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John McCombie's Contribution to the Applied Economics of Growth in a Closed and Open Economy

A. P. Thirlwall

1 Introduction[1]

It is a great pleasure to write this essay in honour of John McCombie who retired in 2017 from his Chair in the Department of Land Economy in Cambridge University, which he first joined in 1990 when Gordon Cameron was the Director. I have known John since 1980, first by correspondence and then in person. Over the years, we have conducted a lot of research and writing together, with John invariably being the major author. Our first contact was when John questioned my 1979 paper 'The Balance of Payments Constraint as an Explanation of International Growth Rate Differences' (Thirlwall 1979). He tried to argue that the simple rule, $y = x/\pi$, where y is the growth of output (GDP), x is the growth of real exports and π is the income elasticity of demand for imports, is a tautology because if the income elasticity of demand for imports is defined as $\pi = m/y$, where m is the growth of imports, the simple rule amounts to saying $x = m$. What he had failed to realise was

A. P. Thirlwall (✉)
School of Economics, Keynes College, University of Kent, Canterbury, UK

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that the π I used was estimated econometrically, controlling for changes in the relative prices of foreign and domestic goods, so what the rule really says is that it is not relative price changes that equilibrate the balance of payments of countries, working through the price elasticity of imports (and exports), but output growth. John generously conceded the point (McCombie 1980b), and so began a long and fruitful friendship and collaboration that culminated in our book *Economic Growth and the Balance of Payments Constraint* (McCombie and Thirlwall 1994). Later we collected together a series of empirical studies on balance of payments-constrained growth entitled *Essays on Balance of Payments Constrained Growth* (McCombie and Thirlwall 2004).

Over the years, John and I have met in several places. He spent a sabbatical term with me at the University of Kent in 1984, and we overlapped at the University of Melbourne when John was a lecturer there between 1985 and 1988, and I was a visitor in 1988. We have also participated in several memorable conferences together in different parts of the world including the Post Keynesian conferences in Knoxville, Tennessee, organised by Paul Davidson; a fiftieth anniversary conference celebrating Verdoorn's 1949 paper 'Fattori che Regolano lo Sviluppo della Produttivita del Lavoro' (Verdoorn 1949) held at the University of Genoa in 1999; Keynesian conferences in Pula, Croatia, organised by Soumitra Sharma; and a conference in 2011 on balance of payments-constrained growth held in Coimbra, Portugal, organised by Elias Soukiazis and Pedro Cerqueira, out of which was published a book *Models of Balance of Payments Constrained Growth: History, Theory and Empirical Evidence* (Soukiazis and Cerqueira 2012).

I also have an anecdote to tell. I was the first person to take John to the continent of Europe when he was already in his 40s. When I asked him why he had not visited before, he replied 'because they don't speak English'! John is quintessentially English, brought up as an only child, educated at Dulwich College and Cambridge University where he read geography and had a grandfather who was Postmaster General, and reserved in character—but very clever and a little iconoclastic. 'Irony' and 'putative' are two of his favourite words.

John's PhD at Cambridge, supervised by Robert Rowthorn, and examined by Roger Tarling and Keiran Kennedy in 1982, was entitled 'Post-War Output and Productivity Growth in the Advanced Countries', and this was the starting point for his interest in Kaldor's growth laws, and particularly Verdoorn's Law relating the rate of growth of labour productivity in manufacturing to the growth of output in manufacturing via static and dynamic increasing returns. He continued to mix his interest in Kaldor's growth laws and balance of payments-constrained growth models well into the new millennium. Then his research interest started to focus on a critique of the neoclassical production function and its application for understanding the sources of growth, which culminated in his book with Jesus Felipe, *The Aggregate Production Function and the Measurement of Technical Change: 'Not Even Wrong'* (Felipe and McCombie 2013).

This essay will be organised under three main heads. The first will be on Kaldor's growth laws, and Verdoorn's Law, and John's contribution to our understanding of them. The second will be balance of payments-constrained growth, and John's innovative contributions to the literature. Kaldor's growth laws refer to a closed economy, while balance of payments-constrained growth models deal with an open economy. Kaldor also gave great importance to the role of exports in economic growth (Kaldor 1970), which is missing from his writing on manufacturing industry as the engine of growth. I shall end the essay, therefore, by marrying together Kaldor's first law of growth that manufacturing is the engine of growth in the closed economy with his export-led growth model for the open economy, and show that the former can be regarded as a reduced form of the latter. I shall give some empirical results which show this across a sample of 89 developing countries.

2 Kaldor's Growth Laws

In his Cambridge Inaugural Lecture in 1966 (Kaldor 1966) and in his Frank Pierce Memorial Lectures at Cornell University in the same year (Kaldor 1967), Kaldor enunciated a series of growth laws, and subsidiary propositions, which he believed explained differences in the growth performance of countries at different stages of development. John spent much of the early part of his career in the 1980s critically examining and testing Kaldor's growth laws. The basic thrust of the Kaldorian vision consists of the following propositions: (i) manufacturing industry is the engine of growth—sometimes referred to as Kaldor's first law. The faster the rate of growth of the manufacturing sector, the faster will be the rate of growth of GDP, not simply in a definitional sense in that manufacturing is a component of GDP, but for fundamental economic reasons connected with induced productivity growth inside and outside the manufacturing sector. This is essentially a *structural* explanation of why growth rates differ between countries, as opposed to the one-good model of orthodox neoclassical growth theory in which structure (and demand) plays no part; (ii) productivity growth in the manufacturing sector is induced by the growth of manufacturing output because of static and dynamic returns to scale, otherwise known as Verdoorn's Law—or Kaldor's second law. Static returns relate to economies of scale, while dynamic returns relate to induced capital accumulation and embodied technical progress, plus learning by doing. There is also the phenomenon to consider of macro-economies of scale in the Allyn Young (1928) sense arising from the interaction between manufacturing industries in the presence of micro-economies of scale within industries and a price elasticity of demand for products greater than unity which sets up a cumulative interactive process leading to fast output and productivity growth. We will consider later John's attempt to understand what lies behind Verdoorn's Law; (iii) productivity growth outside manufacturing is induced by manufacturing output growth because the faster manufacturing grows, the faster the rate of transference of labour from other sectors of the economy where there are diminishing returns or no relationship exists between employment growth and output growth—sometimes called Kaldor's third law. A reduction in the amount of labour in these sectors will raise the average product of labour and therefore will raise productivity growth in those sectors. As the scope for absorbing labour from diminishing returns activities dries up, or as output comes to depend on employment in all sectors of the economy, the degree of overall productivity growth induced by manufacturing output growth is likely to diminish, with the overall growth of GDP correspondingly reduced. It is in this sense that Kaldor believed that countries at a high level of development, with little or no surplus labour in agriculture or other non-manufacturing activities, suffer from a shortage of labour and will experience deceleration of growth, not in the sense that the manufacturing industry is constrained by a shortage of labour which he suggested in his Inaugural Lecture as the UK's problem which he soon retracted (Kaldor 1968). This is an important point because it makes a difference to the choice of independent variables to use in testing the Verdoorn relationship between productivity growth in industry and output growth, whether output growth should be the independent variable or employment growth as argued by Cripps and Tarling (1973) and Rowthorn (1975) (see later); (iv) the growth of manufacturing output is not constrained by labour supply but is fundamentally determined by demand from agriculture in the early stages of development and export growth in the later stages. These are the two fundamental sources of autonomous demand to offset leakages from the industrial sector in the form of payments for food from agriculture and imported inputs from other countries; (v) a fast rate of growth of exports and output will set up a virtuous circle of growth through the link between output growth and productivity growth. Fast export growth leads to fast output growth; fast output growth leads to fast productivity growth; fast productivity growth makes exports more competitive; and greater competitiveness leads to fast export growth. The virtuous circle is complete. The export-led growth model originally came from Kaldor's address to the Scottish Economics Society on 'The Case for Regional Policies' (Kaldor 1970) and was formalised by Dixon and Thirlwall (1975) (see also Thirlwall 2014).

Kaldor (1966, 1967) tested the first three propositions for a cross-section of 12 advanced economies over the period 1954–1964 and found the 'laws' were supported. A strong relation existed between manufacturing output growth and GDP growth, but not between the growth of other sectors and GDP growth, and there is a strong inverse relation between the growth of employment outside manufacturing and overall productivity growth.

John's first paper in this field (McCombie 1980a) attempts to quantify the extent to which the reallocation of labour between sectors of an economy explains overall labour productivity growth. Twelve advanced countries are taken over the two periods 1950–1965 and 1965–1973, with the overall level of productivity disaggregated between industry, agriculture and the rest of the economy, and using different assumptions about increasing returns and surplus labour. It transpires that sectoral differences in the *levels* of productivity *by themselves* explain only a small proportion of the growth of overall productivity, but once the transfer of labour is combined with increasing returns in industry, over 30 per cent of total productivity growth can be explained in at least five of the 12 countries. John reveals here for the first time (at least in print) his Keynesian credentials because he concludes the article by saying that Kaldor is correct in his emphasis on the importance of the transfer of labour from agriculture *but* 'this is by no means an indispensable element in his explanation of why growth rates differ'. Since productivity growth is the difference between output growth and employment growth 'the key to the understanding of differences in productivity growth lies in explaining large differences between countries in the *growth of demand for output* (emphasis added). This stands in marked contrast to the neoclassical approach with its emphasis on the supply side'.

Kaldor regarded his third law of the relationship between industrial output growth and productivity growth outside of manufacturing as important for two basic reasons because first of all it provides an explanation of differences in the growth of *total* productivity in an economy and second, by confirming the existence of surplus labour outside industry, it justifies using output not employment as the independent variable (or regressor) in the testing of Verdoorn's Law (see later). The normal test of Kaldor's third law is to run a regression across countries of the form:

$$P_{\mathrm{T}} = a + b\left(g_{\mathrm{I}}\right) - c\left(e_{\mathrm{NI}}\right) \tag{2.1}$$

where P_{T} is the growth of total productivity, g_{I} is the growth of industry output and e_{NI} is the growth of employment outside of industry. The coefficient on e_{NI} is supposed to provide an estimate of the negative effect of non-industrial growth on total productivity growth, but John argues (McCombie 1981) that because P_{T} is definitionally related to g_{I} and e_{NI}, the estimated coefficients simply reflect the share of industrial output in total output and the share of non-industrial employment in total employment and therefore cannot be given any behavioural interpretation. To see this, total productivity growth can be disaggregated as follows:

$$P_T = a[g_I] - b[e_I] + (1-a)[g_{NI}] - (1-b)[e_{NI}] \qquad (2.2)$$

where *a* is the share of industry output in total output and *b* is the share of industry employment in total employment. Comparing Eqs. (2.1) and (2.2), it can be seen that the coefficient on g_I in Eq. (2.1) is picking up the share of industry output in total output and the coefficient on e_{NI} is picking up the share of non-industrial employment in total employment. By excluding g_{NI} and e_I, the estimates will be biased. Studies that have estimated Eq. (2.1), such as Hansen and Zhang (1996) across 28 provinces of China, and Wells and Thirlwall (2003) across 45 countries of Africa, need to be treated, therefore, with some caution unless it can be shown that the omitted variables are orthogonal to the regressors.

John's first attempt to test Kaldor's first law (McCombie and de Ridder 1983) takes state data for the USA where it is hard to argue that state growth is supply determined because capital and labour are freely mobile across states. Forty-nine states are taken and a subset of 20 largest states. State GDP growth is taken as the regressand and also non-manufacturing output growth to avoid any spurious correlation between manufacturing output growth and total output growth. The results are very similar to the cross-country results originally found by Kaldor. When GDP growth is regressed on manufacturing growth for the 49 and 20 states, the coefficients are 0.632 and 0.622, respectively. When non-manufacturing growth is regressed on manufacturing growth, the coefficients are 0.444 and 0.466, respectively. Manufacturing industry as the engine of growth is supported.

2.1 Verdoorn's Law

Verdoorn's Law, or Kaldor's second law, derives from P.J. Verdoorn's paper 'Fattori che Regalano lo Sviluppo della Produttivita del Lavoro' published in Italian in 1949 in the obscure Italian journal *L'Industria,* where

Verdoorn examines the relationship between labour productivity growth in industry and manufacturing output growth across a variety of countries and industries, and finds a regression coefficient of approximately 0.5. Verdoorn was one of Kaldor's staff in the Research and Planning Division of the Economic Commission for Europe in Geneva where Kaldor was Director between 1947 and 1949. Kaldor never used or quoted Verdoorn's work until his 1966 Inaugural Lecture, but somehow it resurfaced in Kaldor's mind when it became convenient to do so in explaining the UK's poor economic growth record compared to other European countries.[2] Kaldor gives two specifications for testing the Verdoorn relation. One is:

$$p_m = a + b(g_m) \tag{2.3}$$

where p_m is manufacturing productivity growth and g_m is manufacturing output growth. The second is:

$$e_m = -a + (1-b)g_m \tag{2.4}$$

where e_m is employment growth in manufacturing. The two equations are two ways of looking at the same relationship because $g_m = p_m + e_m$. Kaldor estimated both ways, deriving a Verdoorn coefficient (b) of 0.484 and an R^2 greater than 0.8.

In fact, from Eqs. (2.3) and (2.4), there are two other ways of specifying the Verdoorn relation. One is:

$$g_m = \frac{a}{1-b} + \frac{1}{1-b} e_m \tag{2.5}$$

The other is:

$$p_m = \frac{a}{1-b} + \frac{b}{1-b} e_m \tag{2.6}$$

Only if the equations are exact will the estimates be the same. From an economic and econometric point of view, the specification is not a matter of indifference. Cripps and Tarling (1973) estimate the Verdoorn relationship with employment growth as the independent variable because Kaldor had argued in 1966 that in the UK at least employment was the constraint on manufacturing output growth, even though Kaldor (1968) had retracted his view about the UK economy in reply to some niggling points of criticism made by Wolfe (1968). Cripps and Tarling show that their version of the Verdoorn Law held from 1951 to 1965, but seemed to break down in the period 1965–1970. Rowthorn (1975), with no reference to Kaldor's reply to Wolfe, also continued to interpret Kaldor as believing that manufacturing output growth is endogenous and employment growth is exogenous and used the same formulation as Cripps and Tarling. Rowthorn claimed to show that Kaldor's results, as well as those of Cripps and Tarling, are heavily dependent on the inclusion of Japan in the sample which, because of its deviant position on the scatter diagram, must be regarded as a special case. Rowthorn criticises Kaldor for estimating a Verdoorn coefficient 'indirectly' (using Eq. 2.4) rather than what he considers 'directly' (using Eq. 2.6). He argues that had Kaldor done so, his estimate of the Verdoorn coefficient would have been much lower than 0.48. But if output growth is exogenous and employment growth is endogenous, the Cripps-Tarling-Rowthorn specification of the Verdoorn relation is incorrect for well-known econometric reasons. Moreover, Kaldor's original results using the correct specification of the Verdoorn relation do *not* depend on the existence of Japan in the sample. The R^2 between p_m and g_m excluding Japan is 0.536 and between e_m and g_m is 0.685.

2.2 Measuring Increasing Returns

A Verdoorn coefficient less than unity ($b < 1$) implies increasing returns, but to measure the degree of increasing returns, the role of capital accumulation in the determination of productivity growth needs to be recognised. The Verdoorn relation, including the contribution of capital, is:

$$p_m = a + b(g_m) + \varphi(k) \tag{2.7}$$

where k is the rate of growth of capital. Kaldor was aware of this issue, and in Kaldor (1978b), he introduces the gross investment/output ratio in the Verdoorn equation, but the equation was never tested omitting Japan. When John does this (McCombie 1983), substantial economies of scale are found. If the underlying relationship is a Cobb-Douglas production function, then:

$$g = a_1 + \alpha(l) + \beta(k) \tag{2.8}$$

where l is the growth of the labour force. Now $p = g - l$, so:

$$p = g - l = a_1 + \alpha(l) + \beta(k) - l \tag{2.9}$$

Therefore:

$$p = a_1 + l(\alpha - 1) + \beta(k) \tag{2.10}$$

but $l = g - p$. Therefore:

$$p = a_1 + (g - p)(\alpha - 1) + \beta(k) \tag{2.11}$$

Therefore:

$$p(1 + \alpha - 1) = a_1 + (\alpha - 1)g + \beta(k) \tag{2.12}$$

Therefore:

$$p = \frac{a_1}{\alpha} + \left(\frac{\alpha - 1}{\alpha}\right)g + \frac{\beta}{\alpha}(k) \tag{2.13}$$

and the Verdoorn coefficient is: $(\alpha - 1)/\alpha$. Now let us suppose that the capital-output ratio is constant, so $g = k$. Therefore, from Eq. (2.13):

$$P = \frac{a_1}{\alpha} + \left[\left(\frac{\alpha - 1}{\alpha}\right) + \frac{\beta}{\alpha}\right] g = \frac{\alpha_1}{\alpha}\left(\frac{\alpha + \beta - 1}{\alpha}\right) g \tag{2.14}$$

If the Verdoorn coefficient is 0.5, then $(\alpha + \beta - 1)/\alpha = 0.5$. If $\alpha = \beta$, then $(2\alpha - 1)/\alpha = 0.5$. Therefore, $\alpha = \beta = 0.66$, and the returns to scale are 1.32.

Kaldor is clear that the Verdoorn Law is a dynamic relationship reflecting static and dynamic returns to scale. To quote him directly 'it is a dynamic rather than a static relationship—between the rates of change of productivity and of output rather than between the *level* of productivity and the *scale* of output—primarily because technical progress enters into it, and is not just a reflection of economies of large scale production' (Kaldor 1966 p. 10). But John argues in several papers (e.g. McCombie 1981, 1982, 1984) that the Verdoorn Law may also be derived from:

$$E_t = A(\exp at) Q_t^{\,b} \tag{2.15}$$

where E and Q are the *levels* of employment and output. Interestingly, Verdoorn (1949) himself derived the law from a static Cobb-Douglas production function, but that does not necessarily imply that integration of the growth equation will lead to the level equation. This will depend on the assumption made about the constant of integration. But this leads to what John has called the static/dynamic paradox because invariably when the law is tested using *levels* of productivity and output, the coefficient does not differ significantly from unity (constant returns), while when the law is tested using growth rates, increasing returns are found.[3]

To give some examples of John's findings in this field: McCombie (1982) takes a sample of OECD countries over the time period 1950–1973 and finds that taking *levels* of productivity and output, it is not possible to reject the hypothesis of constant returns. McCombie and de Ridder (1983) use US state data from 1963 to 1973 and estimate a significant Verdoorn coefficient using growth rates of productivity and output, giving returns to scale of 1.45. But using level data, there is no evidence of increasing returns. McCombie (1986) looks at the manufacturing sector of nine OECD countries over the period 1955–1979, including capital accumulation in the dynamic Verdoorn equation, and estimates a Verdoorn coefficient of 0.35 (increasing returns). McCombie and Fingleton (1998) use 178 regions across 13 EU countries over the period 1978–1989 and estimate a Verdoorn coefficient of 0.575 (allowing for country dummies). When the static law is estimated, the Verdoorn coefficient falls to 0.057. A novel feature of this study is that they allow for the fact that some of the productivity growth may be due to catch-up. The log of the initial level of productivity in the base year is therefore included in the equation and turns out to be highly significant. The Verdoorn coefficient falls to 0.275. Angeriz, McCombie and Roberts (2008) take 54 regions of the EU over the period 1986–2002 using a variety of spatial econometric techniques, testing both the static and dynamic versions of Verdoorn's Law. The static version gives constant returns, while the dynamic version gives a Verdoorn coefficient of between 0.50 and 0.67, depending on the method of estimation. Finally, McCombie, Angeriz and Roberts (2009) estimate Verdoorn's Law in a spatial econometric framework for six individual manufacturing industries using EU regional data over the period 1991–2002. In this study total factor productivity growth is taken as the dependent variable, and as in the other studies above, the static/dynamic Verdoorn Law paradox is apparent.

It is not entirely clear what lies behind the paradox. Simultaneous equation bias in the dynamic specification is sometimes mentioned, but it is not clear which way the bias goes (McCombie 1982). There may be some bias in the dynamic estimation due to omitted variables, such as capital, but this is not a problem if capital is included, or if the capital-output ratio is constant. Errors in variables (McCombie 1981, 1982) may be another explanation, but it is not clear why measurement errors should be more or less between data in levels and data in growth rates. Spatial aggregation bias is a possibility when regional data are used. McCombie and Roberts (2007) attempt to show this using a simulation exercise showing that spatial aggregation bias biases the estimates of returns to scale downwards using the static specification in log levels.[4] McCombie, Angeriz and Roberts (2009) are more categoric when they say that 'spatial aggregation bias resolves the issue'. But equally they argue that 'the dynamic formulation is the correct specification'. The argument goes back to John's earlier and original conclusion (McCombie 1982) when he says: 'the argument suggests that the dynamic Verdoorn coefficient may provide the unbiased estimate and the result of constant returns to scale provided by the static law may be due to the misspecification of the function. An implication is that the conventional static production function may understate the degree of returns to scale by their abstraction from the dynamic components that Kaldor argues are so important'. In other words, the paradox lies in the second-order identification problem that differentiating the level equation yields the growth equation, but integrating the growth equation will not necessarily yield the level equation because this depends on the constant of integration (as argued earlier).

In fact, John had come to the view much earlier (McCombie 1986) that Kaldor's interpretation of Verdoorn's Law as reflecting various types of dynamic increasing returns is the most satisfactory and accords very closely with Kaldor's linear technical progress function (Kaldor 1961) where the rate of growth of output per man is a function of the rate of growth of capital per man and the rate of productivity growth depends on autonomous productivity growth on the one hand and the extent to which technical progress is embodied in capital accumulation on the other. Dixon and I (Dixon and Thirlwall 1975) first showed how the Verdoorn coefficient can be derived from Kaldor's technical progress function:

$$\text{Let } p_m = d + \pi(k) \tag{2.16}$$

where p_m is the growth of output per man, and k is the growth of capital per man.

$$\text{Now let}: d = \alpha_1 + \beta_1(g_m) \tag{2.17}$$

where a_1 is 'pure' disembodied technical progress and β_1 reflects learning by doing.

$$\text{Now let}: k = \alpha_2 + \beta_2 \left(g_m \right) \tag{2.18}$$

where β_2 reflects induced capital accumulation (the accelerator principle).

Substituting (2.17) and (2.18) into (2.16) gives:

$$p_m = \left(\alpha_1 + \pi\alpha_2 \right) + \left(\beta_1 + \pi\beta_2 \right) g_m \tag{2.19}$$

So, the Verdoorn coefficient depends on learning by doing (β_1); induced capital accumulation (β_2); and the extent to which technical progress is embodied in capital (π). If this interpretation is accepted, it means that the conventional Cobb-Douglas production function is not the correct underlying structure of the Verdoorn Law, and this may be another reason why the estimates of the returns to scale from the static law are biased downwards.

3 Balance of Payments-Constrained Growth

John has made major contributions to the development of the balance of payments-constrained growth model that I first outlined in Thirlwall (1979). He has shown that the simple result I derived, that a country's long-run growth rate can be approximated by the ratio of the growth of exports (x) to the income elasticity of demand for imports (π), is a reduced form of the Hicks' super multiplier (McCombie 1985b). He defends very well the attack on the model by McGregor and Swales (1985, 1986, 1991) and Palley (2002) and discusses extensively the role of non-price competition in the model reflected in the income elasticities of demand for exports and import (McCombie 1989, 1992). He also devised a simple parametric test of the model for individual countries. He showed with myself

(McCombie and Thirlwall 1997a) that if there is a limit to the current account deficit given by the debt to GDP ratio, capital inflows make little difference to the predicted growth rate from the simple model ($y = x/\pi$). On top of this, he has conducted several case studies of the model by himself and with colleagues (McCombie 1997; McCombie and Britto 2009; McCombie et al. 2010; McCombie and Tharnpanich 2013).

3.1 John's Initial Attack on the Model

John was initially hostile to the model (McCombie 1980b). He accused me of circular reasoning. He argued that if we follow Thirlwall and use an estimate of the income elasticity of demand for imports (π) by regressing import growth (m) on income growth (y), it is not surprising that the balance of payments equilibrium growth rate (y_B) closely approximates to the actual growth rate (y) because the analysis borders on circular reasoning.[5] There is a problem in determining the direction of causality; whether growth is demand constrained or supply constrained. My response (Thirlwall 1981) was to say in the context of the UK that if growth was constrained *before* the balance of payments constraint became important, why didn't the UK experience growing balance of payments surpluses like Japan? I continued 'while the simple model itself may not be able to discriminate easily between the demand and supply-led growth hypotheses, I think the *results* of applying the model, combined with judgment, can'.

John wrote to me on 7 November 1980 saying that his balance of payments paper was 'written to a certain extent in the spirit of Devil's Advocate'. He went on: 'while from the point of view of the demand – oriented explanation of growth, I would have been worried if the law did not hold, and it is a remarkable empirical generalisation, I am not so convinced that the law necessarily confirms the hypothesis of export-led growth'. I replied to him on 13 November 1980 that 'I am still a little puzzled why you cannot bring yourself to believe that if the rate of growth of exports were higher, the rate of growth of output could also be higher and that the rate of growth of output is not constrained by a shortage of factor supplies'. John didn't agree with this. He wrote (19 November) 'the reason why the UK ran a deficit is that the government pursued policies trying to increase the growth rate above that permitted by the growth of factor supplies. This, in turn, induced a greater growth of imports and hence a deficit'. Clearly, at that time, John did not believe in the endogeneity of factor supplies! But then, finally, in the same letter, he seems to concede: 'certainly, at the moment, I find the demand-oriented approach more plausible than the supply-constrained assumption, and the model, together with your formulation of the Verdoorn growth model (Thirlwall 1980), is very attractive'. So began a long and fruitful collaboration which still continues, but culminated in our book *Economic Growth and the Balance of Payments Constraint* published in 1994.

3.2 Balance of Payments-Constrained Growth and the Hicks' Super Multiplier

The simple rule $y_B = x/\pi$ turns out to be the dynamic version of the static Harrod foreign trade multiplier of $Y = X/m$, where Y is the *level* of income, X is the *level* of exports and m is the marginal propensity to import (Harrod 1933; Thirlwall 1982). The two 'multipliers' are derived on the same assumptions of no change in the real terms of trade and the existence (necessity) of long-run balance of payments equilibrium.

John (McCombie 1985b) showed that the dynamic Harrod trade multiplier, $y_B = x/\pi$, can be thought of as reflecting a reduced form of the Hicks' super multiplier where all components of demand adapt to the exogenous rate of growth of exports which provides the foreign exchange to pay for the import content of consumption, investment, government expenditure and exports themselves. John shows that the rule $y_B = x/\pi$ can be decomposed into two parts according to the formula:

$$y_B = \frac{1}{k}\left(w_x x + w_a a_B\right) = \frac{x}{\pi} \tag{2.20}$$

where k is the Keynesian multiplier for an open economy; w_x is the share of exports in GDP; a_B is the growth of other components of autonomous expenditure necessary, for a given growth of export, to maintain the growth of income at the balance of payments equilibrium rate; and w_a is the share of autonomous expenditure (excluding exports) in total income. The balance of payments equilibrium growth rate is thus determined jointly by the growth of exports, via the multiplier (w_x/k), and the growth of 'induced' autonomous expenditure working through the associated domestic multiplier, w_a/k. This is identical to the effect of the growth of exports working through the super multiplier, $1/\pi$. The importance of this result is that it shows clearly that not only does export growth have a direct effect on output growth but also an indirect effect by allowing other components of demand to grow faster because export growth pays for the import content of consumption, investment and so on. Exports are a unique component of demand in this respect. Kaldor (1975) was responsible for reviving the doctrine of the Harrod trade multiplier and already in 1970 had presented an export-led growth model applicable to regions and countries alike with cumulative features, but lacking a balance of payments constraint (see Thirlwall 2014).

3.3 Defence of the Model Against McGregor and Swales and Palley

In a series of papers, McGregor and Swales (1985, 1986,1991) attack the balance of payments-constrained growth model as 'incoherent' and lacking empirical support. They make three basic criticisms of the model. Firstly, that if relative prices remain constant because of the 'law of one price', the model is not distinguishable from a neoclassical model in which a country can sell any amount of its goods at a given price, so that exports and output growth are supply constrained not demand constrained. Secondly, the model doesn't capture satisfactorily non-price competition. Thirdly, there is no relation empirically across countries between actual growth (y) and the estimates of the balance of payments equilibrium growth rate (y_B).

John (McCombie 1989, 1992) had no difficulty in refuting each of these criticisms. It is true that if the 'law of one price' holds, there can be no balance of payments constraint because exports would adjust to imports with no need for domestic income adjustment. If true, however, it would mean that the price elasticity of demand for exports is infinitely elastic and that the income elasticity of demand for exports would be insignificant—neither of which are the case empirically. The world income variable is always highly significant in export growth equations which is not consistent with the small open economy assumption of the 'law of one price'. And it needs to be borne in mind, of course, that the 'law of one price' is not the only explanation of why relative prices measured in a common currency, or the real exchange rate, may be 'sticky'. More likely explanations are relative price changes mirroring nominal exchange rate changes, and oligopolistic market structures at least in the production of industrial goods.

On the question of non-price competition, McGregor and Swales are simply wrong. Non-price competition is captured by the income elasticities of demand for exports and imports. McGregor and Swales refute this because they argue that income elasticities will determine the growth of exports and imports but not changes in the share of markets which the country's exports (and imports) take. John points out that there is plenty of empirical evidence for non-price competition, particularly for changes in export shares which cannot be explained by relative price movements—the so-called Kaldor Paradox (Kaldor 1978a).

Not much is known about the determinants of the income elasticities of demand for exports and imports (reflecting non-price competitiveness). Some recent work explores the connection between aggregate income elasticities and the sectoral composition of trade. Gouvea and Lima (2010) and Romero et al. (2011) have estimated export and import demand functions for different technological sectors and find that high-tech sectors have higher income elasticities. Gouvea and Lima (2013) find that capital goods have higher income elasticities than consumption and intermediate goods. McCombie and Romero (2016a) take five technological sectors in 14 developed countries and find higher income elasticities for medium- and high-tech manufactures. McCombie and Tharnpanich (2013) find in Thailand that manufactures have a higher income elasticity of demand than primary commodities.

McCombie and Romero (2016b) modify export and import demand functions by introducing the direct effect of productivity growth on export and import growth via improvements in non-price competitiveness, and Ribeiro, McCombie and Lima (2016) endogenise the income elasticities of demand for exports and imports via changes in the technological gap and income distribution. For example, if a poor country can narrow its technological gap with a rich country, it will raise the ratio of its income elasticity of demand for exports to imports. More unequal countries will tend to import more luxury goods and export necessities, reducing the ratio. This is a research field still ripe for enquiry.

As far as the predictive power of the model is concerned, McGregor and Swales purport to show that y_B is not a good predictor of y across countries. They test by using the linear regression $y = a + b(y_B)$ with the null hypothesis that $a \neq 0$ and $b \neq 1$. Using Thirlwall's (1979) sample of countries, they do not reject the null hypothesis. John criticises the test on two grounds. Firstly, the estimates of y_B depend on the estimated coefficient π which has a standard error. Inverse least squares should therefore be used. Secondly, the cross-section test has outliers which misleadingly rejects the rule that y_B can predict y for individual countries. John shows (McCombie 1992) that if Japan and the USA are excluded from the sample, McGregor and Swales are wrong.

John develops a much more suitable parametric test for individual countries—now called the McCombie test. First calculate the income elasticity of demand for imports π^* that equates the ratio of the rate of growth of exports to the actual growth of output y, that is, $\pi^* = x/y$, and then compare π^* with the statistical estimate of π (π^) from an import growth equation including as a regressor the rate of change of relative prices. If there is no significant difference between π^* and π^, then y_B will be a good predictor of y.

Palley (2002) also attacks the balance of payments-constrained growth model on the grounds that there is no mechanism in the model for reconciling the growth of supply and demand. He argues that if y_B is less than potential output growth (y_N), the income elasticity of demand for imports will fall to equate y_B and y_N, so, in effect, no country is balance of payments constrained in the long run: 'the steady state growth rate [is] uniquely determined by supply-side factors' (Palley 2002, p. 15). There are a number of problems with this argument as John points out (McCombie 2011). Palley claims that $y_B < y_N$ is not observed in practice so there must be some adjustment mechanism, but the adjustment could equally be on the supply side, as Setterfield (2006) has argued. Weak demand growth through a balance of payments constraint can affect adversely both determinants of the rate of growth of productive potential, that is, the rate of growth of the labour force and the growth of labour productivity (by reducing the Verdoorn coefficient). Moreover, if $y_B < y_N$ and governments expand demand to get to y_N, the income elasticity of demand for imports could rise rather than fall which would worsen the situation. Lanzafame (2014) has shown for a panel of 22 OECD countries over the period 1960–2010 that the direction of causation runs from the balance of payments-constrained growth rate (y_B) to the actual growth rate (y) to the potential growth rate (y_N). As Setterfield says 'the demand-side thus rules the roost in what can be identified as a model of *fully demand-determined growth*' (p. 55).

3.4 Capital Flows

Thirlwall and Hussain (1982) were the first to include capital flows into the balance of payments-constrained growth model, which potentially relaxes a balance of payments constraint on growth, but no limit was imposed on the current account or debt to GDP ratio that capital inflows might be associated with.

In 1996, John and I were asked separately by Philip Arestis whether we would write an essay in honour of Geoffrey Harcourt. We decided to join forces and to address the question, which hadn't been asked before, of what difference do capital flows make to the sustainable growth rate, assuming there is a limit to the current account or debt to GDP ratio. It was mainly John who worked on the model and came up with the interesting, but not obvious, conclusion that even if the current account deficit as a proportion of GDP is allowed to be as high as 10 per cent, it makes a relatively small quantitative difference to the growth rate determined by the basic dynamic Harrod trade multiplier result of $y_B = x/\pi$ (McCombie and Thirlwall 1997a).[6] Moreno-Brid (1998, 2003) subsequently derived the same result as us in a simpler (more elegant) way. We both include interest payments on past debt in the full model, but first, for clarity, let us model without interest payments. The fundamental balance of payments identity is:

$$P_d X + FP_d = P_f ME \tag{2.21}$$

where X is the volume of exports, P_d is the domestic price of exports, M is imports, P_f is the foreign price of imports, E is the exchange rate to convert the value of imports in foreign currency into domestic currency, F is the current account deficit in *real* terms and FP_d is nominal capital inflows (C) in domestic currency to finance the deficit. Taking logs of Eq. (2.21) and differentiating with respect to time gives:

$$\theta(p_d + x) + (1-\theta)(f + p_d) = m + p_f + e \tag{2.22}$$

where θ is the proportion of imports financed by exports and $(1 - \theta)$ is the proportion of imports financed by capital flows. Now the growth of exports can be written as:

$$x = \eta(p_d - p_f - e) + \varepsilon(z) \tag{2.23}$$

and the growth of imports as:

$$m = \psi(p_d - p_f + e) + \pi(y) \tag{2.24}$$

where $(p_d - p_f)$ is the difference in the rate of change of domestic and foreign prices; e is the rate of change of the exchange rate and y and z are the growth of domestic and foreign income, respectively; $\eta(<0)$ and $\psi(>0)$ are the price elasticities of exports and imports, respectively; and π and ε are the income elasticities of imports and exports. Substituting Eqs. (2.23) and (2.24) into (2.22) and setting $f = y$, so that the ratio of the current account deficit to GDP is constant, gives:

$$y_D = \frac{\theta\varepsilon z + (\theta\eta + \psi + 1)(p_d - p_f - e)}{\pi - (1-\theta)} \tag{2.25}$$

If the real terms of trade remain unchanged, the constrained growth rate consistent with a fixed deficit/GDP ratio is:

$$y_D = \frac{\theta x}{\pi - (1 - \theta)} \tag{2.26}$$

With no deficit, $\theta = 1$, and the simple rule holds—$y_D = x/\pi$. Now suppose that the deficit to GDP ratio is allowed to be as high as 10 per cent of GDP, so $\theta = 0.9$, and $x = 10$ per cent, and $\pi = 2$, the simple rule gives a balance of payments equilibrium growth rate of 5 per cent, and the modified model gives a prediction of 4.73 per cent—hardly any difference.

If the current account deficits are financed by debt-creating flows, the model needs further modification for interest rate payments. McCombie and Thirlwall (1997a) included this and so too have Elliot and Rhodd (1999), Ferreira and Canuto (2003), Vera (2006) and Alleyne and Francis (2008). Following Moreno-Brid (2003), we can modify Eq. (2.22) by taking interest payments out of capital flows to get:

$$\theta(p_d + x) - \theta_1(p_d + i) + (1 - \theta - \theta_1)(p_d + f) = m + p_f + e \tag{2.27}$$

where i is the rate of growth of real net interest payments abroad (the negative sign implies the country is a net debtor) and θ_1 is the share of foreign exchange devoted to interest payments. Again, setting $f = y$, and substituting for x and m, gives:

$$Y_I = \frac{\theta \varepsilon z - \theta_1 i + (\theta \eta + \psi + 1)(p_d - p_f - e)}{\pi - (1 - \theta - \theta_1)} \tag{2.28}$$

And if the real terms of trade are constant:

$$Y_{I*} = \frac{\theta x - \theta_1 \mathrm{i}}{\pi - (1 - \theta - \theta_1)} \tag{2.29}$$

If there are no interest payments on debt, Eq. (2.29) reduces to Eq. (2.26). But now interest rate payments have the potential to reduce the sustainable growth rate depending on the growth of interest payments and the share of foreign exchange (θ_1) devoted to interest payments. For example, if $i = 4$ per cent per annum and $\theta_1 = 0.2$, the sustainable growth rate will be 4.09 per cent compared with 5 per cent from the simple model.

3.5 Case Studies of Balance of Payments-Constrained Growth

John has used his considerable applied econometric skills to test the balance of payments-constrained growth model for several different countries. His first study (McCombie 1997) was for the USA, Japan and the UK. This was followed by detailed case studies for Brazil (McCombie and Britto 2009), Pakistan (McCombie et al. 2010) and Thailand (McCombie and Tharnpanich 2013).

Crucial to the estimation of the model is a well-determined estimate of the income elasticity of demand for imports. This requires the absence of unit roots in the data and making allowances for any structural breaks. In the case of the study for the USA, Japan and the UK, both log levels of data are used, and first differences of the logs and the import elasticity results are roughly similar. The technique of rolling regressions is also used covering 15-year sub-periods. For the USA, the model predicts well for 1970–1984, but for much of the 1980s, the USA was growing faster than its balance of payments equilibrium growth rate—and then reverted. So over the long period 1974–1993, the growth of the US economy did not differ significantly from its balance of payments equilibrium growth rate. For the UK, the model fits very well over the period 1952–1993. For Japan, growth was always below its balance of payments equilibrium growth rate, as Thirlwall (1979) originally found for the 1950s and 1960s, with Japan running huge balance of payments surpluses.

In the study of Brazil, the model is tested for the period 1951–2006, with the import demand function estimated using Vector Auto Regression (VAR). The estimated income elasticity of demand for imports is 1.7, but using the McCombie test, the hypothetical income elasticity to equate the actual growth rate with the balance of payments equilibrium growth rate is 1.15. The basic model, therefore, turns out not to be a good predictor of growth performance. But when the extended model with capital flows and interest payments on debt is used, the hypothetical import elasticity lies between 1.46 and 1.73, so the extended model is a good predictor of actual growth performance. McCombie and Britto conclude that 'Brazil's growth fluctuates around its long term trend determined by the extended version of Thirlwall's Law'.

In the study for Pakistan, the model is estimated over the period 1980–2007 using co-integration techniques. The estimated income elasticity of demand for imports is 0.91 which is very close to the hypothetical elasticity of 0.88 which would make the actual growth rate and balance of payments-constrained growth rate equal. The maximum annual growth rate consistent with balance of payments equilibrium is 5 per cent compared with Pakistan's target rate of 7–8 per cent. Pakistan has frequent balance of payments crises.

In the study of Thailand, the model is estimated over the period 1962–2009, and the results show that the economy grew at, or very near to, the rate constrained by the balance of payments, but there is a marked deceleration of growth post-1999. This seems to have been due to a fall in the income elasticity of demand for exports as a result of structural changes in the economy and a slowdown of manufacturing output growth. This explains the slowdown of growth from over 9 per cent per annum up to 1998 to only 4 per cent from 1999 to 2009.

4 Manufacturing Output-Led Growth Versus Export-Led Growth

Kaldor's growth laws give primacy to the growth of the manufacturing sector, while the balance of payments-constrained growth model, and Kaldor's (1970) model of export-led growth, gives primacy to the growth of exports. It might be said, therefore, that there is an uneasy connection between the closed economy model of growth rate differences between countries based on the structure of production, and an open economy model in which export growth is the driving force. There *is* an uneasy connection, but it is easy to see that manufacturing as the engine of growth is also a reduced form of export-led growth in which GDP growth is a function of export growth, but export growth is a function of manufacturing output growth. In other words:

$$g_{gdp} = a_1 + b_1(x) \tag{2.30}$$

$$x = a_2 + b_2(g_m) \tag{2.31}$$

and substituting (2.31) into (2.30) gives:

$$g_{gdp} = (a_1 + b_1 a_2) + (b_1 b_2) g_m \tag{2.32}$$

Kaldor's first law of growth is a reduced form of two structural equations and depends on the elasticity of GDP growth with respect to export growth (b_1), and the elasticity of export growth with respect to manufacturing output growth (b_2). A colleague and I have tested these relationships across a sample of 89 developing countries over the period 1990–2011 (Pacheco-López and Thirlwall 2014). Figure 2.1 shows the relationship between GDP growth and manufacturing output growth (Kaldor's first law).

The estimated equation is (t-values in brackets):

$$g_{gdp} = \underset{(9.07)}{2.16} + \underset{(9.43)}{0.43}\, g_m \quad r^2 = 0.50$$

Figure 2.2 shows the relation between manufacturing output growth and export growth.

The estimated equation is:

$$x = \underset{(5.7)}{3.59} + \underset{(6.19)}{0.75}\, g_m : \quad r^2 = 0.30$$

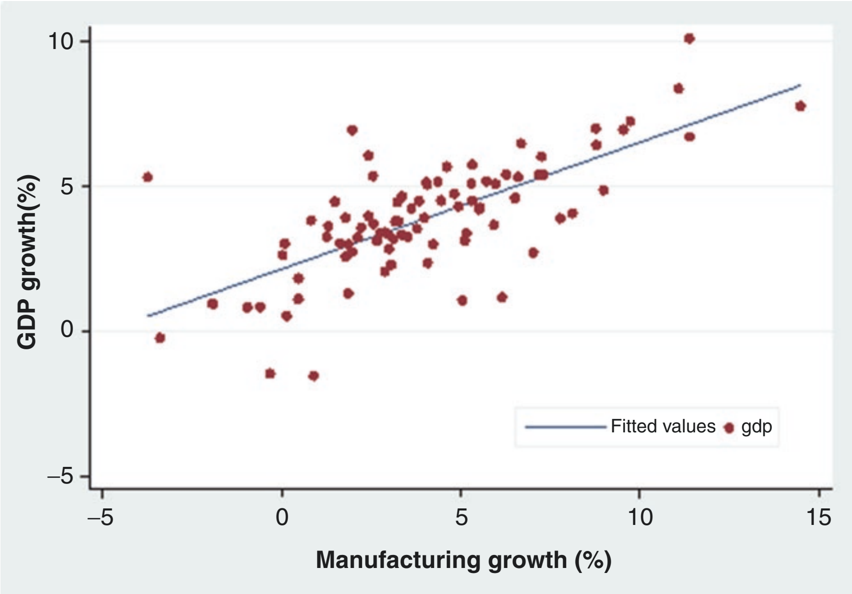

Fig. 2.1 Association between GDP growth and manufacturing growth, 1990–2011

The strong positive relation should occasion no surprise. For any given growth of world income, the growth of exports will depend on the structure of production and the income elasticity of demand for different products. Export growth is endogenous in this sense and is likely to be related to the growth of manufacturing output since all manufactures are potentially tradable. Primary products are also potentially tradable, but they do not have the same production and demand characteristics. Their demand growth in international trade is low (Engel's Law). Some services are tradable, but many are not, and their income elasticity in world markets is not likely to be as high as for medium- and high-technology manufactured goods.

Figure 2.3 shows the link between export growth and GDP growth. The estimated equation by two-stage least squares is:

$$g_{gdp} = \underset{(0.21)}{0.09} + \underset{(9.43)}{0.57} \; x : r^2 = 0.50$$

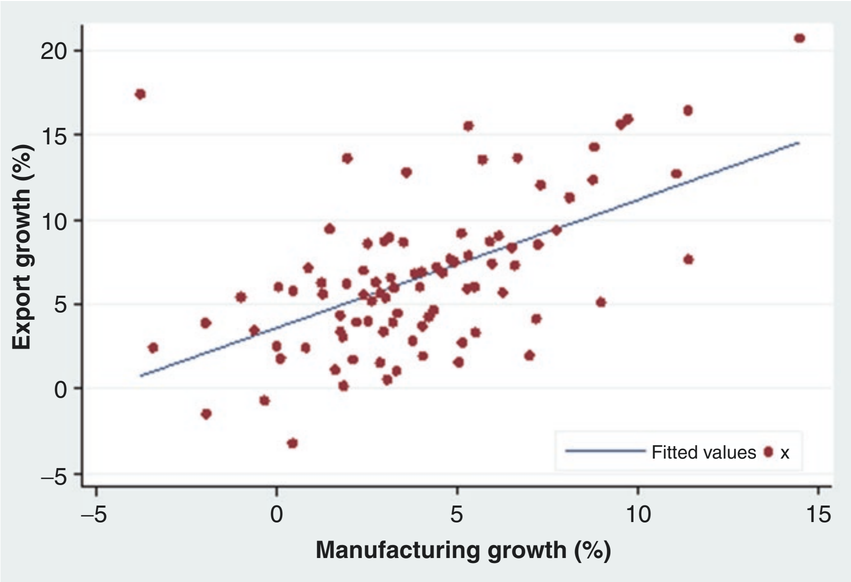

Fig. 2.2 Association between export growth and manufacturing growth, 1990–2011

There are three major reasons for expecting a priori a close link between export growth and GDP growth. Firstly, there is the neoclassical supply-side argument which focuses on the static and dynamic gains from trade and the externalities that the export sector can confer on the non-export sector and the rest of the economy (Feder 1983). Exports also allow the import of inputs and investment goods that may be more productive than domestic resources, thus increasing the supply capacity of the economy. Secondly, if domestic demand is constrained by a shortage of foreign exchange, faster export growth will help relax that constraint. All components of demand have an import content which need to be paid for, and only exports can do so. Exports are a unique component of demand in that respect (McCombie 1985b). Thirdly, export growth may set off a virtuous circle of growth, as outlined earlier (Kaldor 1970).

The results of this research across a wide sample of developing countries support the work of Hausmann, Hwang and Rodrik (2007) on 'What You Export Matters' which shows a close association between what they call EXPY and growth rate differences across countries. EXPY is a weighted

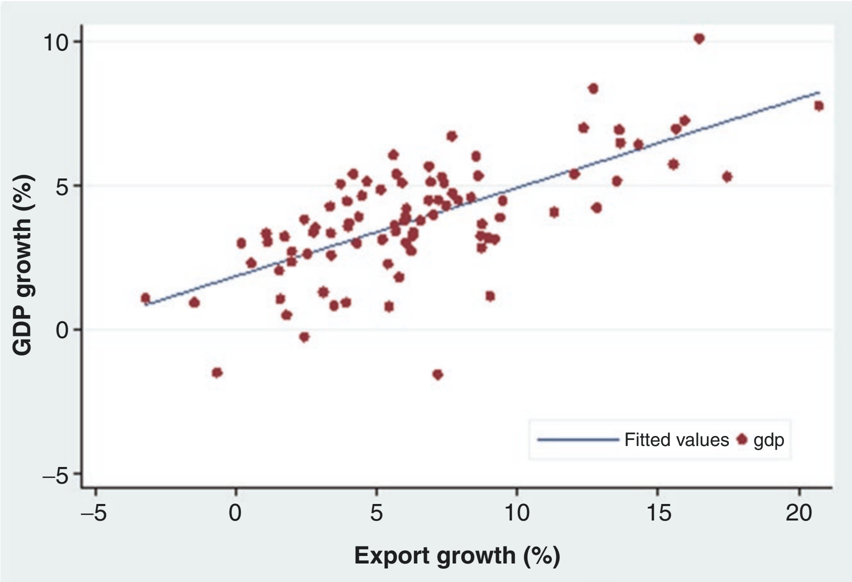

Fig. 2.3 Association between GDP growth and export growth, 1990–2011

average of what they call PRODY which measures the income level that each good produced is associated with. Countries grow fast if they have an export structure geared to the production and income levels of rich countries where the demand for high value-added goods is strong. Countries producing manufactured goods with a high income elasticity of demand in world markets will have a higher growth of exports and a higher growth of GDP. Hausmann et al. show a close correlation across countries between PRODY, EXPY (a weighted average of the PRODYs) and GDP growth. As they remark 'types of goods in which a country specialises have important implications for subsequent economic performance'.

5 Conclusion

John has led the life of a scholar ensconced in Downing College, Cambridge. It has seemed his natural home in a spacious study overlooking the beautiful green of the College quad where he could think, research and write to his heart's content. He did not only live in an ivory tower, however. He took on major advisory jobs, particularly for international development organisations such as the Asian Development Bank where Jesus Felipe was the senior research economist.

His contribution to the understanding of the dynamics of growth in a closed and open economy has been immense. He must surely be the world's leading expert on Verdoorn's Law, confirming that there is something special about the production characteristics of manufacturing industry as opposed to other sectors of the economy. Likewise, he has been the foremost researcher confirming that many countries' growth can be approximated by the simple dynamic Harrod trade multiplier rule—and this cannot be an accident.

I owe a huge debt of gratitude to John for the inspiration he has given me and for all the work we have done together over the years.

Notes

1. The author is grateful to Dr. Penelope Pacheco-Lopez for helpful comments on an early draft of the paper.
2. There are only three references to Verdoorn's 1949 paper between 1949 and 1966: two by Colin Clark (1957, 1962) and one by Kenneth Arrow (1962) (see McCombie et al. 2002).
3. Interestingly, the static/dynamic paradox does not seem to exist using time series data or with panel estimation using two-way fixed effects. The latter is illustrated in Leon-Ledesma (2000) for Spanish regions and, also, Angeriz et al. (2008) across 54 European regions 1986–2002.
4. The authors show that it arises through adding up the output and inputs of so-called Functional Economic Areas within a region to estimate the static law, whereas taking the dynamic specification, the *growth rates* of outputs and inputs are dimensionless.
5. He had forgotten that the income elasticities used from Houthakker and Magee (1969) were estimated controlling for relative price changes in the equation.
6. Allowance for interest rate payments on past debt makes a bigger difference (see later).

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