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Exploring the supply side of Kaldorian growth models

Mark Setterfield*
Department of Economics, Trinity College, Hartford, CT, USA

Recent Kaldorian growth models emphasize the need to reconcile the demand-led actual rate of growth and the potential rate of growth. This issue is revisited in light of criticism suggesting it is a 'red herring'. An explicit model of the supply side is used to show that, in a mature economy, it is unlikely that steady-state, demand-led growth will always be automatically accommodated by the supply side. The conclusion reached is that attention must, therefore, be paid to the possible emergence of supply constraints on growth, and the implications thereof for steady-state, demand-led growth models.

Keywords: *demand-led growth, potential rate of growth, natural rate of growth, Kaldorian growth models*

JEL codes: *E12, O41*

1 INTRODUCTION

Kaldorian growth models belong to a class of Keynesian macrodynamic models in which growth is demand-led.[1] In these models, expansion of aggregate demand is the proximate engine or 'driver' of long-run growth, as a result of which much attention is paid to modelling the dynamics of demand formation. The supply side, meanwhile, plays a more passive role. Usually it is largely hidden from view, with a technical progress function (such as Verdoorn's law) providing the only explicit glimpse of the development of productive forces in the process of growth. This can give the resulting models an under-developed appearance, with supply-side accommodation of the demand-side occuring automatically but according to no explicitly-specified mechanisms of adjustment in a process that Cornwall (1972) likens to

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1. As discussed by King (2010), there are various types of Kaldorian growth models. The focus in this paper is on models of cumulative causation and balance of payments constrained growth. See, respectively, Setterfield (forthcoming) and Thirlwall (2011) for recent surveys of these approaches, and Blecker (forthcoming) for an analysis of their potential synthesis.

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'Say's law in reverse'.[2] It also presents a potential analytical problem: in a steady-state framework, if the actual and potential rates of growth differ, the result would be a secular trend in the rate of resource utilization. Since resource utilization rates can only vary within bounds, this means the steady-state actual rate of growth cannot be sustained indefinitely.

In view of this problem, it is not surprising to find a history of concern in Kaldorian growth theory with reconciling the actual and potential rates of growth.[3] Kaldor (1959) himself advanced a model in which the actual rate of growth adjusts towards the Harrodian natural rate through changes in the functional distribution of income. Cornwall (1972), meanwhile, posits a variety of mechanisms through which the supply side of the economy accommodates the development of the demand side so that, within bounds, the potential rate of growth adjusts to the equilibrium actual rate of growth. More recently, both Palley (2002) and Setterfield (2006) develop models in which the actual and potential rates of growth are reconciled through various channels of adjustment. None of these channels is mutually exclusive, but different channels suggest that either the equilibrium actual rate of growth or the equilibrium potential rate of growth bears the burden of adjustment in the process of reconciliation.

Not all Kaldorians are equally happy with these developments, however. McCombie (2011) argues that concern with reconciling the actual and potential rates of growth – and in particular, the treatment of this issue in the Palley/Setterfield models mentioned above – is at best a misleading distraction and at worst erroneous. According to McCombie (2011), the spirit of the original Kaldorian models on which Palley and Setterfield base their arguments involves supply-side accommodation of demand-side developments,[4] as a result of which it is the demand constraint on growth that is binding and hence the demand constraint alone that is the appropriate focus of attention for growth theorists.[5] From this perspective, there is no need to seek reconciliation of the actual and potential growth rates in Kaldorian macrodynamics – the issue is, at best, a red herring, and Kaldorian growth theory should continue with its traditional focus on the dynamics of aggregate demand formation.

One obvious shortcoming of the Palley/Setterfield models is that they lack an explicit model of the supply side from which the dynamics of the potential output constraint can be shown to emerge. The purpose of this paper is to furnish an explicit account of the supply side and to use this as a basis for revisiting Palley's and Setterfield's concerns in light of McCombie's scepticism regarding the need for Kaldorians to seek

2. Supply-side models – and in particular, neoclassical growth models – suffer the opposite problem, assuming that aggregate demand automatically adjusts to accommodate potential output in the long run, so that growth theory can focus exclusively on modelling the development of productive forces (as represented by an aggregate production function).

3. This concern is not limited to Kaldorian models. See, for example, Dutt (2006; 2010) and Ryoo and Skott (2008) for discussions of reconciling supply constraints with demand-led growth in the context of Kaleckian macrodynamics.

4. See, for example, Thirlwall (1979; 2001).

5. As will become clear in section 2 below, McCombie (2011) is critical of some of the specific adjustment mechanisms responsible for reconciling the actual and potential rates of growth in the Palley/Setterfield models. But the overall *leitmotif* of his objections is that, in Kaldorian theory, the binding (and therefore relevant) constraint on the growth process does not emanate from the supply side of the economy.

reconciliation between the demand-determined actual rate of growth and the potential rate of growth. Specifically, the paper provides:

1. an explicit description of the supply side compatible with Kaldorian macrodynamics, resulting in;
2. an improved understanding of the possible nature of any supply constraints on demand-led growth in a Kaldorian framework, giving rise to;
3. an evaluation of Palley's and Setterfield's concerns with respect to the possibility of supply constraints affecting demand-led growth in Kaldorian macrodynamics, and hence the need to seek mechanisms capable of reconciling the actual and potential rates of growth.

The remainder of the paper is organized as follows. Section 2 briefly summarizes the Palley/Setterfield models and McCombie's objections – both specific and general – to their treatment of the growth process and concern with the potential rate of growth as a meaningful constraint in long-run macrodynamics. Section 3 then provides an explicit model of the supply side consistent with Kaldorian growth theory, on the basis of which the alleged need to reconcile the actual and potential rates of growth is re-evaluated. Section 4 offers some conclusions.

2 THE PALLEY/SETTERFIELD MODELS

An implicit assumption of both Palley (2002) and Setterfield (2006) is that we are modelling what Cornwall (1972) calls a 'mature' economy: an advanced capitalist economy in which conditions of full employment may, in principle, be approached. It is important to note at the outset, then, that the concerns addressed in what follows may not materialize in a 'dual' economy, in which labour resources can be drawn, without (practical) limit, from an 'informal' sector into the 'industrial' sector responsible for capitalistic growth.

2.1 The actual rate of growth

In both Palley (2002) and Setterfield (2006), the equilibrium actual rate of growth is derived from a standard balance of payments constrained growth (BPCG) model of the sort first derived by Thirlwall (1979) and summarized by McCombie and Thirlwall (1994). Since models of this genus are familiar, and since the main concern of this paper is not with the precise form taken by the equilibrium actual rate of growth, we proceed here to a direct statement of the equilibrium growth rate consistent with the BPCG framework in its simplest form (Thirlwall's law):

$$y = \frac{\varepsilon x}{\pi} \tag{2.1}$$

where y is the actual rate of growth, x is the rate of growth of exports, and ε and π are the income elasticities of demand for exports and imports, respectively.[6]

6. For recent surveys of the BPCG theory from which equation (2.1) is derived, see McCombie (2011), Setterfield (2011), Thirlwall (2011) and Blecker (forthcoming).

Throughout the analysis that follows, all variables are in real terms. Because prices are not modelled, all transitional adjustments – including responses to inequality of the actual and

2.2 The potential rate of growth

Both Palley (2002) and Setterfield (2006) model the potential rate of growth by appealing to Harrod's concept of the natural rate of growth, and augmenting this with a technical progress function – Verdoorn's law – in which the rate of growth of labour productivity is a function of the actual rate of growth, thanks to the existence of dynamic increasing returns.[7] The resulting model can be summarized as follows:

$$y_p \equiv q + n \tag{2.2}$$

$$q = \alpha + \beta y \tag{2.3}$$

$$\Rightarrow y_p = (\alpha + n) + \beta y \tag{2.4}$$

where y_p denotes the potential rate of growth, q is the rate of growth of labour productivity, and n is the rate of growth of the labour force. Note that, thanks to the Verdoorn law in (2.3), the model of potential output growth summarized in equation (2.4) does not neglect the traditional Kaldorian theme that there will be induced effects on the supply-side growth capacity of the economy as a result of the demand-led growth rate determined in equation (2.1).[8]

2.3 Reconciling the actual and natural rates

As intimated in the introduction, both Palley (2002) and Setterfield (2006) motivate their efforts to reconcile the actual and potential rates of growth by noting that if the rates of growth in equations (2.1) and (2.4) are different then, in the steady state, the result will be a secular trend in the rate of resource utilization which cannot be sustained indefinitely.[9] To see this, begin by defining the rate of resource utilization as:

$$e = \frac{Y}{Y_p}$$

$$\Rightarrow \dot{e} = e(y - y_p) \tag{2.5}$$

potential rates of growth – involve quantity adjustments. Were prices to be modelled, additional channels of adjustment involving wages, prices, factor shares and the terms of trade may present themselves. The existence and consequences of these additional adjustment channels are left as a topic for further research.

7. See, for example, McCombie et al. (2003).

8. McCombie (2011, p. 374, note 11) refers to the expression in (2.4) as the 'Kaldorian' natural rate of growth, to distinguish it from the Harrodian natural rate of growth, which he regards as genuinely exogenously given.

9. Note that the rates of growth in equations (2.1) and (2.4) *will* be different in all but a special case. Hence if we impose the condition $y = y_p$ on equations (2.1) and (2.4) and solve for x, we obtain:

$$x = \frac{\pi(\alpha + n)}{\varepsilon(1 - \beta)}$$

There is no reason to believe that this particular rate of growth of exports will always materialize from the standard export demand functions posited in BPCG theory (on which, see McCombie and Thirlwall, 1994).

where Y and Yp denote the levels of actual and potential output, respectively. Clearly, if the actual and potential rates of growth differ, the implication (in the steady state) is that e will rise or fall without limit.[10] But because e is a bounded variable, this is not possible. Ergo, absent some mechanism to reconcile y and y_p, the equilibrium growth rate derived from equation (2.1) cannot be sustained.

One possible reaction to this problem is to regard it as a product of the mechanics of steady-state equilibrium analysis run amok. On this view, the *historical* bent of Kaldorian growth analysis (on which see, for example, Kaldor 1985) implies that there is no real-world permanence to the steady-state value of y derived from equation (2.1). Instead, this solution is better conceived as a temporary equilibrium that awaits redefinition as a result of the very process of growth that it describes (see, for example, Setterfield 1997; 2002). But while these principles of historical contingency are laudable, they do not provide a basis for ignoring the *practical* fact that advanced capitalist economies can and do operate at or near full employment, sometimes (as during the post-war, 1948–1973 Golden Age) for protracted periods of time.[11] This makes the potential output constraint a matter of concern even if any particular steady-state rate of growth is unlikely to be maintained indefinitely because of the inherent path-dependency of the growth process.

The chief purpose of the Palley/Setterfield models is to resolve the dilemma with which the difference equation in (2.5) presents us by proposing a variety of auxiliary mechanisms that, in tandem with equations (2.1) and (2.4), extend the model developed so far, so that the outcome $y = y_p$ is achieved in the course of growth, as a result of which the final ('fully adjusted') steady-state growth rate is consistent with a constant (albeit indeterminate) rate of resource utilization, e.[12] Specifically, Palley and Setterfield achieve these results by augmenting the model above with either the equation:

$$\pi = \pi(e), \quad \pi' > 0 \tag{2.6a}$$

Or the equation:

$$\beta = \beta(e), \quad \beta' > 0 \tag{2.6b}$$

To see what these extensions achieve, suppose that $y > y_p$ initially. Then it follows that either:

$$\dot{e} > 0 \Rightarrow \uparrow \pi \Rightarrow \downarrow y$$

until $y = y_p$ (on the basis of (2.6a)),[13] or:

$$\dot{e} > 0 \Rightarrow \uparrow \beta \Rightarrow \uparrow y_p$$

10. Specifically, equation (2.5) implies a constant rate of growth of e (equal to the difference between the steady-state rates of growth of y and y_p.
11. Recall the assumption of a mature economy with which we began this section.
12. This indeterminacy of the rate of resource utilization would be deemed a cause for concern from a Classical perspective, as has been demonstrated in debates that have revolved around the Kaleckian growth model. See Lavoie (1995; 1996) for a summary of and response to these Classical concerns, and Duménil and Lévy (1999), Hein et al. (2011; 2012), Skott (2012), and Schoder (2012) for subsequent contributions to this debate, which are beyond the scope of this paper.
13. Notice that in the course of this adjustment mechanism, we will also observe $dy_p = \beta dy < 0$ thanks to equation (2.4). However, since it is well established empirically that $\beta < 1$

until $y = y_p$ (on the basis of (2.6b)). The adjustment mechanisms in (2.6a) and (2.6b) are qualitatively different, not least by virtue of where they place the burden of adjustment for reconciling the actual and potential rates of growth. With (2.6b), this burden falls exclusively on the supply side, with y_p adjusting towards an unchanging y. With (2.6a), meanwhile, both y and y_p adjust to balance the growth process, so that the burden of adjustment falls on both the demand and supply sides of the economy.[14] But the two mechanisms are by no means mutually exclusive.[15] Moreover, both give rise to the same end result: sustainable steady state growth – that is, steady growth consistent with a constant (albeit indeterminate) rate of resource utilization, e.

It should be noted at this point that in his critique of the Palley/Setterfield models, McCombie (2011) singles out the first of the two adjustment mechanisms posited above (in equation (2.6a)) for particular criticism. The nub of his criticism is that changes in the income elasticity of demand for imports are *cyclical* not *secular*. The result, according to McCombie, is that as the economy booms – that is, as the actual rate of growth exceeds the secular balance of payments constrained growth rate (which is assumed to lie below the potential/natural rate of growth in equation (2.2)) – bottlenecks are encountered that raise the income elasticity of demand for imports and hence temporarily *lower* the 'cyclical' balance of payments constrained growth rate below trend. But the fact that actual growth exceeds the (secular and cyclical) balance of payments constrained growth rate causes the balance of payments to deteriorate, prompting a policy-induced recession, as a result of which the actual rate of growth falls below the secular balance of payments constrained growth rate, the income elasticity of demand for imports falls, and the 'cyclical' balance of payments constrained growth rate temporarily rises above trend. In the long run, McCombie argues, the fluctuations associated with this 'stop–go' cycle cancel out, leaving the secular balance of payments constrained growth rate unaltered. Because the latter lies (by assumption) below the potential rate of growth, this establishes the balance of payments constraint as *the* pre-eminent constraint on long run growth.

In terms of the analytics of the Palley/Setterfield models as presented above, McCombie's argument is difficult to sustain for one simple reason: at all times in McCombie's analysis, the actual rate of growth lies below potential. This means that e will be decreasing in equation (2.5), subjecting the income elasticity of demand to secular decline (in equation (2.6a)), thus increasing the secular balance of payments constrained growth rate (in equation (2.1)), regardless of the cycles around this trend that McCombie describes. As previously indicated, these adjustments will only stop when the secular balance of payments constrained growth rate equals the potential rate of growth. Of course, it could be that other mechanisms are operative which mean that bottlenecks arise as the actual rate of growth rises above the secular balance of payments constrained growth rate but remains *below* the potential rate of growth. These could thwart and even reverse

(see McCombie and Thirlwall, 1994; McCombie et al, 2003), the combined processes of adjustment will ensure convergence to new (lower) steady-state actual *and* potential rates of growth consistent with $y = y_p$.

14. See Setterfield (2006) and McCombie (2011) for further discussion and comment.
15. Nor, indeed, are they exhaustive. See for example, Cornwall (1972; 1977) for discussion of the endogenously-induced response of the rate of growth of the labour supply (n) to variation in employment and vacancy rates, a theme that has recently been revisited in the context of balance of payments constrained growth theory by Porcile and Lima (2010).

the adjustment mechanism in equation (2.6a), although it is not clear from McCombie's argument what these additional mechanisms are.[16] Nevertheless, the discussion here introduces an element of doubt into the Palley/Setterfield results. It suggests that, regardless of the veracity of specific adjustment mechanisms such as that in equation (2.6a), McCombie's greater concern – that Kaldorian models are properly conceived as demand-constrained, and that supply constraints do not bind in these models – may have some merit: the Palley/Setterfield models may misrepresent the growth process, and their concern with reconciling the actual and potential rates of growth may be, if not altogether erroneous, a misleading distraction.

3 EXPLORING THE SUPPLY SIDE OF KALDORIAN GROWTH MODELS

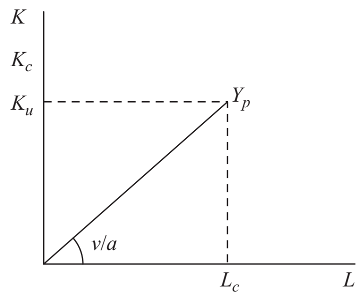
In this section, we revisit the Palley/Setterfield concerns with the relationship between the actual and potential rates of growth in light of McCombie's (2011) scepticism. We begin with an explicit description of the supply side from which the potential output constraint, at any point in time, can be derived:

$$Y_p = \min\left[\frac{L_c}{a}, \frac{K_c}{v}\right] \tag{3.1}$$

where L_c is the current labour force, K_c is the current capital stock, and $a \equiv L_c/Y_p$ and $v \equiv K_c/Y_p$ are the full employment labour to output ratio and the full capacity capital to output ratio, respectively. According to the Leontief production function in equation (3.1), capital and labour are complements in the production process: the two factors must always be combined in the strict proportion *v/a* in order to produce any given level of output.

Before proceeding, it is worth addressing an obvious question: is the description of the supply side in (3.1) Kaldorian? Explicit description of the supply side in terms of a Leontief technology is not a standard feature of contemporary Kaldorian growth models. But as noted earlier, *any* description of the supply side (excepting the glimpse provided by Verdoorn's law) is usually absent from these models. Furthermore, note that the assumption that v is fixed in (3.1) accords with Kaldor's (1961) stylized facts concerning long-run growth. At the same time, it is quite consistent with (3.1) to postulate secular decline in a (that is, labour-augmenting or Harrod-neutral technical progress) which is, in turn, perfectly consistent with Verdoorn's law in equation (2.3) (where $-\hat{a} \equiv q = \alpha + \beta y$). On this basis, it seems reasonable to argue that equation (3.1) is a defensible starting point as a characterization of the supply side in Kaldorian macrodynamics.[17]

16. Moreover, as long as the trend actual rate of growth is below the trend potential rate of growth, there will be a secular trend in the rate of resource utilization, which is at variance with the stylized facts of long-run growth and the logic of steady-state growth models.
17. Indeed, the assumptions of a constant full-capacity capital output ratio and technical progress that is labour-augmenting (Harrod-neutral) have traditionally been common first principles throughout heterodox growth theory. See, for example, the various contributions to Setterfield (2011). Note that although factor substitutability is not a feature of Leontief technology, the fixed factor proportions in (3.1) are only characteristic of the short run: factor proportions (*v/a*) can and will change over time as a result of labour-augmenting technical progress ($-\hat{a} \equiv q = \alpha + \beta y \neq 0$).



Note: $Y_p = \frac{L_c}{a} = \frac{K_u}{v} < \frac{K_c}{v}$

Figure 1 Potential output in a labour-constrained economy

As is well known, the Leontief technology in (3.1) yields two possible solutions. For the purposes of this paper (and for reasons that will become obvious), the first can be labelled the Palley/Setterfield solution. This states that:

$$Y_p = \frac{L_c}{a} \Rightarrow y_p = n - \hat{a} = q + n$$

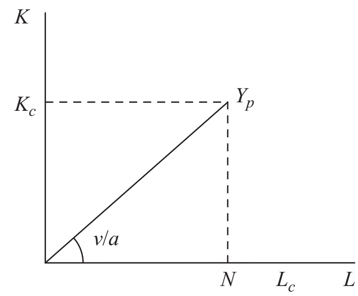
In this scenario, the economy is *labour constrained* on the supply side at any point in time, and under-utilizes its capital stock even when operating at full productive capacity (see Figure 1).[18] The dynamics of this solution give rise to the specification of the potential rate of growth found in Palley (2002) and Setterfield (2006), so that it may be said to be an implicit feature of the Palley/Setterfield models.[19]

But inspection of equation (3.1) reveals a second, alternative solution:

$$Y_p = \frac{K_c}{v} \Rightarrow y_p = \hat{K}_c$$

In this scenario, the economy is *capital-constrained* on the supply side, and will under-utilize its labour resources even when operating at full productive capacity (see Figure 2). Note that the specification of the potential rate of growth that arises from this alternative solution is quite different from that found in the Palley/Setterfield models. Hence we can immediately identify an error of omission in these models (failure to consider the alternative, capital-constrained solution to equation (3.1)), as a result of which we must at least entertain the possibility that the chief concern of these models – reconciling the equilibrium actual rate of growth in (2.1) with the potential rate of growth as stated in (2.2) – is either a special case (limited to intervals during which Palley/Setterfield solution to (3.1) applies), or possibly even a complete red herring (*à la* McCombie) if the alternative solution to (3.1) is *always* true at any point in time.

18. The reader is reminded that Figure 1 (and Figure 2 below) describe the determination of *potential* output, Y_p. Demand-determined *actual* output may (and likely will) fall short of Y_p, and therefore may (and likely will) involve the under-utilization of both capital and labour, even as its manufacture conforms to the basic law of production (that factors be combined in the proportion v/a) imposed by equation (3.1).
19. More explicit recognition of the fact that the economy is conceived as being labour-constrained on the supply-side is found in Setterfield's (2011, p. 412) review of the Palley/Setterfield models.



Note: $Y_p = \frac{K_c}{v} = \frac{N}{a} < \frac{L_c}{a}$

Figure 2 Potential output in a capital-constrained economy

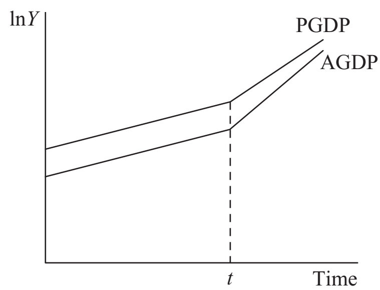


Figure 3 Actual and potential output growth in the Palley/Setterfield models

The dynamic implications of the Palley/Setterfield solution to (3.1) are illustrated in Figure 3. In Figure 3 – following the Palley/Setterfield solution to (3.1) in tandem with Verdoorn's law in equation (2.3) – the path of potential output (PGDP) can be stated, as in equation (2.4), as:[20]

$$y_p = q + n = \alpha + n + \beta y$$

Figure 3 is drawn so that, prior to period t, $y = y_p$. As a result, we will observe $\dot{e} = 0$ in equation (2.5). It is then assumed that in period t, there is a discrete increase in the actual rate of growth, y, represented by a steepening of the AGDP schedule. Because of the Verdoorn law and hence the relationship between the potential and actual rates of growth as stated above, this raises the potential rate of growth $y_p = \alpha + n + \beta y$ (represented in Figure 3 by the steepening of the PGDP schedule) – but by an amount that is smaller than the increase in y, since $\beta < 1$ so that $dy_p = \beta dy < dy$. With $y > y_p$, we will now have $\dot{e} = 0$ in (2.5). The unsustainability of this state of affairs is clearly illustrated in Figure 3: the AGDP path cannot continue in the manner depicted because this would involve AGDP > PGDP eventually, which is (by definition) impossible. The upshot of these observations is that the model requires the Palley/Setterfield reconciliation mechanisms (for aligning y and y_p) if it is to make sense as a description of long-run, steady-state growth outcomes.

20. The path of actual output (AGDP) in Figure 3 and throughout the discussion that follows is, of course, given by the description of y in equation (2.1).

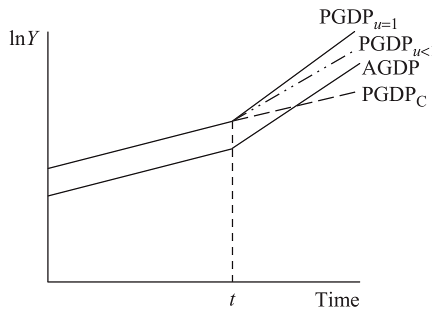


Figure 4 Actual and potential output growth: an alternative view

Two caveats to this last claim are worthy of note. First, if $\beta = 1$, then $dy = dy_p$, so that any increase in the actual rate of growth at time t will be matched by an equivalent increase in the potential rate of growth, with the result that $y = y_p$ and hence $\dot{e} = 0$ are automatically preserved.[21] This would mean that the new (faster) actual rate of growth is automatically sustainable. Second, if $n = \gamma + \delta y$ – that is, if the rate of growth of the labour force is endogenous to the actual rate of growth in the manner postulated by Cornwall (1972; 1977) and Porcile and Lima (2010), so that $y_p = \alpha + \gamma + (\beta + \delta)y$ – *and* $\beta + \delta = 1$, then we will once again have $dy_p = dy$. Once again, any change in the demand-determined actual rate of growth will be fully accommodated on the supply side by equivalent variation in the potential rate of growth, so that, once again, any change in y will be automatically sustainable. These caveats point to a second error of omission in the Palley/Setterfield models, since we can now see that, even beginning with the Palley/Setterfield solution to equation (3.1), it is possible that there will be no binding supply constraint on long run growth (*à la* McCombie). Note, however, that this is true only as a result of one or other of two special cases, neither of which seems likely to materialize in practice. Hence, as previously noted, empirical evidence suggests that $\beta < 1$, while there is no obvious reason to expect $\beta = 1 - \delta$ except as a coincidence.

Consider now the dynamic implications of the alternative solution to equation (3.1), which are illustrated in Figure 4. In Figure 4, following directly from the alternative solution to (3.1), the path of potential output follows a trajectory determined by:[22]

$$y_p = \hat{K}_c$$

Once again, Figure 4 is drawn so that prior to period t, we observe equality of the actual and potential rates of growth. This again ensures $\dot{e} = 0$ in equation (2.5), and hence the sustainability of the AGDP path depicted in Figure 4 prior to period t. A discrete increase in the actual rate of growth, represented by a steepening of the AGDP schedule, is again assumed to occur in period t. Figure 4 shows that there are two possible consequences of this event, depending on the response of $\hat{K}_c$ to the increase in y.

21. In terms of Figure 3, the slopes of the AGDP and PGDP schedules would become steeper in period t but would remain parallel thereafter.
22. It is clear by inspection that the potential rate of growth no longer corresponds to the natural rate of growth by any definition (Harrodian or Kaldorian).

First, assume that $\hat{K}_c$ is exogenously given, so that the potential rate of growth is unaffected by the increase in the actual rate of growth, and potential output follows the path depicted as $PGDP_C$ in Figure 4. In this case, and assuming that the capital-output ratio is invariant with respect to the scale of production at any point in time so that:

$$\frac{K_u}{Y} = \frac{K_c}{Y_p} = v$$

where K_u is the capital stock actually used in the production of output Y, it follows that:

$$y > y_p \Rightarrow \hat{K}_u > \hat{K}_c.$$

In other words, we will now observe $\dot{e} > 0$ in equation (2.5) or more concretely (in light of the result derived immediately above), an implied secular increase in the rate of capacity utilization $u = K_u/K_c$. Hence beyond period t the AGDP path depicted in Figure 4 is unsustainable: the model once again requires reconciliation mechanisms capable of aligning y and y_p in order to make sense as a description of steady-state growth outcomes.

Of course, the assumption that $\hat{K}_c$ is independent of the growth process is distinctly un-Kaldorian, and this observation gives rise to the second set of possible consequences arising from the increase in the actual rate of growth in period t depicted in Figure 4. Hence suppose that we write:

$$I = v\Delta Y = vyY \tag{3.2}$$

$$\Delta K_c = I \tag{3.3}$$

where I denotes aggregate investment. Following Kaldor (1970, p. 146), equation (3.2) describes a simple accelerator mechanism according to which firms invest (in accordance with the capital-output ratio, v) in response to changes in output – that is, in order to meet the needs of production.[23] Equation (3.3), in which depreciation is ignored for the sake of simplicity, shows how this investment translates into new capital capacity. In the present context, equations (3.2) and (3.3) forge a link between the demand-side of the economy (which is responsible for determining real output, Y, at any point in time), and the process of capital formation which, under the alternative solution to (3.1), ultimately determines the economy's supply constraint on productive activity. Substituting (3.3) into (3.2) yields:

$$\Delta K_c = vyY$$

Recalling that $v = K_u/Y = K_c/Y_p$, this last expression can be written as:

$$\hat{K}_c = \frac{K_u}{K_c} y$$

$$\Rightarrow y_p = uy \tag{3.4}$$

23. See Palumbo (2009, pp. 350–351 and 355–359) for further discussion of the accelerator principle in Kaldor's analyses of growth and cycles.

since $y_p = \hat{K}_c$ by hypothesis. The expression in equation (3.4) is analogous to that in equation (2.4) insofar as it describes an endogenous potential rate of growth, but this time in the context of a capital-constrained (rather than labour-constrained) economy.

Suppose now that we assume that $u < 1$ in the course of growth. Then it follows from (3.4) that $dy_p = udy < dy$, so that, following the increase in the actual rate of growth in period t depicted in Figure 4, potential output will follow the path denoted $\text{PGDP}_{u<1}$. It is clear from the depiction of this potential output path in Figure 4 that beyond period t, the AGDP path is once again unsustainable. Because the increase in the actual rate of growth exceeds the induced increase in the potential rate of growth, so that $y > y_p$ after period t, then, as in the case where $\hat{K}_c$ is taken as exogenously given, a secular trend in the rate of capacity utilization will emerge. Reconciliation mechanisms capable of aligning y and y_p are therefore required in order for the underlying growth model to make sense as a description of steady-state growth outcomes. What this analysis demonstrates is that, as in the case of the labour-constrained economy that is the (implicit) focus of the Palley/Setterfield models, simply positing that the dynamics of the supply side are responsive to variations in the actual rate of growth (as in equation (3.4)) does not suffice to ensure *sufficient* supply-side accommodation of the demand side to warrant neglect of the potential emergence of a supply-side constraint on growth.

Note, however, that if $u = 1$, $dy_p = dy$ so that following the increase in the actual rate of growth in period t, potential output will now follow the path denoted $\text{PGDP}_{u=1}$ in Figure 4. In this case, any change in the demand-determined actual rate of growth will be accompanied by an equivalent change in the potential rate of growth, so that we will continue to observe $y = y_p$ (as illustrated by the fact that $\text{PGDP}_{u=1}$ is parallel to AGDP in Figure 4) and hence a constant rate of capacity utilization. The demand side is now fully accommodated by the supply side and there is no independent supply constraint on growth (*à la* McCombie). However, this situation only arises as a special case ($u = 1$) that, in the context of a long-run growth model, must be considered highly unrealistic. In the US, for example, although the rate of capacity utilization is highly volatile, its mean value over the past 3 decades has been approximately 80 per cent.[24]

Moreover, note that even if we start with $y_p = K_c/v$ in equation (3.1) and assume *both* the applicability of equation (3.4) *and* that $u = 1$, a capital-constrained economy can transform into a labour-constrained economy with the result that, unless it is *also* the case that either $\beta = 1$ or $n = \gamma + \delta y$ and $\beta = 1 - \delta$ (the special cases of equation (2.4) discussed earlier), the need for Palley/Setterfield-type reconciliation mechanisms to align y and y_p will re-emerge.[25] This is illustrated in Figure 5, where, consistent with the alternative solution to equation (3.1) (and hence $y_p = \hat{K}_c$) and the assumption that $u = 1$, the initial path of potential output is depicted as $\text{PGDP}_{u=1}$. In period t, an increase in the actual rate of growth raises both $y_p = \hat{K}_c$ *and* $y_p = \alpha + n + \beta y$ consistent with the assumptions that $u = 1$ and $0 < \beta < 1$. In and of itself, the increase in $y_p = \hat{K}_c$ of equivalent size to the hypothesized increase in y may appear to obviate the need to consider the emergence of a supply constraint on long-run growth. But, as is clear from Figure 5, by period $t + k$, the economy is labour-constrained: the potential output path of the economy is thereafter described by PGDP, which is associated with $y_p = \alpha + n + \beta y$. And as a

24. Author's calculations based on Federal Reserve Board data, 1986–2009.

25. Of course, we could also postulate an initially labour-constrained economy where either $\beta = 1$ or $n = \gamma + \delta y$ and $\beta = 1 - \delta$ that is subsequently transformed into a capital-constrained economy where, if $u < 1$, we will arrive at the same conclusions as those reached in the text. This exercise is left to the reader.

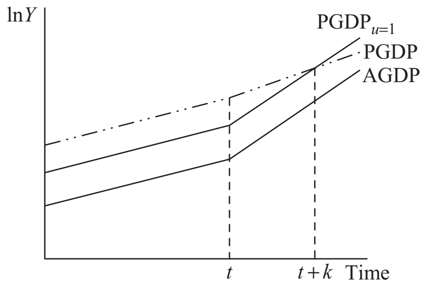


Figure 5 Switching between supply constraints in the course of growth

result of this, the AGDP path depicted in Figure 5 is now clearly unsustainable. Once again, we need Palley/Setterfield-type reconciliation mechanisms to align y and y_p if the underlying model is to make sense as a description of long-run, steady-state growth outcomes. The point that emerges from this analysis is that, ultimately, *both* special cases relating to the responsiveness of supply conditions to the demand side (that is, *both* $u = 1$ in equation (3.4) *and* either $\beta = 1$ or $n = \gamma + \delta y$ and $\beta = 1 - \delta$ in equation (2.4)) must apply in order for us to safely ignore the emergence of a potential supply constraint on steady-state, demand-led growth.

4 CONCLUSIONS

The purpose of this paper has been to reassess the emphasis that Palley (2002) and Setterfield (2006) place on reconciling the actual and potential rates of growth in Kaldorian growth models, in light of McCombie's (2011) objections that these exercises are a distraction, and that only the demand side creates a binding constraint on growth in Kaldorian macrodynamics. Our investigation has revealed that there are problems with the Palley/Setterfield models. In the first place, these models provide no explicit account of the structure of the supply side, from which the potential output constraint with which they are concerned can be shown to emerge. Second, and in part by virtue of the first problem, the Palley/Setterfield models suffer certain errors of omission, providing an incomplete account of the dynamics of potential output.

By beginning with an explicit model of the supply side, the analysis in this paper overcomes these problems. In so doing, it furnishes a better understanding of whether (and how) the supply side can ultimately constrain demand-led Kaldorian macrodynamics, and hence whether or not there is a need for Palley/Setterfield-type reconciliation mechanisms that align the actual and potential rates of growth. Our results show that it *is* possible that even a mature Kaldorian economy will *not* confront a binding supply constraint on growth. But this is not likely: the results arise only as special cases; there is little reason to believe that any of these special cases are applicable in practice; and, despite this last observation, more than one of the special cases must hold simultaneously in order for potential supply constraints to be safely ignored. The conclusion, therefore, is that Kaldorians need to take the supply side seriously. Specifically, they need to consider carefully what mechanisms capable of reconciling the actual and potential rates of growth might be operative if their demand-led growth models are to provide plausible descriptions of steady-state growth outcomes in mature economies.

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