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Endogenous Growth: A Kaldorian Approach

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Abstract

This chapter explores the Kaldorian approach to endogenous growth theory. The central principles of this approach are explored, including the claims that growth is: (a) demand-led, with trade playing a central role in aggregate demand formation; and (b) path-dependent. It is shown that both the actual and natural rates of growth are path dependent in the Kaldorian tradition. The implications of inequality between the actual and natural rates of growth are investigated, and it is shown that mechanisms exist within the Kaldorian tradition that are capable of reconciling these growth rates. This results in the sustainability (in principle) of any particular equilibrium value of the actual rate of growth.

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1. Introduction

The ambition of this chapter is to develop a model of endogenous growth that provides a unified and coherent account of capitalist macrodynamics along Kaldorian lines. According to this model, there are two fundamental properties of growth: it is both demand-led (with international trade playing a particularly important role in generating the growth of autonomous demand) and path dependent. Path dependence is found in both the actual and the (Harrodian) natural rates of growth, and ultimately involves the economy evolving through a historically-specific series of technologically and/or institutionally specific regimes or episodes of growth.

The chapter is organised as follows. Section 2 outlines the basic vision of growth developed by Nicholas Kaldor following his inaugural lecture at Cambridge University (Kaldor, 1966). In section 3, the canonical formal model of Kaldor's growth schema – based on Dixon and Thirlwall (1975) – is presented, and its properties are highlighted. Section 4 then discusses path dependence in the actual rate of growth. The potential importance of initial conditions is discussed first, following which richer conceptions of path dependence are introduced, which draw on Cornwall and Cornwall's (2001) conception of "evolutionary Keynesian" macrodynamics. Particular importance is attached in this discussion to the recursive interaction of institutions, demand conditions, and growth outcomes. It is shown that a variant of the Kaldorian model that emphasizes this recursive interaction can help illuminate the rise and decline (or at least, contemporary crisis) of the recent "financialised" growth process centred in the US. Section 5 then discusses path dependence in the natural rate of growth. This draws attention back to the response of supply conditions to demand conditions that is a basic feature of the Kaldorian vision of growth. It also results in investigation of the ways in which supply and demand conditions may interact in the course of growth so as to reconcile the rates of growth of actual and potential output – an important theme in Post Keynesian growth theory since Cornwall (1972).[1] Finally, section 6 offers some conclusions.

2. The Kaldorian vision of growth

Modern Kaldorian growth theory builds on the growth schema found in Nicholas Kaldor's writings on cumulative causation (see, for example, Kaldor, 1970, 1985, 1996). Kaldor's basic vision of growth is, in turn, based on the two-way interaction between the division of labour and the extent of the market first discussed by Adam Smith. Hence for Kaldor – as for Smith – "the division of labour depends on the extent of the market". In other words, the expansion of demand induces changes in the potential supply of goods, by affecting the efficiency with which goods are produced. Kaldor appealled to the Verdoorn law, according to which the rate of growth of productivity depends on the rate of growth of output, to capture this dynamic. The Verdoorn law is commonly understood as a dynamic analog of Smith's original dictum, that represents the influence of output growth on not just the extent of specialization in the production process, but also on learning by doing, the propensity to engage in research and development, and firms' willingness to invest in "lumpy'' physical capital that embodies technological improvements (see, for example, Setterfield (1997, chpt. 3) for further discussion).

[1] See, for example, Palley (2002a), Setterfield (2006a) and Dutt (2006, 2010) for more recent discussion and development of this theme in Post Keynesian macrodynamics.

For Smith, it was also true that the extent of the market depended on the division of labour – i.e., supply created demand, as in Say's law. Kaldor, however, regarded demand as being relatively autonomous of supply conditions – *influenced* but not *determined by* supply conditions, as in Keynes' principle of effective demand.[2] This Keynesian conception of demand formation privileges the causal role of demand in the two-way interaction between demand and supply originally envisaged by Smith. In other words, demand formation becomes the focus of growth analysis, and growth is conceived as an essentially demand-led process.

In his writings on cumulative causation, Kaldor placed particular emphasis on external demand (i.e., exports) as the key source of the expansion of aggregate demand. Indeed, for Kaldor, the expansion of exports is the proximate source of growth, so that the basic "equation of motion" in growth theory is:

$$y = \lambda x \qquad [1]$$

where y is the rate of growth of real output, x is the rate of growth of real exports, and λ is the dynamic foreign trade multiplier. Note that if equation [1] were to imply that growing economies must run balance-of-trade surpluses, it would suffer a simple fallacy of composition. It would lack generality as a description of capitalist growth, because not all economies can simultaneously accumulate trade surpluses. However, equation [1] does *not* necessarily have this implication. To see this, consider the foundations of equation [1] based on the following simple static model of output determination:

$$Y = C + I + (X - M) \qquad [2]$$

$$C = cY \qquad [3]$$

[2] See, for example, Toner (1999, chpt.6) on the importance of the principle of effective demand in Kaldor's growth schema.

$$I = v\Delta Y = vyY \quad [4]$$

$$M = mY \quad [5]$$

where Y is real output, C, I, X and M are (respectively) consumption, investment, exports and imports (all in real terms), and c, v and m are (respectively) the propensity to consume, the (fixed) full capacity capital-output ratio and the propensity to import. The structure of this model is consistent with Kaldor's (1970) insistence that, ultimately, exports are the only truly autonomous source of demand: both consumption and investment are wholly endogenous to income.[3]

Solution of [2] – [5] yields:

$$Y = \frac{1}{1-(c+vy)+m}X$$

Suppose we now assume that $c + vy = 1$. This implies (from equations [3] and [4])) that the savings-income and investment-income ratios are always equal, and is again consistent with Kaldor's thinking.[4] Under these conditions, the solution to [2] – [5] reduces to:

$$Y = \frac{1}{m}X \quad [6]$$

where $1/m$ is the Harrod foreign trade multiplier. Finally, it follows from [5] and [6] that:[5]

$$\dot{M} = m\dot{Y} \quad [7]$$

$$\dot{Y} = \frac{1}{m}\dot{X} \quad [8]$$

and from combination of [7] and [8] that:

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[3] See Palumbo (2009) for further discussion of Kaldor's treatment of consumption, investment and exports.
[4] Again, see Palumbo (2009) for further discussion.
[5] Note that it follows from [8] that, in this case, $\lambda = 1$ in equation [1].

$$\dot{M} = m\frac{1}{m}\dot{X} = \dot{X}$$

In other words, starting from a position of external balance ($X = M$), any expansion of output due to an expansion of exports ($\dot{X} > 0$) will automatically be consistent with the *maintenance of external balance*, since $\dot{M} = \dot{X}$. In short, the notion that export-led growth (as in equation [1]) necessarily suffers a fallacy of composition – in the sense that not all countries can pursue export-led growth simultaneously – is false. This result is, of course, intuitive. It holds for the same reason that an increase in the size of Firm A does not necessarily come at the expense of Firm B: both firms can expand simultaneously as a result of a *general expansion of trade*.[6]

For Kaldor, the two-way interaction between demand and supply conditions that has been discussed above is properly interpreted as a process of cumulative causation – i.e., a self-reinforcing, causal-recursive process, as a result of which initially rapid growth induces dynamic increasing returns (via the Verdoorn law), which enhances export competitiveness and hence export growth, which results in further rapid growth (via equation [1]), and so on. In this schema, growth is certainly endogenous in the "narrow" sense identified by Roberts and Setterfield (2007): technical change is explicitly modelled (in the form of the Verdoorn law); and actual growth outcomes arise from causal interactions within the schema itself, rather than being imposed from without. But Kaldor's growth schema is also consistent with Roberts and Setterfield's "deeper" conception of endogenous growth, in which the growth rate today is sensitive to the pace of growth in the past. In other words, growth is *endogenous to its own past history*, or is

[6] The view that trade (specifically exports) can drive long run growth *without* creating external imbalances is properly formalised in the balance-of-payments-constrained growth (BPCG) theory originally developed by Thirlwall (1979). See also Blecker (2009) for discussion of BPCG theory and a formal reconciliation of this theory with the export-led model of cumulative causation developed in this paper.

path-dependent. The importance of this theme to Kaldor is evident in the following quotation:

> it is impossible to assume the constancy of anything *over* time, such as the supply of labour or capital, the psychological preferences for commodities, the nature and number of commodities, or technical knowledge. All these things are in a continuous process of change but the forces that make for change are endogenous not exogenous to the system. The only truly exogenous factor is *whatever exists at a given moment of time*, as a heritage of the past.
>
> (Kaldor, 1985, p.61; emphasis in original)

Along with the importance of trade for aggregate demand formation, the notion of growth as a historical or path-dependent process has also informed much of the literature that has built on Kaldor's growth schema. This will become clear in the development and discussion of the Kaldorian growth model that follows.

3. A model of cumulative causation

The canonical formal model of Kaldor's growth schema for a "representative" capitalist economy, originally developed by Dixon and Thirlwall (1975), can be stated as follows:[7]

$$y = \lambda x \qquad [1]$$

$$x = \beta(p_w - p) + \gamma y_w \qquad [9]$$

$$p = w - q \qquad [10]$$

$$q = r + \alpha y \qquad [11]$$

[7] The Dixon-Thirlwall model is actually a traditional equilibrium model, in which the equilibrium rate of growth is defined and reached independently of the adjustment path taken towards it. It may thus appear to be at odds with the importance placed on path dependence in Kaldorian growth theory. But in fact, suitably extended, the model provides a good vehicle for discussing growth as a path-dependent process, as will be demonstrated in sections 4 and 5 of this chapter.

where p is the rate of inflation, w is the rate of growth of nominal wages, q is the rate of productivity growth, the subscript w denotes the value of a variable in the "rest of the world," and all other variables are as previously defined. Equation [1] is already familiar. Equation [9] describes the rate of growth of exports in terms of the inflation differential ($p_w - p$), which measures the rate of change of the relative price of tradable goods, and the rate of growth of income in the rest of the world. It can be derived from a Cobb-Douglas export demand function of the form:

$$X = \left(\frac{P_w E}{P}\right)^{\beta} Y_w^{\gamma}$$

where P denotes the price level, E is the nominal exchange rate (assumed fixed for simplicity), β is the price elasticity of exports, γ is the income elasticity of exports and other variables are as previously defined. Equation [9] describes the rate of inflation, and follows from a pricing equation in which prices are set as a (fixed) mark up over unit labour costs. Finally, equation [10] represents the Verdoorn law discussed earlier. The parameter r captures exogenous influences on productivity, while α – the "Verdoorn coefficient" – measures the elasticity of productivity with respect to real output.

Combining equations [1], [9] and [10] yields:

$$y = \lambda(\beta[p_w - w + q] + \gamma y_w) \qquad [12]$$

If we now assume that:

$$p_w = w_w - q_w$$

$$q_w = r + \alpha_w y_w$$

(in other words, that inflation and productivity growth in the rest of the world are determined in the same fashion as they are in our representative economy), and that:

$$w = w_w$$

(the Kaldorian stylized fact of constant wage relativities), then equation [12] can be re-written as:

$$y = \Omega + \lambda\beta q \qquad [13]$$

where $\Omega = \lambda([\gamma - \alpha_w\beta]y_w - \beta r)$. Following Cornwall and Setterfield (2002), we can identify the Verdoorn law in equation [11] as the *productivity regime* (PR) of the model, describing how productivity growth is determined through (*inter alia*) growth-induced technical progress, and equation [13] as the *demand regime* (DR), which describes the dynamics of demand formation. Equation [13] summarises a process of demand formation that includes the influence of productivity growth on domestic inflation (in equation [10]) and hence export growth (in equation [11]) and hence output growth (in equation [1]) – thus establishing the influence of supply conditions on aggregate demand pre-supposed by Smith.[8] But the dynamics of demand formation are not *limited* to this influence of supply on demand (thanks to the role of Ω), thus establishing the relative autonomy of aggregate demand from aggregate supply pre-supposed by Kaldor (following Keynes' principle of effective demand).

Together, the productivity and demand regimes outlined above describe the recursive interaction of aggregate demand and aggregate supply in the determination of the growth rate, as envisaged by Kaldor in his discussions of the process of cumulative

[8] Note, then, that the influence of supply on demand in the Dixon-Thirlwall model assumes that some importance attaches to cost competition in international trade. This is not a necessary feature of the model. Its essential structure – the two-way interaction of supply and demand conditions – would remain unchanged if we were to assume constant relative prices (i.e., $p_w = p$), but if we were also to assume that productivity growth enhances the quality of goods, and hence their non-price competitiveness, and hence the income elasticity of demand for exports (γ). See, however, Carlin et al (2001) for evidence of the influence of unit labour costs on export competitiveness.

causation. This is illustrated in Figure 1, in which y^* and q^* denote the equilibrium rates of growth of output and productivity, respectively, and where it is assumed that $\Omega > 0 > -r/\alpha$ and $1/\alpha > \lambda\beta \Rightarrow \lambda\alpha\beta < 1$. The significance of the first of these conditions is clear by inspection of Figure 1; the second implies that, as they are presented in Figure 1, the PR is steeper than the DR. Together, these conditions are sufficient to ensure the stability of the growth equilibrium depicted in Figure 1 at economically meaningful (i.e., positive) values of y and q. This is captured in Figure 1 by the values of y^*, $q^* > 0$, coupled with the observation that if we begin in Figure 1 with any value of q that is lower (higher) than q^*, the resulting rate of growth (read off the DR) will cause a subsequent increase (decrease) in q due to movement along the PR, which will induce a rise (fall) in y due to movement along the DR and so on, until the point (q^*, y^*) is reached.

[FIGURE 1 GOES HERE]

The model developed so far serves to illustrate an important theme in Kaldorian growth theory: the possibility of income divergence, and hence growing inequality, between economies in the course of growth. To see this, consider two economies, *A* and *B*, that differ only with respect to their income elasticities of demand for exports, γ, such that:

$$\gamma_A > \gamma_B$$

Then in terms of their respective DR's (and as is revealed by inspection of equation [13] and the definition of Ω) we have:

$$\Omega_A > \Omega_B$$

and hence, as is illustrated in Figure 2:

$$y_A^* > y_B^*$$

[FIGURE 2 GOES HERE]

Now assume that $Y_A > Y_B$ initially. The consequences of this assumption, when coupled with the growth outcomes depicted in Figure 2,[9] are illustrated in Figure 3. Figure 3 makes clear that, thanks to its initial advantage in the level of *Y* and (from Figure 2) its self-perpetuating advantage in growth, economy *A* will grow ever richer than economy *B* over time in both absolute and relative terms.[10] In other words, the inequality of income as between economies *A* and *B* will steadily increase, in both absolute and relative terms, in the course of growth. This pattern of divergence between "rich" and "poor" economies is consistent with the observed experience of advanced capitalist economies *vis a vis* the rest of the world (see, for example, Maddison, 1991, Table 1.5).

Even as the model illustrates the potential for divergence between rich and poor economies, however, it is important to note that it is also consistent with empirical findings of "conditional convergence" – the tendency of poorer countries to grow faster than richer ones once a variety of influences on growth *other than the initial level of development* has been controlled for (see, for example, Mankiw et al, 1992). These

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[9] Note that in Figure 3, $d(\ln Y_A)/dt = y_A^* > y_B^* = d(\ln Y_B)/dt$, which is consistent with the results in Figure 2.

[10] Harcourt's (1992, pp. 12-13) "wolf-pack analogy" provides a useful metaphor for the tendency for income divergence that results from cumulative causation. As wolves break away from the pack, so forces are set in motion that allow them to get further and further ahead. This contrasts with a situation in which breakaway wolves are subject to forces that swiftly return them to the pack.

That the difference between Y_A and Y_B grows in *absolute* terms becomes clear if we define the difference between these income levels at any point in time as:

$$G_a = Y_A - Y_B = Y_{A0}e^{y_A^* t} - Y_{B0}e^{y_B^* t}$$

from which it follows that:

$$dG_a / dt = Y_{A0}e^{y_A^* t} y_A^* - Y_{B0}e^{y_B^* t} y_B^* > 0$$

since both $Y_{A0} > Y_{B0}$ and $y_A^* > y_B^*$ by hypothesis. That economy *A* also becomes richer in *relative* terms can be demonstrated by defining the difference between the log levels of Y_A and Y_B as:

$$G_r = \ln Y_A - \ln Y_B = \ln(Y_A / Y_B)$$

and noting, by inspection of Figure 3, that G_r – and hence the (log) level of income in economy *A* relative to that in economy *B* – is increasing over time.

findings are usually interpreted in terms of a neoclassical growth framework, from which the result of conditional convergence was first derived. But as shown by Roberts (2007), the same result can be derived from the canonical Kaldorian model outlined above. Essentially, this is because the transitional dynamics of the model above are qualitatively identical to those of the neoclassical growth model: the growth rate will tend to rise (fall) over time in any economy that initially grows slower (faster) than its equilibrium growth rate, as was illustrated in Figure 1 (see Roberts, 2007, pp.624-6). Conditional convergence results that are usually interpreted in terms of neoclassical growth theory are therefore compatible with the canonical formal model of Kaldor's growth schema that has been outlined in this section.

4. Path Dependence in the Actual Rate of Growth

The model developed in the previous section is certainly faithful to the circular interaction between actual and potential output emphasised by Kaldor. Nevertheless, it seems to lack the requisite emphasis on history and path dependence in the growth process: it is, to all appearances, an ahistorical, traditional equilibrium model.[11] But contrary to appearances, the model in fact provides a good vehicle for exploring path dependence in the growth process, as will be demonstrated in this and the following section.

[11] Setterfield (1997A, p.6) defines the traditional equilibrium approach to economic analysis "as one in which the long run or final outcomes of economic systems ... are both defined and reached without reference to the (historical) adjustment path taken towards them".

i) A disequilibrium approach to historical contingency It was noted in the previous section that, providing certain existence and stability conditions are observed, the rates of growth of output and productivity will automatically gravitate towards their equilibrium values even if they are above or below these equilibrium values initially. In other words, equilibrium outcomes such as (q^*, y^*) in Figure 1 act as *point attractors*. Of course, if the rates of growth of output and productivity *are* different from their equilibrium values initially, then throughout the process of adjustment towards equilibrium, their values will depend on the rates of growth established initially.[12] Moreover, it may not be possible to "get into" equilibrium if the speed of adjustment towards equilibrium is slow relative to the rate at which the data defining the equilibrium are changing over time (Harcourt, 1981, p.218; Fisher, 1983, p.3; Cornwall, 1991, p.107; Halevi and Kriesler, 1992, p.229).[13] The upshot of these considerations is the following: the existence of a point attractor such as (q^*, y^*) in Figure 1 notwithstanding, the rates of growth of output and productivity actually observed in the economy may always be a product of their initial rates in a system characterized by perpetual disequilibrium adjustment. We thus have a model of "weak" path dependent growth "in which initial conditions, but no other feature

[12] The choice of any arbitrary initial rate of growth in Figure 1 will result in a sequence of subsequent rates of growth (produced by the process of disequilibrium adjustment) that is uniquely determined by the choice of initial growth rate. Formally, if we re-write the PR from section 3 as:

$$q = r + \alpha y_{-1}$$

and combine this expression with the DR in equation [13], we get (recalling the definition of Ω):

$$y = \lambda(\gamma - \alpha_w \beta) y_w + \lambda\alpha\beta y_{-1}$$

This expression can, in turn, be re-written as:

$$y = (\lambda\alpha\beta)^t y_0 + \lambda(\gamma - \alpha_w \beta) y_w \sum_{i=1}^{t} (\lambda\alpha\beta)^{i-1}$$

where y_0 denotes the initial rate of growth of output and t is the number of periods that has elapsed since these initial conditions were established. Clearly, *ceteris paribus*, the choice of y_0 determines the value of y in all subsequent periods.

[13] The significance of this possibility is reinforced if the "data" defining the equilibrium are understood to derive from relatively enduring but ultimately transmutable institutions, as in the model developed by Cornwall and Setterfield (2002). See section 4(iv) below for further discussion.

of the economy's growth trajectory, influence subsequent growth outcomes in a purely self-reinforcing manner" (Setterfield, 2002, p.220).[14] This is in keeping with Kaldor's emphasis on the lasting influence of initial conditions on growth outcomes in a system that never "settles down" into a steady (equilibrium) rate of growth (see, for example, Kaldor, 1985, pp.61-3).

ii) A unit root in the growth process

An alternative to the disequilibrium approach is to postulate the existence of a unit root in the growth process – specifically, to assume that:

$$\lambda\alpha\beta = 1$$

It will immediately be recognised that in so doing, we have changed one of the two conditions identified earlier as sufficient for the existence and stability of the equilibrium identified in Figure 1. The consequence of this unit root assumption is easiest to demonstrate if we also assume that:[15]

$$\Omega = -r / \alpha$$

Now note that $\lambda\alpha\beta = 1 \Rightarrow \alpha = 1/\lambda\beta$ and $\Omega = -r/\alpha \Rightarrow r = -\alpha\Omega$. If we substitute these last two expressions into the PR in equation [11], we get:

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[14] That the influence of initial conditions is strictly self-reinforcing can be demonstrated by differentiating the expression for y in the previous footnote with respect to y_0, from which we obtain:

$$\frac{\partial y}{\partial y_0} = (\lambda\alpha\beta)^t > 0$$

[15] The qualitative result reported below – that the existence of a unit root ensures that initial conditions always matter in the growth process – is unaffected by this second assumption, which is introduced only for purposes of simplicity. To see this, note that the assumption of a unit root transforms the final expression derived in footnote 12 into:

$$y = y_0 + t[\lambda(\gamma - \alpha_w\beta)y_w]$$

from which it is evident by inspection that initial conditions *always* affect subsequent growth outcomes, regardless of the values of other parameters.

$$q = -\alpha\Omega + \frac{1}{\lambda\beta} y$$

from which it follows that:

$$y = \Omega + \lambda\beta q$$

(recalling that $\lambda\alpha\beta = 1$). This is, of course, exactly the same as the expression for the DR in equation [13]. In other words, the DR and the PR of our model are now identical, as depicted in Figure 4. And as is also illustrated in Figure 4, *any* initial choice of productivity growth rate (such as q_0) will generate a rate of growth of output (y_0), read off the PR, that will, in turn, generate a rate of growth of productivity (read off the DR) that is exactly equal to q_0. In other words, *ceteris paribus*, whatever growth rate is established initially will be indefinitely self-perpetuating. Put differently, all points along the DR ≡ PR schedule depicted in Figure 4 are steady-state growth equilibria, so that $q_0 = q^*$, $y_0 = y^*$ for all q_0, y_0. The substance of this result is that, once again, the decisive influence of initial conditions on subsequent growth outcomes (*à la* Kaldor) – i.e., the "weak" path dependence of growth – is established.

[FIGURE 4 GOES HERE]

iii) Strong path dependence I: technological lock-in and growth

The "weak" path dependence inherent in both the disequilibrium and unit root variants of the canonical Kaldorian model means that initial conditions affect long run growth outcomes. But in these models, in the absence of unexplained, exogenous shocks, initial conditions are the *only* feature of the economy's prior growth trajectory that influence subsequent growth outcomes. However, a richer sense of historical contingency exists, which can be identified with "strong" path dependence. Strong path dependence involves *structural change* within an economy in response to its prior trajectory, where the latter may involve either a sequence of disequilibrium adjustments (as discussed in section 4(i) above), or cumulative experience of the same (equilibrium) outcome (such as that depicted in Figure 1). Specifically, strong path dependence exists when either the path towards or the cumulative experience of a particular equilibrium outcome affects the conditions of equilibrium (the data defining the equilibrium, such as the values of Ω and α in the DR and PR depicted in Figure 1) and hence the position of equilibrium (i.e., the precise equilibrium outcomes, such as q^* and y^* in Figure 1).[16] From this point of view, *all* positions of equilibrium (such as that depicted in Figure 1) are "provisional" or "conditional" (Chick and Caserta, 1997; Setterfield, 1997b). They exist only as long as the "data" defining them remain constant, and await subsequent redefinition resulting from discontinuous change in the structure of the economy that is induced by prior (equilibrium or disequilibrium) outcomes themselves. Hence, in the context of the model developed here, Figure 1 depicts no more than a transitory growth "regime" – a provisional or conditional characterization of the system that is adequate for the description of a particular "episode" of growth that may last for several consecutive business cycles, but which is ultimately susceptible to re-configuration induced by the very outcomes that constitute the episode.

There are various ways in which the structural change associated with strong path dependence may assert itself in the Kaldorian growth model. One of these concerns the

[16] Setterfield (2002, p.227) identifies strong path dependence with hysteresis, on the basis that structural change is the *sine qua non* of hysteresis. The term hysteresis is, however, used in various different ways in economics – including that of a label for the unit root processes discussed earlier – and as such, is avoided altogether here. See Setterfield (2009) for fuller discussion of hysteresis.

pace of induced technological progress, as captured by the PR in equation [11]. Recall that α, the Verdoorn coefficient, captures the elasticity of productivity with respect to output – i.e., the capacity of the economy to realise productivity gains on the basis of any given rate of growth of output. The value of this elasticity may be subject to discrete, growth induced structural change due, for example, to technological interrelatedness and lock in (Setterfield, 1997a; 1997c; 2002). Suppose, for instance, that rapid growth in the past causes an economy to get "stuck" with certain industries and/or technologies inherited from the past. This might occur if rapid growth promotes specialisation in production (as per the Verdoorn law), but if at the same time, different components of the increasingly specialised production process (including plant, equipment and human capital both within and between firms, industries and the public sector) are *interrelated* – i.e., subject to common technical standards that create interconnections between them. For example, certain types of computer software will work only on specific computer hardware, and require a specific skill set in order to be operated. Such interrelatedness makes it difficult to change one component of the production process without changing others. For example, an accounting firm may not be able to improve its software without simultaneously changing its computer hardware and re-training its employees. The upshot is that technical change may become prohibitively costly and/or (in an environment of private ownership and decentralised decision making) difficult to coordinate in an economy that has grown extensively (i.e., rapidly and/or over a protracted period of time) by accumulating certain interrelated types of human and physical capital, and in which the degree of interrelatedness between components of the production process has, as a result, surpassed a critical threshold level. Such an economy can be said to have become “locked in” to a particular technological base, inherited as a legacy of its past, from which it subsequently becomes difficult to deviate. And this, in turn, may impair the ability of the economy to realize induced technological progress in the future. Hence if a technological improvement is incompatible with existing components of the production process, it may be foregone. The result is that the economy will experience a discrete drop in the size of its Verdoorn coefficient, α, which measures the ability of the economy to capture induced technological progress, as the threshold level of interrelatedness is surpassed and the economy experiences lock in. The consequences of this are illustrated in Figure 5. Beginning with the same conditional growth equilibrium (at q^*, y^*) depicted in Figure 1, assume that cumulative experience of these growth outcomes creates lock in to a particular technological base, as described above. This, in turn, will transform the economy's PR from:

$$q = r + \alpha y \qquad [11]$$

to:

$$q = r + \alpha' y \qquad [11a]$$

where $\alpha' < \alpha$. The upshot of this development is a reduction in the conditional equilibrium rates of output and productivity growth to y' and q' respectively, as illustrated in Figure 5. Clearly, Figure 5 exemplifies strong path dependence as defined earlier. In this case, the cumulative experience of a particular (conditional) equilibrium outcome affects the conditions of equilibrium (the Verdoorn coefficient, α) and hence the position of equilibrium itself.

iii) Strong path dependence II: institutional change and growth

Technology is not the only source of discontinuous structural change that can be associated with strong path dependence. Another source is institutions, defined broadly to include conventions and norms as well as formal (e.g., legal) rules. According to Cornwall and Setterfield (2002), institutions create a framework akin to a computer's operating system,[17] within which the income generating process summarised in equations [1] and [9] – [11] is embedded. Hence the parameters (and even the precise functional forms) of the DR and PR in equations [11] and [13] reflect the structure of the economy's institutional framework. For example, a "value sharing" norm that ensures that both workers and firms benefit from productivity gains may reduce conflict over technological change at the point of production, and thus increase the responsiveness of productivity growth to output growth (as captured by the Verdoorn coefficient, α). This, in turn, will affect the position of the PR schedule in Figure 1 and hence the economy's rates of growth of output and productivity.

According to Cornwall and Setterfield (2002), the economy's institutional framework is relatively inert and hence enduring – sufficiently so to give rise to precisely the sort of discrete episodes of growth, lasting for several consecutive business cycles, alluded to in the previous sub-section. And as was suggested earlier, these growth episodes can be characterised by equilibrium growth outcomes of the sort depicted in Figure 1, as long as such equilibria are understood to be strictly conditional – in this case, conditional on the reproduction over time of the specific constellation of institutions within which the DR and PR are embedded. This conditionality of equilibrium draws our attention to the fact that, whilst relatively enduring, the institutional framework is not

[17] See Colander (1999) for the origins of this metaphor.

immutable. It can and does change over time, not least in response to the cumulative effects of the growth outcomes to which it gives rise.[18] For example, if sustained economic growth creates "aspiration inflation" resulting in the breakdown of the value sharing norm described earlier, then heightened distributional conflict at the point of production may impair the capacity of the economy to realise induced technological change, reducing the size of the Verdoorn coefficient, shifting the PR and thus reducing the rates of growth of output and productivity in a manner similar to that depicted in Figure 5. In other words, the institutional framework shapes the DR and PR in equations [11] and [13], thus creating a discrete episode of growth characterised by a conditional growth equilibrium (such as that depicted in Figure 1). But growth outcomes then have feedback effects on institutions, that eventually become manifest as institutional change. The upshot will be a new DR and/or PR, and hence a new episode of growth, and so on. Once again, we are describing a process whereby the cumulative experience of a particular (conditional) equilibrium outcome affects the conditions and hence the position of equilibrium – in other words, a system that displays strong path dependence.

Cornwall and Setterfield (2002) use the model described above to chart the rise and decline of the post-war Golden Age (1945-73) of macroeconomic performance in terms of discrete institutional changes interacting with the Kaldorian income-generating process summarised in equations [11] and [13]. As a further example of their approach, consider the international transmission of the rise and decline of the financialised US growth process over the past 20 years. It is widely accepted that growth in the US economy over the last twenty years was consumption-led, and financed by unprecedented

[18] In keeping with the durability of institutions (and hence the episodic nature of growth), such change will be discrete and discontinuous.

household debt accumulation (Palley, 2002; Cynamon and Fazzari, 2008). According to Cynamon and Fazzari (2008), this financialised growth episode in the US was brought about by significant changes in the borrowing and lending norms of households and creditors, respectively. Moreover, the institutional change that Cynamon and Fazzari identify can be thought of as having been (in part) induced by the macroeconomic performance experienced in the US during what Cornwall and Setterfield (2002) identify as the low-growth "Age of Decline" (1973-89).[19] Hence one important macroeconomic outcome that was established during this low-growth episode was the tendency for real wages to grow slower than productivity for the majority of workers, thus depressing the wage share of income (see, for example, Palley, 2002). This outcome can be traced directly to an important institutional feature of modern American capitalism that emerged during the Age of Decline – its "incomes policy based on fear", associated with changes in corporate organization, labour law and macroeconomic policy designed to increase worker insecurity and reduce the relative power of workers in the wage bargain (Setterfield, 2006b; 2007). And as Cynamon and Fazzari (2008) argue, stagnant real wage growth has contributed to an increased acceptance among American households of debt accumulation as a mechanism for pursuing the "American dream" of rising living standards. At the same time, the incomes policy based on fear alluded to above was designed to subdue inflationary pressures in the US economy – something it was successful in doing (Setterfield, 2006b; 2007). The resulting low (and stable) inflation environment that began to materialise towards the end of the Age of Decline helped to induce changes in creditors' lending norms, by reducing their macroeconomic risk and

[19] The analysis that follows was inspired by, and is in part based upon, a conversation with Wendy Cornwall that took place in August 2008.

hence creating an incentive for them to pursue greater microeconomic risk, such as accepting greater household leverage and lending to sub-prime households (see, for example, Goodhart, 2005, p.300).

The upshot of these developments was a debt-financed, consumption-led growth episode in the US after 1990, which has had beneficial effects for countries exporting to the US as a "consumer of last resort". The international transmission of this financialised US growth episode (and its recent demise) is captured in Figure 6.[20] Suppose, then, that we begin at the equilibrium denoted by q^*, y^* as originally depicted in Figure 1. The emergence of the financialised growth process in the US can be reckoned to have had two effects on the DR of countries exporting to the US. The first, direct effect is an increase in $y_w = y_{US}$ and hence $\Omega = \lambda([\gamma - \alpha_w \beta]y_w - \beta r)$, where y_{US} denotes the rate of growth of the US economy which is treated as a proxy for y_w in economies exporting to the US as a "consumer of last resort". The second, indirect effect operates via the income elasticity of demand for exports, γ. The increased leverage of US households over the past two decades suggests that, for any given proportional increase in real income, the proportional increase in expenditures by US consumers on all goods and services (including imports) has increased (*ceteris paribus*), as income growth (which funds additional consumption) has been accompanied by debt accumulation (which finances additional consumption over-and-above what would be possible out of additional income). This will manifest itself as an increase in γ and hence (again) $\Omega = \lambda([\gamma - \alpha_w \beta]y_w - \beta r)$. In other words, both the direct and indirect consequences for countries exporting to the US of the financialised

[20] The domestic impact on the US economy itself can also be captured by the variant of the model developed in this chapter that is used by Cornwall and Setterfield (2002). This exercise is not pursued here for reasons of expedience.

US growth process involve an increase in Ω (to Ω′ in Figure 6), which will shift the DR upwards (to DR′ in Figure 6) thus raising the equilibrium rates of output and productivity growth (to y' and q', respectively, in Figure 6).

[FIGURE 6 GOES HERE]

As the events of 2007-2009 demonstrated, however, the financialised US growth regime was unsustainable.[21] And as the US entered the Great Recession and accompanying financial crisis, this had both direct and indirect effects on countries exporting to the US as the "consumer of last resort" that are again captured in Figure 6. First, the direct effect of the Great Recession was to reduce $y_w = y_{US}$ and hence $\Omega = \lambda([\gamma - \alpha_w \beta] y_w - \beta r)$. Second, the combination of the Great Recession and the financial crisis has changed the proclivity of households and creditors to borrow and lend respectively, with the result that the proportional expansion of expenditures accompanying any given proportional expansion of income – and hence the value of γ – has dropped, again lowering $\Omega = \lambda([\gamma - \alpha_w \beta] y_w - \beta r)$. These developments are captured by the decrease in Ω (to Ω″ in Figure 6), the resulting downward shift in the DR (to DR″ in Figure 6), and the accompanying fall in the equilibrium rates of output and productivity growth (to y'' and q'', respectively, in Figure 6). The remaining question, of course, is whether these events prove to be temporary, or whether the financialised growth regime in the US is truly exhausted – in which case, *ceteris paribus*, lower growth

[21] See, for example, Palley (2002b) and Godley and Izurieta (2002) for anticipations of this unsustainability that, in tandem with the discussion above, focus on the likely consequences for the aggregate-demand-generating process.

Note that in what follows, the shift in the DR to DR″ in Figure 6 is hypothesised to have resulted from the *exhaustion* and subsequent collapse of a growth episode, rather than from institutional change induced by cumulative experience of the growth outcomes associated with the episode (and hence strong path dependence). In this sense, there is an important qualitative difference between the account provided above of the *rise* of the financialised US growth regime (which *does* involve appeal to strong path dependence based on institutional change induced by macroeconomic performance during the previous growth episode), and the account of the regime's subsequent *decline*.

outcomes similar to y'' and q'' in Figure 6 will persist as a new growth episode as the US leads the world into a period of secular stagnation.

5. Reconciling the Actual and Potential Rates of Growth

In the Kaldorian model outlined in section 3, not only is the actual (equilibrium) rate of growth path dependent but so, too, is the Harrodian *natural* rate of growth – the maximum rate of growth that the economy can achieve in the long run. This is because the natural rate is sensitive to the actual rate of growth that the economy achieves, thanks to the operation of the Verdoorn law. This is illustrated in Figure 7 below. Figure 7 shows how the equilibrium rate of productivity growth, q^*, established by the intersection of the DR and PR in the north-east quadrant of the diagram, determines the equilibrium natural rate of growth, y_n^*, in the south-east quadrant, given the rate of growth of the labour force, l.[22]

[FIGURE 7 GOES HERE]

It is also evident from Figure 7 that, even though the natural rate of growth is endogenous, the first Harrod problem – inequality of the equilibrium and natural rates of growth – may persist (Cornwall, 1972). In fact, as in Harrod, $y^* = y_n^*$ will emerge only as a special case in the model developed thus far. The reasons for this can be made clear as follows. First, note that from the solution to equations [11] and [13], it follows that:

$$y^* = \frac{\lambda(\gamma - \alpha_w \beta) y_w}{1 - \lambda \alpha \beta} \qquad [14]$$

[22] The rate of growth of the labour force can also be made endogenous to the actual rate of growth (see, for example, Cornwall, 1972, 1977), but this possibility is overlooked here for the sake of expedience. See also León-Ledesma and Thirlwall (2000, 2002) and León-Ledesma and Lanzafame (2010) for evidence of the endogeneity of the natural rate.

Meanwhile, since:

$$y_n \equiv q + l$$

it follows from appeal to the Verdoorn law that:

$$y_n^* = r + l + \alpha y^* \qquad [15]$$

Finally, solving equations [14] and [15] under the condition $y^* = y_n^*$ yields:

$$\frac{r+l}{1-\alpha} = \frac{\lambda(\gamma - \alpha_w \beta) y_w}{1 - \lambda\alpha\beta} \qquad [16]$$

It is clear by inspection that the equality in [16] is possible but not likely: it involves a constellation of independently determined parameters, and there is no obvious mechanism that will ensure these parameters take on values that exactly satisfy [16].

The result derived above raises an important question about the *sustainability* of the equilibrium rate of growth depicted in Figure 7. Hence note that since:

$$y \equiv q + n$$

where *n* denotes the rate of growth of employment, it follows from this definition and that of the natural rate of growth stated earlier that, if $y^* > y_n^*$ as in Figure 7, we will observe:

$$q^* + n^* > q^* + l$$

$$\Rightarrow n^* > l$$

where n^* is the equilibrium rate of growth of employment derived from the equilibrium rates of output and productivity growth determined in Figure 7, and the definition of the actual rate of growth stated above. Now note that:

$$E = \frac{N}{L}$$

$$\Rightarrow \dot{E} = E(n^* - l) \qquad [17]$$

where E denotes the employment rate. Equation [17] tells us that, given the rate of growth of the labour force, the employment rate E will keep increasing if $n^* > l$. But since the employment rate is bounded above (it cannot exceed one), this is impossible.[23] The condition $y^* = y_n^*$ therefore constitutes a "golden rule" for sustainable, long run equilibrium growth. Only if we are analysing a "dual" economy – that is, one with an abundant "latent reserve army" of labour in a subsistence or informal sector, that can be drawn (on demand) into the modern sector whose growth is described by the model we have developed so far – can the "golden rule" be satisfactorily ignored. But advanced capitalist economies are not dual economies, and it is clear from their post-war experience that they are capable of operating near to full employment – in which case any growth outcome similar to that depicted in Figure 7 must be regarded as ultimately unsustainable. Of course, it must be remembered that we are treating growth equilbria such as that depicted in Figure 7 as "conditional" and that, as such, a growth regime or episode such as that in Figure 7 may come to an end before the logical bounds of the employment rate have been tested. Nevertheless, the possibility that a growth episode may become labour constrained (i.e., unsustainable because $n^* \neq l$) should alert us to the potential importance of the "golden rule" $y^* = y_n^*$, and hence to the importance of studying processes through which the equilibrium actual and natural rates of growth (and hence n and l) might be brought into alignment, so that growth episodes can be made consistent with a constant employment rate and thus become (in principle) sustainable in the long run.

[23] Note that the employment rate is also bounded below – it cannot be less than zero – so an equilibrium growth outcome that involves $n^* < l$ will also raise a problem of unsustainability similar to that identified above.

One such process, proposed by Setterfield (2006a), involves changes to the Verdoorn coefficient brought about by changes in the employment rate.[24] Specifically, Setterfield postulates that:

$$\alpha = \alpha(E) \quad , \quad \alpha' > 0 \qquad [18]$$

In other words, the Verdoorn coefficient is increasing in the rate of employment. The rationale for this relationship is that it is not just the *rate of growth* but also the *level* of economic activity that influences induced technological progress. Specifically, a tighter goods market, from which the tighter labour market associated with a high value of E is understood to derive, will encourage firms to engage in more innovation, changes in technique etc. at any given rate of growth.

The consequences of equation [18] are illustrated in Figure 8 below. Figure 8 depicts, as a function of α, both the equilibrium actual rate of growth in equation [14] (the schedule denoted y^*), and the rate of growth necessary to satisfy the "golden rule" $y^* = y_n^*$ (the schedule denoted y_G) which, by referring to the left-hand-side of equation [16], can be stated as:[25]

[24] See Palley (2002a) for discussion of alternative processes.

[25] The schedules depicted in Figure 8 are based on the facts that, from equation [19]:

$$\frac{dy_G}{d\alpha} = \frac{r+l}{(1-\alpha)^2} > 0$$

and:

$$\frac{d^2 y_G}{d\alpha^2} = \frac{2(r+l)}{(1-\alpha)^3} > 0$$

while, from [14]:

$$\frac{dy^*}{d\alpha} = \frac{\beta\lambda^2(\gamma - \alpha_w \beta) y_w}{(1-\lambda\alpha\beta)^2} > 0$$

and:

$$\frac{d^2 y^*}{d\alpha^2} = \frac{2\beta^2\lambda^3(\gamma - \alpha_w \beta) y_w}{(1-\lambda\alpha\beta)^3} > 0$$

$$y_G = \frac{r+l}{1-\alpha} \quad [19]$$

Figure 8 depicts a situation where, with $\alpha = \alpha_1$, $y_1^* > y_{G_1}$ and hence, as demonstrated earlier, $n^* > l$. This will result in $\dot{E} > 0$ in equation [17], as a result of which α will rise in equation [18], increasing the values of both y^* and y_G in Figure 8. These adjustments will continue until $\alpha = \alpha^*$ in Figure 8, at which point $y_e^* = y_{G_e}$. At this point, the economy will have achieved a conditional equilibrium rate of growth that satisfies the "golden rule" and is therefore sustainable in the long run.

[FIGURE 8 GOES HERE]

6. Conclusion

This chapter has explored the Kaldorian approach to endogenous growth. The central principles of this approach are that growth is: (a) demand-led, with exports playing a crucial role in aggregate demand formation; and (b) path-dependent. In Kaldor's original vision, path dependence is associated specifically with the process of cumulative causation, in which initial conditions are self-reinforcing. In modern Kaldorian growth theory, the actual rate of growth may display either "weak" path dependence (sensitivity to initial conditions) or "strong" path dependence. When growth is subject to strong path dependence, the experience of a particular (equilibrium or disequilibrium) growth trajectory can induce discrete structural change associated with

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Note also that $\lim_{\beta \to 0}\left(dy^* / d\alpha\right) = 0$ – so a small enough value of β (the price elasticity of demand for exports) is sufficient to ensure that $dy^* / d\alpha < dy_G / d\alpha$ (as depicted in Figure 8), thus ensuring the stability of the system as a whole. See, for example, McCombie and Thirlwall (1994) for discussion of the inelasticity of trade to price competition in the context of Kaldorian growth theory.

the economy's technology and/or institutions, as a result of which the economy will evolve through a series of discrete "regimes" or "episodes" of growth. The natural rate of growth is also path dependent in Kaldorian growth theory, although in and of itself this does not resolve important questions about the *sustainability* of any growth regime characterized by inequality of the actual and natural rates of growth. As has been shown, however, it is possibility to identify solutions to this sustainability issue. These solutions reconcile the basic Kaldorian vision of growth with precisely the type of balance in the growth process necessary to render growth outcomes sustainable in the long run.

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Figure 1: The Canonical Kaldorian Growth Model

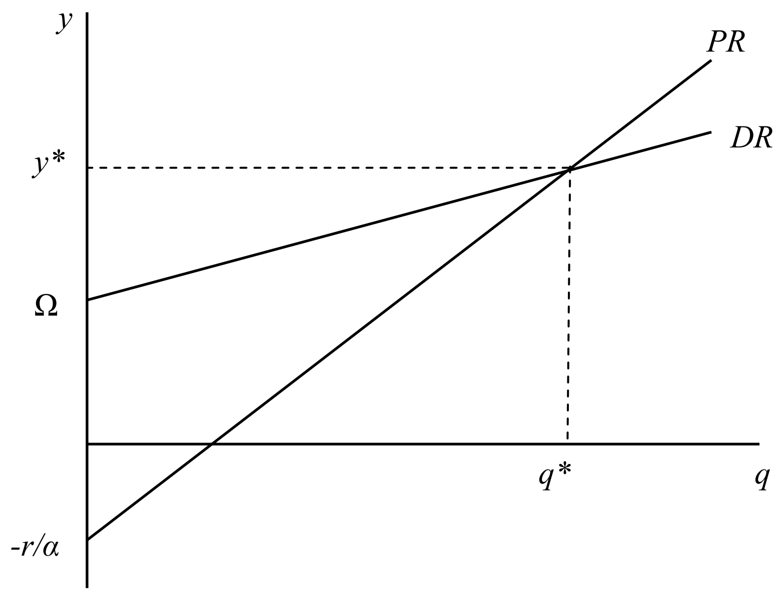

Figure 2: Growth Outcomes in Two Different Economies

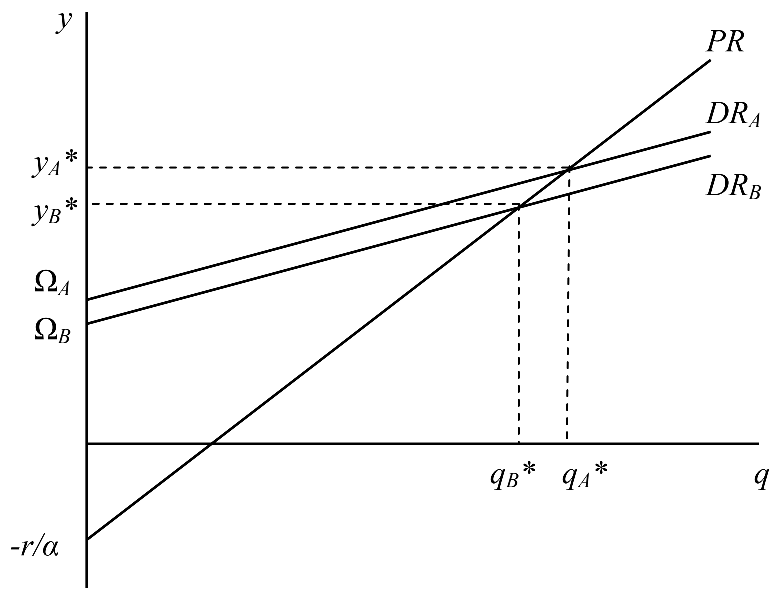

Figure 3: Income Divergence in the Canonical Kaldorian Model

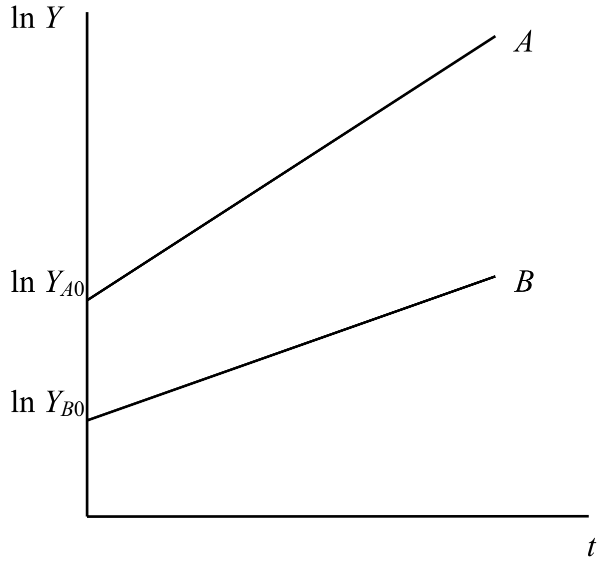

Figure 4: The Influence of Initial Conditions Due To a Unit Root in the Growth Process

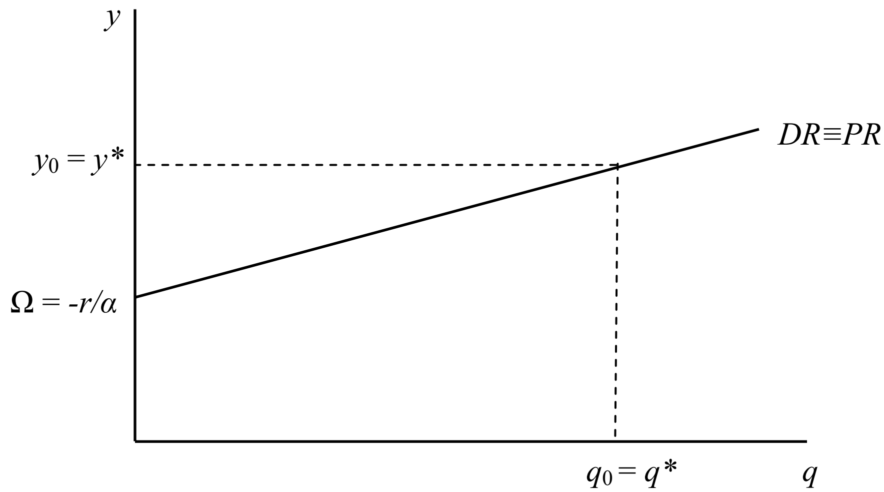

Figure 5: The Consequences of Technological Interrelatedness and Lock In

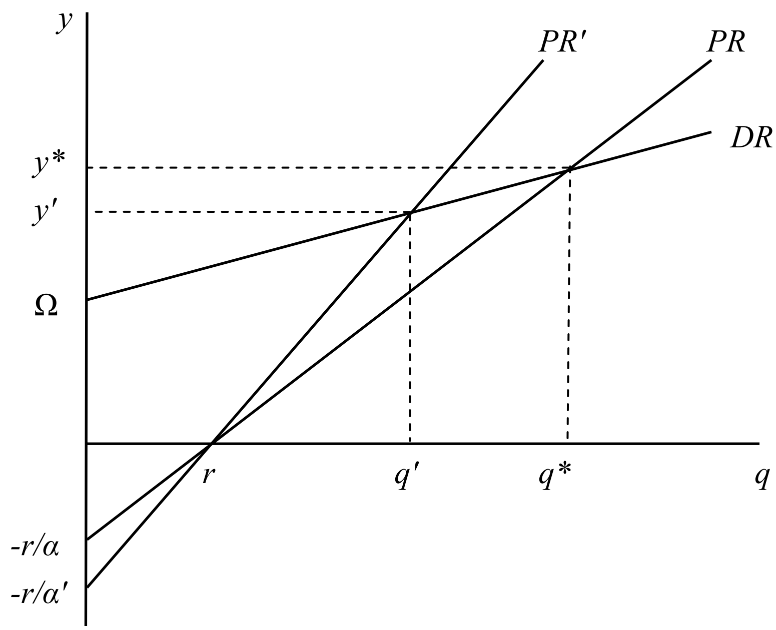

Figure 6: International Transmission of the Rise and Demise of the Financialised US Growth Regime

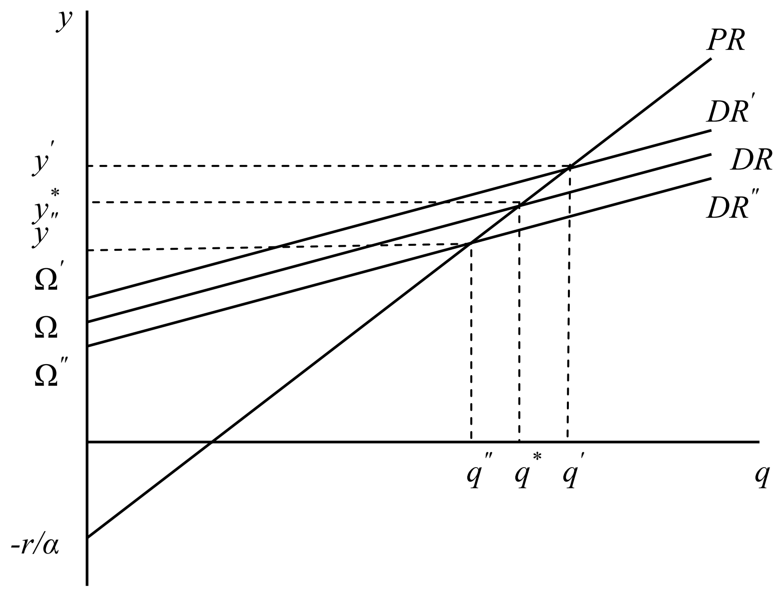

Figure 7: The Endogeneity of the Natural Rate of Growth

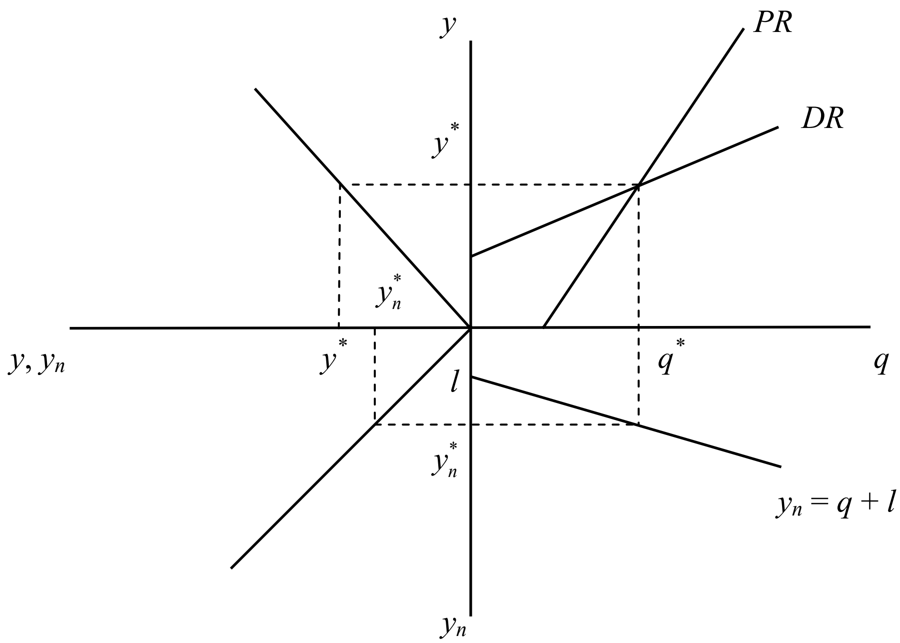

Figure 8: Adjustment Towards a Sustainable Equilibrium Growth Rate