Supply and demand in Kaldorian growth models: a proposal for dynamic adjustment

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Abstract

This paper analyses the dynamic adjustment of supply and demand in Kaldorian growth models. We discuss how the growth rate of a country, given by demand constraints, adjusts towards the growth rate given by the supply-side, and vice-versa, presenting the necessary conditions and empirical plausibility for these adjustments. The Palley-Setterfield approach brings a possible reconciliation to supply- and demand- long-term growth rates. However, this approach have some important empirical drawbacks, and we raise many considerations about the labour market in order to capture their analysis in a common framework. In this sense, we draw from the criticism developed by McCombie, and synthetize his view in terms of complete endogeneity, in a way in which employment adjusts immediately to guarantee equilibrium between supply and demand. The main contribution of the paper is to propose a theoretical reconciliation between the Palley-Setterfield and the McCombie approaches, presenting an initially simple model focused in a labour market adjustment, in which both types of adjustments represent extreme cases. We also discuss the theoretical possibility and the characteristics of hysteresis effects that lead to intermediate cases.

Keywords: economic adjustment, demand-led growth, natural rate of growth, Kaldorian growth models

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1. Introduction

The Harrod-Domar model was the first contemporary macroeconomic model that explicitly provided a theory for economic growth. It focused on defining the investment and saving growth rates capable of maintaining a growing economy in equilibrium - analysing the determinants of the divergence between supply and demand. This canonical model, however, could not offer an explicit adjustment mechanism for this divergence. The first Harrod problem (Harrod, 1939) resulted in the emergence of distinct traditions trying to propose answers to this question (Blecker and Setterfield, 2019).

In neoclassical and endogenous growth models, countries' long term growth were explained by the supply factors (rate of growth of population and labour productivity), as demand automatically adjusts to supply via Say's law. Post-Keynesian growth models (Blecker & Setterfield, 2019; Harcourt & Kriesler, 2013), on the other hand, relying on the effective demand theory, have stressed the central role of demand on explaining the differences between countries' growth rates. According to Kaldor (1966), although some changes in demand have their origin on changes in supply, the prominence is on the demand side, and it is mainly supply that adjusts to demand. Countries' growth rates are then primarily governed by the growth of effective demand, and not by resource constraints. From the Post-Keynesian perspective, growth is constrained by demand, and its growth rate may be different from the natural rate. In the long-run, however, those growth rates need to converge in order to avoid an ever-growing excess of capacity. Three-quarters of century since Harrod first published his paper on the dynamics of supply and demand, there is still no consensus on the central drivers of economic growth (Fazzari *et al.*, 2020).

The aim of this paper is to analyse this dynamic adjustment of supply and demand based on Kaldorian supply and demand models, using the recent literature published on this topic (Blecker, 2013; McCombie, 2011; Palley, 2003; Setterfield, 2006, 2011, 2013). By assuming a monopolistic economy, where firms invest to maintain a constant level of capital utilization, capital constraints do not emerge. However, depending on specific conditions, an economy may face labour constraints, and thus we need an adjustment mechanism in the labour market.

The contribution of this paper is twofold: first, to organize the recent literature on the adjustments between supply and demand Kaldordian models in a unified framework. We explicitly model the behaviour of labour supply and labour demand in the adjustment, as the determinants of a stable employment dynamics. Second, we propose the introduction of a simple general theoretical model, that does not only deal with the different streams of the debate (Palley-Setterfield and McCombie), but also represents possible intermediate adjustments.

The paper is divided in five sections. After this introduction, Section 2 presents the macro-dynamics of supply and demand adjustments based on the Palley-Setterfield controversy (Palley, 2003; Setterfield, 2006), and on McCombie's (2011) critique. Section 3 presents Setterfield (2013) argument for the need of a supply-side for Kaldorian growth models, highlighting the importance of capital and labour constraints. Section 4 presents an alternative approach for the adjustment mechanisms based on McCombie's (2011) critique and Setterfield's (2013) argument, as well as the necessary conditions a reconciliation of supply and demand. Finally, we conclude the paper on Section 5.

2. The macro-dynamics of supply and demand

In the long run, the growth rate of demand and the growth rate of supply have to converge. The supply side is given by natural growth rate, which is the summation of the growth of the labour force and the growth of labour productivity. However, different from Harrod's version, this rate of growth, from a Kaldorian perspective, is endogenous once productivity is determined by output growth based on the Kaldor-Verdoorn law (Kaldor, 1961; Verdoorn, 2002), which means that there is one natural growth rate for each given demand growth rate:

$$y_N = n + p = n + \lambda + vy \tag{2.1}$$

where y_N and y are, respectively, the natural and actual growth rates, n is the labour force growth rate, and p is the growth rate of productivity. Productivity follows the Kaldor-Verdoorn law, in which λ is the exogenous technical change, and v is the Verdoorn's coefficient (the sensibility of productivity growth to actual growth rate).

Following Palley (2003), demand is constrained by the rate of growth compatible with stability in the balance of payments. From the Balance-of-Payment Constrained Growth (BPCG) model, we have that the demand rate, which defines the actual growth rate, is given by Thirlwall's law (Thirlwall, 1979)[3]:

$$y = y_B = \frac{\varepsilon}{\pi} z \tag{2.2}$$

where y_B is the BPCG rate, ε and π are the income elasticities of demand for exports and imports, respectively, and z is the world growth rate.

Following the first Harrod problem, we do not have an explicit convergence mechanism for the equilibrium between supply and demand ($y_N = y_B$), as the model is over-determined. Given the world growth, the income elasticities, the Verdoorn coefficient, the exogenous technological change and the labour force growth, the only way to supply and demand to converge is when:

$$\frac{n + \lambda}{1 - v} = \frac{\varepsilon}{\pi} z \tag{2.3}$$

[3] Although the effective growth rate should be given by the sum of the aggregate demand macroeconomic variables, we follow Palley (2003) and Setterfield (2006, 2011) in using the Thirlwall's law equation for the actual growth rate (direct convergence in $y \to y_B$). In the long-run, the actual growth rate needs to converge to the rate compatible with balance-of-payments constraints, otherwise the economy goes out of bounds in terms of its net exports (see Porcile & Spinola, 2018).

but there is no reason to believe that all of these exogenous variables assume values that guarantee this equality.

In order to solve the over-determination, Palley (2003) adds an extra equation, arguing that the income elasticity of demand for imports is negatively related to the excess of capacity utilization. “imports are driven by bottlenecks” (p. 80)[4]. Hence:

$$\pi = \pi(E), \pi' > 0 \tag{2.4}$$

where E is defined as the degree of resources utilization (labour or capital).

Palley’s adjustment argues that a firm’s investment plans are such that the growth of demand is initially at the BPCG rate, in a “unique” natural rate of growth. If firms increase their capacity below a threshold level, resources utilisation falls, leading to a fall in the long-run income elasticity of demand for imports. This increases the BPCG rate (π falls), and hence, in Palley’s adjustment the growth rate of the economy is determined by the natural rate, which is only partially endogenous to demand growth (due to Verdoorn’s coefficient), characterising a *quasi-supply-determined growth*.[5]

Setterfield (2006) provides another mechanism (closure) to solve the over-determination problem. Setterfield argues that the elasticity of productivity in relation to output (the Verdoorn coefficient) is a positive function of resources utilisation. The natural growth rate is then endogenous to actual growth rate:

$$v = v(E), v' > 0 \tag{2.5}$$

The *rationale* is the following: learning by doing processes result that the rate of economic activity induces productivity growth, affecting the Verdoorn’s coefficient (v). If the level of demand is low relative to the full capacity utilization, then firms will be less likely to engage in technical change, reducing productivity gains. In Setterfield (2006)’s adjustment, the economy has a *fully-demand-determined growth* pattern.

Palley (2003) and Setterfield (2006) rely on the idea that short-run effects (resource utilizarion) may affect either the income elasticities or the Verdoorn coefficient.

McCombie (2011) offers a critique to the Palley (2003) and Setterfield (2006) approaches. In his perspective, short-run income elasticities may change due to short-run cyclical effect, but they are constant stable structural variables in the long-run. In the long-run, income elasticities of demand for imports do not change due to fluctuations in resources utilization. Furthermore, McCombie (2011) argues that the growth rates of labour force (n) and technical change (λ) are also endogenous to the capacity utilization, which means that there is no unique rate of growth

[4] Evidence for the Palley mechanism can be found since White and Thirlwall (1974).

[5] When the rate of growth of a country runs into capacity constraints, there is increased expenditure on imports, which is caused by the lack of availability of domestically import-competing goods.

associated with a stable rate of unemployment. Growth rate is then always balance-of-payment constrained (demand-determined) even if the Verdoorn's coefficient is not endogenous.

$$n'(E) > 0, \lambda'(E) > 0 \tag{2.6}$$

Cornwall (1977) argue that "employment patterns were demand determined in the various market economies in the post-war period", and "when entrepreneurs in the manufacturing sectors of different economies wanted labour they found it one way or another" (p.95). Thereby he argues that the supply of labour is endogenous to output growth, in which migration is an important mechanism to attract workers from different regions. The economic benefit of migration is also discussed by Borjas (1995).

Based on Cornwall (1977), McCombie (2011) argues that even mature economies have an elastic labour force. He also argues that technical progress is stimulated by the increase in the degree of capacity utilization due to a great number of factors, such as an increase of R&D expenses and investments in more productive capital. Thereby, according to him, countries are not supply constrained, but balance-of-payment constrained.

In other words, if labour force and technological change are completely endogenous[6] to the degree of capacity utilization, the supply side does not constraint growth (completely accommodated by demand shocks), and thus the economy is demand-driven. Some studies, such as León-Ledesma & Lanzafame (2010), León-Ledesma & Thirlwall (2012) and Lanzafame (2014), have investigated the relationship between the BPCG and the natural growth rates, and found unidirectional causality from the BPCG rate to the natural growth rate. More recently, Cordeiro & Romero (2021) presented evidence that the potential rate of growth adjusts towards the demand growth rate arguing that the increase of resource utilization have a positive effect on productivity, but no effect on the volume of imports.

3. Capital and labour constraints: necessary conditions for reconciliation

In a next step of the debate, Setterfield (2013) argues that McCombie (2011)'s critique to the Palley-Setterfield approach is based on the assumption that the actual rate of growth is always bellow its potential, being unconstrained by capital or by labour. That, however, only happens under very specific conditions. In order to explain those conditions, Setterfield (2013) uses an explicit description of the supply side. First, the potential growth rate is given by a Leontief production function:

[6] It is important to mention the distinction between 'partial endogeneity' and 'complete endogeneity'. When there is a 'partial endogeneity', potential output growth is merely endogenous to actual output growth (as we see in eq. 2.1), while in the model that we will later describe in McCombie (2011), we have 'complete endogeneity' (McCombie model). Cornwall (1972) argues that complete endogeneity is a particular case that needs to be taken into account under some specific conditions.

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

where Y_P is the potential growth rate, L_c is the labour available, K_c is the capital available, a is the potential labour output ratio, and b is the potential capital-output ratio.

In this type of production functions, two possible constraints emerge. First, a labour constraint, if the actual rate of growth is higher than the growth rate of $\frac{L_c}{a}$. Second, a capital constraint, if the economy grows faster than $\frac{K_c}{b}$.

Labour constrained economy

The labour constraints is described from the first part of Leontief function (3.1). In growth rates:

$$Y_P = \frac{L_c}{a} \rightarrow y_P = n - \hat{a} \tag{3.2}$$

Two channels in which the actual growth rates affect y_P can be observed. First, the abovementioned Verdoorn's law:

$$-\hat{a} \equiv q = \lambda + \nu\, y \tag{3.3}$$

in which $\hat{a}$ is the growth of labour-output ratio.

Second, the total available labour force (n) is endogenous to the output growth, such as argued by McCombie (2011):

$$n = \gamma + \delta y \tag{3.4}$$

where γ is the exogenous growth of labour, and δ is the labour-elasticity to output.

Hence, growth rate of potential output can be written as the sum of a linear function of exogenous technical change-labour force growth, and endogenous technical change-labour force growth:

$$y_P = \gamma + \lambda + (\delta + \nu)y \tag{3.5}$$

The impact of an increase of the actual rate of growth (which is given by the demand side) impacts the labour side of potential growth rate as follows:

$$\frac{d(y_P)}{d(y)} = \delta + \nu \tag{3.6}$$

Based on this relationship, Setterfield (2013) concludes that there is only one specific case in which the economy does not face a labour constraint: $\delta + \nu = 1$. In this case, y_P and y grow at the same rate not only in the long run, but also in the short run. However, if $\delta + \nu < 1$, then the economy faces labour constraints, which requires a reconciliation between supply and demand.

The value of δ is the labour supply elasticity to output, and ν is the Verdoorn's coefficient. Most of the empirical studies that estimate the Verdoorn's coefficient found values between 0 and 1 (as discussed by Basu & Badhiraja, 2020). Magacho & McCombie (2017; 2018), for example, discuss the empirical validity of the Kaldor-Verdoorn law, which states that this coefficient is positive. The authors conclude that, from a demand-side perspective, this value is around 0.5, even though it varies from sectors and according to countries' stage of development. Therefore, from Setterfied's (2013) perspective, the labour supply elasticity to output should have a value of around 0.5 for growth to be *fully-demand determined.*

Capital constrained economy

Setterfield (2013) also presents the necessary conditions for having a capital constraint in the economy:

$$Y_P = \frac{K_c}{b} \rightarrow y_P = \widehat{K_c} - \hat{b} \tag{3.7}$$

According to Kaldor (1961), the capital-output ratio (b) is constant in the long run. Consequently, there is only one possible response for a faster growth in y_P, which is a faster growth of capital accumulation. Hence, potential output growth rate can be described as:

$$y_P = \widehat{K_c} \tag{3.8}$$

Setterfield (2013) adds an investment function based on a simple accelerator mechanism:

$$\Delta K_c = I = b\,\Delta Y = byY \tag{3.9}$$

There is no depreciation, and thus growth of capital equals investment. Moreover, given a constant capital-output ratio, investment is determined uniquely by the growth of output, and hence we have:

$$b = \frac{K_u}{Y} = \frac{K_c}{Y_P} \tag{3.10}$$

and

$$u = \frac{Y}{Y_P} = \frac{K_u}{K_c} \tag{3.11}$$

where u is the degree of capital capacity utilization, and K_u the capital employed.

The rate of growth of potential product can be written as:

$$y_P = \widehat{K_c} = \frac{\Delta K_c}{K_c} = b\, y \frac{Y}{K_c} = \frac{K_u}{Y} y \frac{Y}{K_c} = u\, y \tag{3.12}$$

Analogous to the analysis of labour constraints, the impact of a faster growth of the actual rate of growth on the growth rate of potential output is:

$$\frac{d(y_P)}{d(y)} = u \Rightarrow d(y_P) = u\, d(y) \tag{3.13}$$

The only way potential and actual outputs grow at the same rate is when $u = 1$, which is a specific and heroic assumption. Thereby, based on capital and labour constraints, the demand side is fully accommodated by the supply side only under the specific case where $u = 1$ and $(\delta + v) = 1$. Consequently the need for a reconciliation between supply and demand based on Palley-Setterfield mechanisms re-emerges.

3.1. Capital constraints in monopolistic economies

In a monopolistic economy, capitalists aim to keep the degree of capital utilization unchanged[7]. This behaviour leads the growth rate of Y_P being equal to the growth rate of demand, a situation in which there are no capital constraints. In a more detailed explanation, based on the assumption that b is constant (Kaldor, 1961) and that there is no depreciation:

$$I = \Delta K_c = b\, \Delta Y_P \tag{3.14}$$

[7] Empirical evidences, as presented in Caiani et al. (2016), show that firms aim for normal rates of utilization. Lavoie (2014) offers a survey on the topic.

Once $u = \frac{Y}{Y_P}$, we can write investment in terms of capacity utilization:

$$I = b\left(Y_P - Y_{P_{-1}}\right) = b\left(\frac{Y}{u} - \frac{Y_{-1}}{u_{-1}}\right) \tag{3.15}$$

Investment here is a function of output, as stressed by Setterfield (2013), but also of the degree of capacity utilization, as we assume that capitalists invest to keep the degree of capacity utilization unchanged. The investment function can then be written as[8]:

$$\Delta K_c = I = b\,\frac{\Delta Y}{u} = \frac{b}{u} yY \tag{3.16}$$

This equation is very similar to Setterfield's (2013) accelerator mechanism, but the degree of capacity utilization keeps unchanged. The growth of potential output is given by:

$$y_P = \widehat{K_c} = \frac{\Delta K_c}{K_c} = \frac{b}{u} y \frac{Y}{K_c} = \frac{K_u yY}{uYK_c} = y \tag{3.17}$$

which means that $d(y_P)$= $d(y)$.

Thereby, when investment is oriented to keep the degree of capacity utilization unchanged, <u>there is no capital constraint</u>[9]. The previous result was a result of the sole static accelerator mechanism. Once we assume that investment is a function both of demand growth and the degree of capacity utilization, the supply side will be fully accommodated by the demand side even if $u < 1$.

4. General model: a reconciliation

In a monopolistic economy, where capital supply is *fully*-endogenous to demand growth (when we do not have funding constraints), all demand for capital is fulfilled by its supply. Thereby, there are no capital constrains. Nevertheless, labour constraints may still emerge, and one need to present a reconciliation between supply and demand.

In order to address the reconciliation between growth rates under labour constraints, we propose a review of the debate. We then propose a general model addressing all the contributions - Palley

[8] It does not mean that capacity utilization keeps unchanged. The assumption is that investment is made trying to keep it unchanged. However, it may vary due to many factors, including a faster demand growth or investors' difficulties to find funding for their investment.

[9] We are not neglecting here that capital constraints will never emerge. Countries can have funding problems both domestically and internationally. However, these capital constraints do not emerge from Setterfield's (2013) critique if firms invest to maintain a constant level of capital utilization.

(2003), Setterfield (2006), McCombie (2011), and Setterfield (2013). Our central interpretation is that the McCombie's (2011) critique is, in its core, not about the hypothesis that income-elasticity of demand for imports or Verdoorn's coefficient respond to the rate of capacity utilization. Instead, it is on how Palley (2003) and Setterfield (2006) do not address some specific factors that respond to actual output growth in the labour market.

We start our revision of the theory by writing the basic equations of the Kaldorian model considering the Palley and Setterfield mechanisms (π and v). In our formulation we implement linear representations for $\pi = \pi(E)$ and $v = v(E)$, for the sake of simplification:

$$y_B = \frac{\varepsilon}{\pi_0 + \pi_1 E} z \tag{4.1}$$

$$y_N = n + \lambda + (v_0 + v_1 E)y \tag{4.2}$$

where π_0 is the exogenous component of the income-elasticity of demand for imports, π_1 is the sensitivity of the income-elasticity of demand for imports to the capacity utilization (Palley effect[10]), E is employment, v_0 is the exogenous component of the Verdoorn coefficient, v_1 is the sensitivity of the Verdoorn coefficient to the capacity utilization (Setterfield effect). Since we are only dealing with labour constraints, we define E it as the degree of labour utilization.

Employment rate (E) is given by the ratio of effectively absorbed labour (L) and the supply of labour (N).

$$E = \frac{L}{N} \tag{4.3}$$

or, in terms of growth rates,

$$e = l - n \tag{4.3b}$$

Where the lower cases represent the (log-derived) growth rates.

Equation (4.3b) defines the dynamic adjustment of supply and demand. Rather than using the approach presented in Section 2, which is based on the relation between E and y, in this section we analyse the dynamics of e.

4.1. Revisiting the Palley-Setterfield debate in light of the Labour market

[10] The reasonings behind the impact of employment on the *income elasticity of demand for imports* have some supply and some demand elements. On the supply side, employment constraints increase unit labour costs, and this price effect makes domestic production more expensive than imported goods, which leads to a higher income elasticity of demand for imports (a substitution effect). On the demand side, a lower unemployment increases consumption (assuming a higher workers' propensity to consume), resulting in a higher demand for both local and imported products (income effect).

For both Palley (2003) and Setterfield (2006) it is implicit that the labour supply is not sensitive to the rate of capacity utilization. In dual economies *à la* Lewis (1954), however, traditional sectors act as a reservoir of labour force for the more productive sectors, and hence these advanced sectors face a elastic supply labour force (McCombie & Thirlwall, 1994). As countries reach most advanced stages of development, the surplus labour from traditional sectors is exhausted, and the supply of labour moves toward a more inelastic pattern.

Following this idea, we first consider a full inelasticity hypothesis, in which the labour supply (n) is constant, given by an exogenous component (n_0) (exogenous population growth):

$$n = n_0 \tag{4.4}$$

We first examine the dynamics of the effectively employment of labour (l). The higher is the actual growth rate (y), the more it demands labour, increasing the growth rate of labour effectively employed. Given that productivity is endogenous to output growth, it also increases the natural rate of growth (y_n), which reduces the demand for labour (given productivity gains) The growth rate of the labour force effectively employed is given by:

$$l = \phi(y - y_N) + n \tag{4.5}$$

ϕ is the speed of the adjustment mechanism.

As McCombie (2011) highlights, the identity in which $p = y - l$, where p is the productivity growth, must be valid, since productivity is defined as the output-labour ratio. Because actual growth rate (y) is the summation of productivity growth (p) and employment growth (l), in order to have this identity, ϕ must be equal to one. Replacing equation (4.2) in (4.5a), and considering that $\phi = 1$:

$$l = -\lambda + (1 - v_0 - v_1 E)y \tag{4.5b}$$

Equations (4.4) and (4.5b) provide the system that gives the adjustments of the model, determining the growth of the employment rate (e). By assuming $y_B = y$, equations (4.1), (4.2), (4.3b), (4.4) and (4.5b) are enough to solve the Palley-Setterfield version of our model.

Figure 4.1 presents two graphs. The upper one shows the demand (and effective) growth rate, given by the BPCG. Given z and the elasticities ratio, we determine y, following Thirlwall's law. The lower graph shows l, n as a function of y, and the difference between l and n gives us e. In this case, the supply of labour is entirely inelastic to y ($n = n_0$), and hence it is a horizontal line. It means that variations in the actual growth rate do not affect the labour supply since it is exogenously given. Labour effectively employed, on the other hand, is positively related to output growth[11].

When the world output growth (z) is given by z_0, the economy finds itself in equilibrium, since labour effectively employed is equal to labour supply ($l = n$), resulting in $e = 0$ (stable employment). In this case, the growth rate of the economy (y_0), given by the elasticities ratio and the world growth, is the one that guarantees that labour supply and labour effectively employed in the economy grow at the same rate. This situation is the one presented in Equation (2.3), where the exogenous variables of the over-determined system of equations assumes the exact value needed for the stability.

Figure 4.1 around here

However, as one can see in Figure 4.1, an adjustment is necessary whenever the world output growth is different than z_0. If the economy finds itself in a position in which $z_1 > z_0$, the actual growth rate will increase (due to Thirlwall's law), and hence the growth of labour force effectively employed will be higher than the growth of labour supply. Since initially nothing guarantees that $-\lambda + (1 - v)y = n_0$, the natural and the actual growth rates will differ, which may lead to instability. Employment rate (E) changes in time since there is a gap between labour effectively employed and labour supply, once e is positive, as $l > n$.

Based on the Palley-Setterfield adjustment mechanisms, when $e \neq 0$, the Verdoorn coefficient and/or the income-elasticity of demand for imports change. As can be seen from Figure 4.2, these movements serve as adjustment mechanisms, changing the actual growth rate (y).

Figure 4.2 around here

The cases presented in Figure 4.2 are those proposed by Setterfield (2006) (left part) and Palley (2003) (right part of the figure). In the Setterfield adjustment, whenever $e > 0$, the employment rate increases, and the Verdoorn coefficient grows from v to v'. The curve of the labour effectively employed labour growth rotates clockwise, resulting in a new equilibrium, with higher actual growth rate. In this case, demand fully accommodates supply, and the growth rate of an economy is *fully-demand determined.*

In the Palley case, when $e > 0$, the income-elasticity of demand for imports increases from π to π'. Here, there is no change in the effective labour growth curve. Instead, the actual growth rate reduces towards a new equilibrium (the elasticities ratio curve will move anti-clockwise). In this case, supply fully accommodates demand, and hence the growth rate of an economy is *partially-supply determined.*

[11] If Verdoorn coefficient is lower than one ($v < 1$).

4.2. Revisiting the McCombie adjustment

According to McCombie (2011), the Palley-Setterfield (Palley, 2003; Setterfield, 2006) adjustment ignores that both labour supply and technological progress are endogenous to the rate of capacity utilization, and hence to the actual output growth. Based on Cornwall (1977), who argues that, even in advanced economies, the supply of labour may be elastic to wage and output growth, McCombie argues that the supply of labour is endogenous to output growth. Moreover, technical progress is stimulated by the increase in the degree of capacity utilization due to a great number of factors, such as an increase of R&D expenses and investments in more productive capital. However, as the Verdoorn coefficient is already considering the impacts output growth on technological change,[12] we focus entirely on the impact of actual output growth on labour supply.

However, and our main contribution resides here: how long does the short-run takes to adjust to the long-run? If capacity utilization takes time to return to its original level (or, as argued by Setterfield (2019), it presents long-term variations within a range), countries structural changes can take place during this adjustment period, and it would allow for partial Palley-Setterfield adjustments.

Based on McCombie's critique, we assume that the supply of labour responds to output growth, guaranteeing that the natural rate of growth will not differ. This assumption implies that $y_N = y$, and that the adjustment is entirely done on the growth rate of labour supply (n). It implies no gap between labour supply and employment, maintaining the employment rate constant. Once $p = y - l$, and that the productivity is given by Verdoorn's law, $p = \lambda + vy$, we replace equation (4.1) in this identity. Therefore, if $y_N = y$, then:

$$n = l \tag{4.6}$$

Once the natural rate of growth is defined by (4.1), and the actual output growth is defined by the BPCG rate, which is given by (4.2), then we have that always $y_B = y = y_N$. Labour supply is thus given by:

$$n = (1 - v)\frac{\varepsilon}{\pi}z - \lambda \tag{4.7}$$

where π and v are constant since e is always equal to zero, and hence $E = E^*$.

[12] It is possible to consider it more precisely by including a term in the productivity that accounts for deviation from capacity utilization, $p = \lambda + vy + c(y - y_N)$. It is important to avoid that rather than measuring the Verdoorn coefficient, we could be measuring Okun's law (Magacho & McCombie, 2017). However, for simplicity we will ignore it here.

Since E is fixed, the model is always stable. Assuming equation (4.6) ($n = l$), as $e = 0$, E^* is thus give by:

$$E^* = \frac{(1 - v_0)\varepsilon - \pi_0(\lambda + l)}{v_1\varepsilon + \pi_1(\lambda + l)} \tag{4.8}$$

In graphical terms, the labour supply growth curve coincides with the labour effectively employed growth curve. In Figure 4.3 we see that the economy is always in equilibrium (immediate adjustment, as the natural and actual growth rates do not diverge). In this case, again, supply accommodates to demand, and the growth rate of an economy is *fully-demand determined*.

Figure 4.3 around here

4.3. General reconciliation proposal

Although the results of the adjustments presented in the previous sections are structurally different – in McCombie's approach it is always the natural growth rate that adjusts towards the BPCG rate, whilst in Palley-Setterfield approach both results are possible – the models are very similar in terms of their required equations, which opens the space to make them compatible. The core difference resides in the determination of labour supply (n), which is endogenous to McCombie (2011) and exogenous in Palley (2003) and Setterfield (2006). Equations (4.1), (4.2), (4.3b) and (4.5b) are valid in both views. Thereby, for the reconciliation, we define an equation for labour supply that encompasses the different approaches.

If one assumes that income-elasticity of labour supply is linear, such as in Setterfield (2013), both approaches can be summarized by:

$$n = \gamma + \delta y \tag{4.9}$$

$\gamma = n(0)$ and $\delta = dn(y)/dy$.

Palley (2003) and Settefield (2006) assume that labour supply is constant and equal to n_0, which results in $n(0) = n_0$ and $dn(y)/dy = 0$. McCombie (2011), however, assumes that labour supply adjusts to labour demand, and hence $\gamma = n(0) = -\lambda$ and $\delta = dn(y)/dy = (1 - v)$. In terms of the labour supply and employment growth diagram, the discussion becomes about the intercept and the slope of the labour supply curve.

Equation (4.9) replaces equations (4.4) and equation (4.7), and γ and δ define whether the McCombie's approach or Palley-Setterfield approach are valid. Replacing (4.12), (4.3b) and (4.5b) in $\dot{E} = Ee$, given by the definition of $e = l - n$, then:

$$\dot{E} = E[(1 - v_0 - v_1 E)y - \lambda - \gamma - \delta y] \quad (4.10)$$

If one assumes that actual output growth is equal to long-term demand growth ($y = y_B$), equations (4.1) and (4.2) and (4.10) are enough to define the general model, which encompasses all different approaches. The values of δ and γ also impacts the employment equilibrium value, which is given by:

$$E^* = \frac{(1-v_0)\, \varepsilon z - \delta \varepsilon z - (\lambda+\gamma)\pi_0}{(\lambda \pi_1 + \gamma \pi_1 + v_1 \varepsilon z)} \quad (4.11)$$

Equation (4.9) is interesting as it also allows us to represent intermediate cases (which would depend on how long the adjustment takes to occur), in which neither labour supply is exogenous, nor it is completely endogenous to its demand. The intermediate cases can on one hand be in line with evidences of endogeneity (see McCombie and Thirlwall (1994) for a discussion on that), but also it does not require a complete endogeneity, as argued by McCombie (2011).

Figure 4.4 presents both Setterfield (2006) and Palley (2003) adjustments in this intermediate case. In the left-hand case, where the Verdoorn coefficient is the adjustment variable, long-term growth rate is fully-demand determined. This adjustment is very similar to the one of Figure 4.2, but labour supply also increases to accommodate its demand, and hence the Verdoorn adjustment does not need to be as large as it was required before. In a nutshell, what makes the regimes different is the speed of adjustment of the labour supply, captured by δ. When there is a fast response, the Palley-Setterfield mechanisms do not occur, and we have the labour supply adjusting in the McCombie case. When it takes more time for the adjustment to occur, then the Verdoorn effect and the effect in the income elasticity of imports change the demand curve, which may result in a quasi-supply determination (especially when the Palley effect is stronger).

Figure 4.4 around here

The main difference resides in the right-hand case, where income elasticity of demand for imports is the variable of adjustment. In this case, if one assumes a demand shock (i.e. in z), a complex process emerges since demand adjusts via changes in elasticities ratio, and supply adjusts via movements in the labour market – and the labour supply will respond positively to the shock.

4.4. Dynamic adjustment in supply and demand in the general case

For better understanding the consequences of the dynamic adjustment for supply and demand proposed here, we present a graphical representation for each of the cases. Figures 4.5 to 4.7 present how this dynamic adjustment takes place, considering different parameter values.

We present nine possible cases. In all cases, the economy is in equilibrium when world growth (z) is equal to 4%. In order to simulate a positive external demand shock we consider $z = 5\%$.[13]

The first group of simulations, presented in Figure 4.5, consider that only the Verdoorn coefficient is endogenous to capacity utilization, as proposed by Setterfield (2006). The three cases in this group differentiate themselves for considering distinct labour supply curves. The blue one considers that labour supply is exogenous (Palley-Setterfield's assumption), the black one considers that labour supply is completely endogenous to its demand (McCombie's assumption), and the red one considers an intermediate case, where it is not exogenous but do not adjusts perfectly to accommodate its demand.

Figure 4.5 around here

As can be seen from the left-hand side of Figure 4.5, output growth is *fully-demand determined* in all cases, as suggested before. The natural rate of growth always converge to the actual growth rate (but in a different paths). In McCombie's (2011) case (black line), where labour demand accommodates labour supply, the adjustment is instantaneous. Thereby we cannot see the black dashed line (which represents the natural growth rate) as it is equal to the solid line (which represents the actual growth). However, as the labour supply became less endogenous (blue line) as the time necessary for the adjustment increases.

The adjustment process can be seen in the labour market dynamics (right-hand side): in McCombie's (2011) case, represented by the black line, labour supply growth is always equal to labour effectively employed growth, and thus there the solid and the dashed lines are coincident. Conversely, if labour supply is exogenous, a demand shock increases labour effectively employed growth, but, as Verdoorn coefficient, increases, employment growth reduces to adjust towards labour supply growth. Not surprisingly, the intermediate case (in red) provides a halfway adjustment: the demand shock will increase labour demand and labour supply, but the effect in the first is higher than in the second. However, as time passes, since actual output growth does not change (all adjustment is in the Verdoorn coefficient), employment growth decreases and adjusts towards the new labour supply growth rate.

Results become more interesting (and less predictable) when there is an adjustment in income elasticity of demand for imports, as suggested by Palley (2003). If one assumes that the Verdoorn coefficient is not endogenous, but we may face with different labour supply schedules, growth can be either *fully-supply* or *fully-demand determined*. As can be seen from Figure 4.6, if one assumes that labour supply is completely endogenous to its demand (McCombie's assumption), growth is fully-

[13] The simulations use the following parameters for all cases: $\varepsilon = 1.5$, $\lambda = 0$, $z = 0.05$. In the first group, $\pi_0 = 1.5$, $\pi_1 = 0$, $v_0 = 0$, $v_1 = 1$; in the second group, $\pi_0 = 1$, $\pi_1 = 1$, $v_0 = 0.5$, $v_1 = 0$; in the third group, $\pi_0 = 1$, $\pi_1 = 1$, $v_0 = 0$, $v_1 = 1$. Within the groups, the following variables are different for the labour supply: in black, $\gamma = 0$, $\delta = 0.5$; in blue, $\gamma = 0.02$, $\delta = 0$; in red, $\gamma = 0.01$, $\delta = 0.25$.

demand determined, since labour supply adjusts instantaneously to it demand, and there is no change in capacity utilization.

In the case of labour supply being not perfectly endogenous (even in intermediate cases), growth in the long run is fully-supply determined. In the other extreme case, where it is exogenous, one could expect this result, since the labour effectively employed growth will have to adjust to labour supply growth as the only adjustment mechanism is the income elasticity, and hence the actual growth rate. Labour effectively employed adjusts towards its supply (which is given), and the economy returns to an equilibrium where the actual growth is independent of demand dynamics.

The intermediate case, however, is the most interesting, bringing new elements to the debate. A demand shock increases both the actual and the natural rate of growth. However, the actual growth rate will be higher than the natural growth rate, once the Verdoorn coefficient is lower than one (the impact of y on y_N is lower than the unity). Labour supply growth is also lower than labour effectively employed, as the adjustment is not complete. This causes employment rate (capacity utilization) to increase, and, consequently, raises the income-elasticity of demand. As a consequence, actual growth rate will decrease, reducing both labour effectively employed and labour supply growth rates. In the long run, when the new equilibrium is reached, growth rate returns to its original state (before the demand shock), which means that the economy is *fully-supply determined* even though labour supply is endogenous.

It is **fundamental** to highlight the time (speed) of the adjustment. The adjustment can take years (many time periods). Moreover, since it takes so long for the adjustment takes place; one could expect that a hysteresis effects could emerge, and the supply side of the economy to be permanently affected (as the effect of changes in capacity utilization affect the supply and demand rates through the Palley-Setterfield mechanisms). A possible impact is an increase in R&D investments and other aspects, changing the exogenous technological change, λ, or the elasticity of labour supply to output (δ), which means that growth can be demand determined in the long run.

Figure 4.6 around here

Finally, the last group we simulate is the one in which both the Verdoorn coefficient and the income elasticity of demand for imports are endogenous to capacity utilization (Figure 4.7). The left-hand graph shows that growth can be fully-demand or partially demand-partially supply determined, depending on parameters. In the extreme case, where McCombie's (2011) adjustment takes place (labour supply is completely endogenous), growth is fully demand-determined, as in all other groups of cases. Conversely, when labour supply is completely exogenous, convergence occurs in an intermediate case, where both demand and supply forces are relevant to explain growth dynamics. In this case, labour supply growth is given, and labour demand adjusts towards it. However, during this process, employment rate (or rate of capacity utilization) rises and both the Verdoorn coefficient and the income elasticity of demand for imports also increases. Consequently, the actual and the natural growth move in opposite directions. The actual growth rate, which had grown due to demand shock, is reduced, whilst the natural growth rate, which had also grown but less than the actual growth rate, increases. In this sense, they will converge to an intermediate case.

The red lines in the right-hand side graph show that a positive shock on demand increases the labour supply, but it is not enough to reach the labour effectively employed. Therefore, employment rate will increase, as well as the Verdoorn coefficient and the import elasticity. This movement has negative impacts on the actual growth rate, and, consequently, labour supply decreases. Labour effectively employed decreases, since Verdoorn is increasing and demand is decreasing. However, it will decrease faster than labour supply growth rate, resulting in convergence. The left-hand graph shows that actual and natural growth rates converge to a higher level than the case where labour supply is exogenous. Growth is then *partially-demand* and *partially-supply* determined. Moreover, the faster the labour supply adjusts to its demand, more growth is demand determined.

Figure 4.7 around here

The value of δ, which measures the labour supply elasticity to output, is a key variable on understanding whether growth is demand or supply determined, such as presented by McCombie (2011) and Setterfield (2013). However, only looking at this variable is not enough to understand the dynamics of supply and demand. With the aim of understanding the dynamic adjustment of actual and natural growth rates, we also need to consider the adjustment issues discussed by Palley (2003) and Setterfield (2006). If labour supply does not adjust completely to its demand, different results emerge from distinct adjustments of the Verdoorn coefficient and the income elasticity of demand for imports. These results are heterogenous not only in terms of the stable equilibrium, but also in terms of the time (speed) needed to reach it.

These three classes of cases summarize each of the possible adjustments we present in the debate. This contributes to the literature, showing different cases for the reconciliation of the debate about the convergence between supply and demand growth rates.

5. Conclusion

In this paper we present the state of the current debate in terms of the convergence between supply and demand in Kaldorian models. We raise the literature on the different adjustment propositions between the natural rate of growth and the effective rate based on the Palley (2003) and Setterfield (2006) debate, the main empirical drawbacks, and McCombie's (2011) critique. We follow the response by Setterfield (2013), and his considerations on growth adjustments under capital and labour constraints. Our contribution accept the vision on labour constraints, but proposes a critique to Setterfield (2013) in terms of capital constraints, showing that there is no need for reconciliation if firms invest to keep the rate of capital utilization unchanged. However, Setterfield's (2013) discussion on labour constraints brings some important elements to the debate, and hence the need for reconciliation, in terms of modelling the labour market.

In order to reconciliate the different perspectives, we analyse the adjustment on employment through the dynamic behaviour of labour supply and effective labour. We propose an interpretation of the labour market, following Setterfield (2013), proposing a general model capable of critically summarizing the Palley-Setterfield (Palley, 2003; Setterfield, 2006) and the McCombie (2011) perspectives, understood as extreme cases of the same general model.

From simulations we found that growth is always *fully-demand determined* when (1) labour supply is completely endogenous to labour demand or (2) if there is no adjustment in income elasticities of import. However, the adjustment processes occurs differently in each of these cases. In the case of a completely endogenous labour supply, all adjustment occurs in n. In the case of exogenous labour supply, all adjustment happens on the Verdoorn coefficient (v). In the intermediate case both variables n and v adjust for the natural growth rates to adjust towards the actual growth rate.

Interesting results emerge when the income elasticity of demand for imports (π) is endogenous. If it is the case and the Verdoorn coefficient is not sensitive to capacity utilization, growth is only *fully-demand determined* if labour supply is completely endogenous to its demand. In all the other cases, growth is *fully-supply determined* in the long run. This result, however, cannot be interpreted without considering the time required for the adjustment. The higher is the sensibility of labour supply to output, the slower is the adjustment. If one considers the parameters used in our simulation, the convergence can take a very long time period. Thereby, one cannot ignore that supply can change substantially during the adjustment process. If, for example, higher actual growth rates increase investment in R&D, other variables can adjust, such as the exogenous technological progress (λ).

Another important result arises when both the Verdoorn coefficient and the import elasticities are endogenous to capacity utilization. The higher is the sensibility of labour supply to output, the more the economy is demand determined. With exogenous labour supply, the economy might be either *partially-demand determined* or *fully-demand determined*, depending on the sensibility of productivity and the volume of imports to factor utilization. Conversely, with completely endogenous labour supply growth, the economy is always *fully-demand determined*.

The baseline model that we propose in this article opens the possibility of different types of expansions. Adding structural change, through changes in the income elasticity ratio (Romero and McCombie, 2016) and in the Verdoorn coefficient (Magacho and McCombie, 2017; 2018) or by considering explicitly dual economies (Skott, 2021) may lead to more complex adjustments, where in some economies may be supply-constrained and others may be demand-led depending on their sectoral structures.

The model, however, has some limitations due its assumptions, which are necessary to focus on the long-run dynamics. We assume demand growth rate as given by the value compatible with countries' balance of payments constraints, and wages grow at the same pace as productivity, which implies an exogenous functional income distribution. Therefore, despite its importance, the distributional cycle debate is not considered. An extension for the model could endogenize income distribution, which might generate hysteresis effects. For that, a Kaleckian short-run regime (Stockhammer & Stehrer, 2011) could be included, with (1) a conflicting claims distribution theory (Kalecki, 1954), and (2) the demand growth rate given by the effective growth rather than by the BPCG rate, as discussed in Porcile & Spinola (2018). Moreover, as we are considering only the long-run aspect of the Thirlwall model, and hence terms of trade are exogenous and fixed. Another interesting extension in the model would be to endogenize terms of trade (Dutt, 2003).

Another assumption of the model is that technical progress is Harrod-neutral, which means that only labour productivity is impacted by technological progress (capital productivity is constant). Even though this is in accordance with most of the Kaldorian literature (Kaldor, 1961), dropping this assumption might have important implications for the results. This could be other important extension of the model, with very relevant consequences for the capital constraint stability, discussed in section 3.1, as it is assumed that the economy is capable of generating the funding necessary to finance its investment needs. In a context of Marx-biased technical change (Foley et al., 2019), for example, this is not necessarily the case, and one need to consider that the model stability is not given only by constraints in the labour market, but also by factors that might affect capital constraints.

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List of Variables

y	Effective growth rate	ε	Income elasticity of demand for exports
y_B	BOP Constrained Growth Rate	π	Income elasticity of demand for imports
y_N	Natural growth rate	π_0	Autonomous part of the income elasticity of demand for imports
E	Employment level	π_1	Sensitivity of the BOP constrained growth rate to the rate of capacity utilization.
e	Employment growth rate	z	Foreign GDP growth rate
N	Total labor supply	v	Kaldor-Verdoorn coefficient
n	Growth of labor supply	v_0	Autonomous part of the Kaldor-Verdoorn coefficient.
L	Total labor demand	v_1	Sensitivity of the Kaldor-Verdoorn coefficient to the rate of capacity utilization.
l	Growth of labor demand	λ	Autonomous productivity growth
δ	Labor-elasticity to output	γ	Exogenous growth of labor
a	Labor-output ratio	b	Capital-output ratio