increasing returns is not to be discerned adequately by observing the effects of variation in the size of the individual firm or of a particular industry, ... What is required is that industrial operations be seen as an interelated whole" (Young, 1928, 539).

Alfred Marshall devised the analytical concept of external economies for two reasons. First, along with "internal economies" it provided a means whereby the gains from the specialisation of labour and capital could be introduced into his static constructions. Second, and in particular, since increasing returns could accrue as external economies, it seemed possible to reconcile increasing returns and competitive equilibrium. Marshall recognised the logical difficulties that increasing returns posed for his static partial equilibrium method and inserted several warnings to that effect in Appendix H of "Principles". Nevertheless, his analytical device of "external economies" and his solution to competitive equilibrium with increasing returns were virtually unchallenged for thirty years (Blitch, 1983, p. 361).

However in the 1920's there began an intellectual ferment in the United States and in Britain which demanded a consistent logical rigour in the older theories. Young felt that the professional preoccupation with the logical rigour and refinements of static equilibrium theory was at wide variance with what the mounting empirical evidence showed. US data reflected an economy undergoing rapid change and growth in productivity in manufacturing, industrial structure, goods and services and capital investment.

A contemporaneous discussion of the theoretical problems associated with "external economies," increasing returns and competitive equilibrium had developed in Britain, involving such notables as Clapham, Pigou, D.H. Robertson and Shove. The "empty boxes" debate of 1922 was followed by Piero Sraffa's famous criticisms of Marshallian economics (Sraffa, 1926), and this culminated in the symposium on the Laws of Return in the *Economic Journal* of 1930. Young protested the application of equilibrium methodology to what he saw as a process of change: "No analysis of forces making for economic equilibrium ... will serve to illumine this field, for movements away from equilibrium, departures from previous trends are characteristic of it" (Young, 1928, 528). Young felt that the changes in production methods and industrial organisation induced by the extension of the division of labour were not systematic enough to be subjected to any type of equilibrium analysis, partial or general. "Every important advance in the organisation of production," he wrote "... alters the conditions of industrial activity and initiates responses elsewhere in the industrial structure which in turn have a further unsettling effect. Thus change becomes progressive and propogates itself in a cumulative way" (Young, 1928 p. 533).

The Contribution of Nicholas Kaldor

In his lecture at Cambridge in 1966 on the causes of the U.K's slow growth rate, Kaldor (1966) presented a series of "laws" to account for growth rate differences between advanced capitalist countries. These laws, known as Kaldor's three growth laws have been the subject of considerable scrutiny and debate in terms of their interpretation and validity. The basic thrust of Kaldor's initial model consists of the following propositions:

Firstly, the faster the rate of growth of the manufacturing sector, the faster will be the rate of growth of Gross Domestic Product, not simply in a definitional sense in that manufacturing output is a large component of total output, but for fundamental economic reasons connected with induced productivity growth inside and outside the manufacturing sector. This idea can be summed up in the maxim that the manufacturing sector of the economy is the "engine of growth".

Secondly, there is a strong positive relationship between the rate of labour productivity growth in manufacturing and the growth of manufacturing ouput, the "Verdoorn Law". Kaldor attributed much importance to what he called endogenous productivity growth; i.e. productivity growth that is functional to output growth. In terms of endogenous productivity growth, Kaldor emphasises the important link between output growth, the division of labour, increasing returns and technical progress: "A greater division of labour is more productive, partly because it generates more skill and know-how; more expertise in turn yields more innovations and design improvements". Kaldor cites Arrow (1962) when he attributes, as does Verdoorn and Clark, the significance of learning by doing as a contributing factor in the process of productivity growth: "Learning is the product of experience ....which means, as Arrow has shown, that productivity tends to grow the faster output expands" (Ibid p.288). Kaldor in his interpretation of the Verdoorn law, also stresses that the relationship is a dynamic rather than a static one. He is more interested in the link between the rates of change of productivity and output rather than investigating the "level" of productivity and the "scale" of output. Kaldor also identifies technical and technological progess as part of this dynamic, cumulative process.

Finally, Kaldor's third law states; the faster the growth of manufacturing output, the faster the rate of labour transference from non-manufacturing to manufacturing, so that overall productivity growth is positively related to the growth of output and employment in manufacturing and negatively associated with the growth of employment outside manufacturing. Noting his three growth laws and acknowledging that they are very much in the vein of cumulative causation, Kaldor (1966) argued that the slow rate of economic growth in the UK was due to a shortage of labour for manufacturing. This conclusion would prove to invoke the Rowthorn critique..

The Rowthorn Critique

Rowthorn (1975a) suggested that if the slow growth rate in the UK is due to a labour supply constraint faced by the manufacturing sector, then a more appropriate approach would be to regard employment growth as exogenous and view output growth and productivity growth as the dependent variables. Gomulka (1971) adopted a similar approach, when he advanced the thesis that differences in productivity between countries could be explained by the diffusion of advanced

technology from the more to the less advanced countries. Rowthorn concluded that constant returns to scale prevail in the manufacturing sectors of the developed OECD countries and as a consequence, the existence of dynamic increasing returns to scale had not been established by Kaldor in his original study (Rowthorn 1975b, p.897).

Kaldor promptly replied to Rowthorn's article in late 1975. He rejected the Rowthorn reformulation of the Verdoorn Law, emphasising that in his inaugural lecture, he alleged that only the UK was constrained by a shortage of labour. He reminds Rowthorn of his reply to Wolfe (1968) where he retracts his view attributing slow growth to a labour shortage. In no way did Kaldor intend explicitly or implicitly, to suggest the exogeneity of employment growth or a positive relationship between productivity growth and employment growth (Kaldor, 1975b, 891). Kaldor argues: "...that economic growth is demand induced and not resource constrained - i.e. that it is to be explained by the growth of demand which is exogenous to the industrial sector and not by the (exogenously given) growth rates of the factors of production, labour and capital, combined with some (exogenously given) technical progress over time" (Kaldor, 1975b, 895). In his 1975 reply to Rowthorn, Kaldor goes on to specify the sufficient condition for the presence of "static" or "dynamic" economies of scale within the context of the Verdoorn Law.

The Static/Dynamic Paradox

It is important to distinguish between static and dynamic economies of scale. Thirlwall and Dixon (1975) derived the Verdoorn law from the linear specification of Kaldor's technical progress function (Kaldor 1960). Black (1962) has shown that the linear technical progress function may be derived from the Cobb-Douglas production function. Using the same approach as Verdoorn initially adopted, i.e. logarithms of the actual levels of employment and output, a "static" Verdoorn law may be specified. McCombie argued that if the Cobb-Douglas production function is the true underlying theoretical structure beneath the Verdoorn law, then estimates of the coefficients should be identical for both static and dynamic specifications (McCombie, 1983, 422).

McCombie identified what has become known as the "static-dynamic Verdoorn Law paradox". He found no evidence of increasing returns to scale using the static specification, whereas statistically significant economies of scale were implied by the coefficients using the dynamic specification. The paradox has been investigated by de Vries (1980), and McCombie and de Ridder (1984) have incorporated capital in their specifications. They concluded with the same results.

This provides a useful backdrop for Arrow's "learning function" and Kaldor's "technical progress function". It will be argued that the two function's are dealing with the same phenomenon, but the former is the product of a "static" methodology where as the latter is the product of a "Harrodian dynamic" methodology. McCombie (1982a) has shown that the "static" Verdoorn law, which more closely resembles the original specification by Verdoorn (1949), can be derived from a learning by doing function. Some of the earliest instances of the incorporation of the concept of "learning by doing" in economics are Hamilton (1791) and List (1841) (infant-industry argument). The concept was also recognised in principle by John Stuart Mill (Bardhan, 1970, 104). In his celebrated paper, Arrow (1962) advanced his learning

function. Arrow borrowed from the theory of learning (by individuals) in psychology, the empirical generalisation that learning is primarily the product of experience, which is not simply a function of time, but is dependent on practice or doing.

A second empirical generalisation adopted by Arrow is that: "learning associated with repetition of essentially the same problem is subject to sharply diminishing returns" (1962, 155). This is the basic hypothesis of his model. The current level of knowledge or technical expertise in an economy is seen as the result of past experience; and improvements in productive techniques are a consequence of growing experience of the problems involved in production. Arrow assumed that technical progress is wholly embodied in new capital equipment - in effect that it takes place only in the sector producing capital goods, the design of which is being continuously improved as experience in their production increases. Arrow also points out that the derived production function shows increasing returns to scale. Verdoorn (1956, 433-4) attributed learning as the theoretical basis of his static specification of the Verdoorn law. He explained the positive correlation between the logs of productivity and output levels as resulting from the increase in the capital to labour ratio (1949, 7-11). Arrow (1962, 155) regards such an explanation as inadequate.

Kaldor described his technical progress function as postulating a "relationship between the rate of increase of capital and the rate of increase in output and which embodies the effect of constantly improving knowledge and know-how, as well as the effect of increasing capital per man, without any attempt to isolate one from the other." This relationship more clearly specified is a positive correlation between the growth of output per unit of labour and the growth of capital per unit of labour. Kaldor stressed the importance of the "speed" with which capital is accumulated. He viewed the rate of technical improvement as dependant on the rate of capital accumulation. As Kaldor states; "whether the increase in output would be more or less proportionate to the increase in capital will depend, not on the state of knowledge or the rate of progress of knowledge, but on the speed with which capital is accumulated relative to the capacity to innovate and to infuse innovations into the economic system" (p.36).

It is through the adoption of a linear technical progress function that Dixon and Thirlwall (1975, 209) derived the dynamic Verdoorn law. As Dixon and Thirlwall state: "The rate of autonomous productivity growth,...and the Verdoorn coefficient...will depend on the technical dynamism of productive agents...and the extent to which capital accumulation is induced by growth and embodies technical progress."

The only attempt to estimate the Verdoorn Law within a general equilibrium/simultaneous equation framework is the study by Parikh (1978). Ironically, Parikh's results support the increasing returns hypothesis and also appear to substantiate the demand-orientated hypothesis of economic growth (Bairam, 1987, 38). As Parikh states: "Kaldor's law as formulated by Rowthorn and Cripps-Tarling thus does not turn out to be tenable with the empirical data of 12 OECD countries and demand factors seem to be relevant in explaining the slow growth of the manufacturing sector" (McCombie, 1983, 424).

Breakdown of the Verdoorn Law?

Finally, some doubt has arisen as to the stability of the Verdoorn coefficient which was the central proposition made by Verdoorn (1949) and re-affirmed by the

empirical work of Clark (1961, 359-367). Indeed it was Verdoorn himself (1980, 385) who, on the basis of a derivation made within the Tinbergen general equilibrium framework, repudiated the stability claim. There is no evidence offered to support his claim which is based soley on logical deduction. He states: "the 'law' that has been given my name appears therefore to be much less generally valid than I was led to believe in 1949." The research into Australian manufacturing that I have undertaken suggests otherwise.

Hodgson (1989, 88) suggests that the "Kaldor-Verdoorn relationship" may only apply in times of an upswing and may breakdown in a downswing. Hodgson cites members of the "French regulation school" who have suggested that the "Kaldor-Verdoorn relationship" may have broken down since the oil shock of 1973. Indeed 1973 could well have marked the beginning of the "downswing" of the long wave identified by Kondratiev in 1926.

Implications of findings

The implications of the Verdoorn Law embodying technical progress for growth models and indeed the competitive general equilibrium framework are far reaching. Firstly, in terms of the Harrod Domar model, endogenous labour productivity growth that is largely induced by the actual growth rate must imply that the natural growth rate (growth of full employment labour force plus growth in labour productivity) will be to some extent determined by the actual growth rate and not exogenously determined as is the usual assumption (Weintraub, 1977, 340).

If one assumes a Kondratiev long wave upswing that is typified by the explosive combination of an actual growth rate that exceeds the warranted growth rate, one would expect that the natural growth rate would follow the upward trend. Continual growth in investment, that, via an assumed multiplier fuels even more growth in actual output would, in consequence, lead to continued productivity growth due to technical progress and dynamic economies of scale. It could be expected that this would to some extent offset inflationary pressures. Experience has shown however that upswings "plateau" for a number of possible reasons: balance of payments constraints, supply shocks, supply constraints.

A downswing may be typified by continued investment collapses. It could be assumed that these collapses are due to the warranted growth rate exceeding the actual growth rate. With the so called autonomous rate of productivity growth trending downward during the latter part of the 1980's there could well be a case for assuming that the natural growth rate could indeed become negative in a "Leaden Age" scenario.

The consequences of dynamic economies of scale and endogenous technical progress for the competitive general equlibrium framework are marked. The inevitable consequence of such forces at work are imperfect competition, i.e. monopoly or at least oligopoly, if these economies are internal to the firm. The apparent inability of general equilibrium model builders to escape from constant return, perfect competition assumptions highlights what Hahn (1981) has described as the "end of that road" (p.123) and as a "cul de sac" (p.128). Hahn states his views on the General equilibrium framework: "the world is no longer as decentralised as it used to be...the road we pursued was excessively straight and narrow and made - we now feel - with

too little allowance for the wild and varied terrain it had to traverse. We have certainly arrived at an orderly destination, but it looks increasingly likely that we cannot rest there" (p.123).

Acknowledging that models of imperfect and monopolistic competition have been with the discipline since the 1930's, why haven't they been more extensively incorporated into mainstream models? This infamous admission by Hicks (1939, 83-84) may shine some light on the matter:

> "...it has to be recognised that a general abandonment of the assumption of perfect competition, a universal adoption of monopoly, must have very destructive consequences for economic theory. It is, I believe, only possible to save anything from the wreck - and it must be remembered that the threatened wreckage is that of the greater part of economic theory - if we can assume that the markets confronting most of the firms with which we shall be dealing do not differ very greatly from perfectly competitive markets."

Models of imperfect competition failed to be fully incorporated into orthodox theory, not through any inherent weakness or lack of rigour, but because the implications of these models presented insurmountable difficulties to the marginalist paradigm. The existence of such characterisations e.g. product differentiation, underutilisation of capacity and market power were not compatible with propositions derived from Pareto optimality and the marginal productivity theory of distribution, which collapse once the assumption of perfect competition is abandoned.

The admission of Debreu (1959, 41) was that the assumption of convexity for each producer's production set, which implies constant returns to scale, was "crucial" to the existing theorems derived from the Arrow-Debreu models. However, Hahn (1973, 13) has explained, referring to results formalised by Starr (1969), how an Arrow-Debreu economy could, asymptotically reach a position of "approximate equilibrium", if and only if increasing returns to scale were "small relatively to the scale of the economy." Hahn concedes (1984, 116) that the whole of general equilibrium theory remains at risk if increasing returns are "large relative to the size of the economy." Arrow (1985, 113) has also recognised the significance of Hahn's point in his important statement on the limitations of marginalist general equilibrium theory: "... the propensity to monopolise is an intrinsic feature of the profit system ... The theory of imperfectly competitive equilibrium is in its infancy, but such a theory is badly needed in the presence of increasing returns on a large scale relative to the economy and is superfluous in its absence." However, it should be mentioned that over the last decade there have been serious efforts made to incorporate imperfect competition, and increasing returns, into general equilibrium analysis.

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