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On the Separation between Prices and Quantities. A Note on the Interest Rate as an Artifact of Self-Validating Beliefs[1]

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Abstract

Following Aspromourgos' (2007) steps, in this paper we examine the role of the interest rate as a "conventional" variable under different assumptions regarding price and quantity determination, that aim to characterize the reaction functions of Central Banks, represented in standard New Consensus models. More specifically, we lay out a minimal model and suggest a taxonomy that helps examining under which conditions prices and quantities can be determined independently of each other, and whether there is or there is not a unique natural rate of interest consistent with the equilibrium level of output. We argue that the natural rate of interest need not exist even if, as the New Consensus argues, we allow prices and quantities to be somehow connected.

Key Words: Inflation Targeting, Interest Rates, Monetary Theory of Distribution, New Consensus Model.

JEL Codes: E31; E52; E58.

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1. Introduction

Standard macroeconomic theory argues that interest rates are governed by the forces of productivity and thrift. The market interest rate may deviate from its fundamental or "natural" (i.e., consistent with full employment) level in the short run, but the economy gravitates around its unique equilibrium where factors of production are fully employed.

As is well known, a different strand of economic thought inspired by Keynes (1936), argues that interest rates are a monetary phenomenon, whose level need not ensure the full employment of labour. In a recent contribution, Aspromourgos (2007) provided a representative and updated claim that, considering the role of Central Banks that target inflation using a monetary policy rule, captures several of the dissatisfaction of Keynes (and many followers) on how interest rates are determined.

According to Keynes, there is no such thing as a "natural" rate of interest, and contrariwise, whatever interest rate the Central Bank believes is sustainable, becomes the equilibrium. According to the surplus approach, this equilibrium interest rate, in turn, influences the rate of profit and, consequently, the distribution of income between capitalists and workers. This is a key message that is aligned with the so-called "Monetary Theory of Distribution" (Panico, 1988; Pivetti, 1991). In this setting, moreover, the level of output and employment is determined by effective demand, and there is, *a priori*, no clear-cut connection between quantities and prices and distribution.

Following Keynes, Aspromourgos' claims that the Central Bank's beliefs regarding how equilibrium is determined affect how the interest rates are set in practice. Central Banks estimate the natural rate using a combination of statistical tools and judgment, to adjust monetary conditions. The goal is to prevent interest rates from deviating significantly from the natural rate, assuming that those departures may create price and output instability. But the natural rate is not an observable variable, and thus in their attempt to align market rates with the natural rate, Central Banks may create the conditions for the natural rate to emerge. Consequently, if what is deemed to be the natural rate changes (perhaps driven by the method of estimation or the recent data), financial market conditions will change in such a way as to validate the Central Bank's beliefs.

But in their attempts to set financial market conditions, Central Banks should be able to influence the level of aggregate demand. Or at least one should consider the possibility that this is the case. One need not resort on neoclassical kind of arguments to defend such a claim. To the extent that the propensity to consume is different among the social classes, presumably higher for workers, a rise in the interest rate will reduce aggregate demand and hence output. As shown by Dvoskin and Libman (2014) or Levrero (2024), a standard equation with the same structural form as a Taylor Rule can capture the interaction between monetary policy, wage setting and pricing decision by firms, in a way that is consistent with a conflict approach to inflation. Moreover, the model can be extended to an open economy set-up (Libman, 2018).

To sustain his point, Aspromourgos (2007) assumes that there is some connection between prices and quantities, too. However, unlike the reaction functions of the Central

Bank, represented in the standard New Consensus Model, where the real interest rate affects output and employment, in Aspromourgos' model the real interest rate affects *their rates of change*, which is not a standard assumption. As a result, prices and quantities are independently determined. And one may be wrongly induced to believe that Aspromourgos' results *only* hold because of this independence, which is not the case.

The aim of this paper is precisely to show that Aspromourgos' main take home message is far more general. To show this, we reexamine his results under different assumptions regarding price and quantity determination. More specifically, we lay out a minimal model and suggest a taxonomy that helps examining under which conditions prices and quantities can be determined independently of each other, and whether there is or there is not a unique natural rate of interest consistent with the equilibrium level of output. We argue that the natural rate of interest need not exist *even* if we allow prices and quantities to be somehow connected, as the New Consensus reasons.

Toward those ends, the remainder of this paper is structured as follows. Section 2 presents the model of Aspromourgos (2007), section 3 discusses our taxonomy, section 4 presents a more complete model, section 5 discusses open economy issues; and finally, section 6 concludes.

2. Aspromourgos' model

Aspromourgos' (2007) main claim is that interest rates are conventional variables, determined by the Central Bank in its interaction with the financial markets. The beliefs of the Central Bank about how the world works will influence rates, even if they are based on biased estimations, as they are eventually validated by markets. The contribution of Aspromourgos is thus related to the views of Keynes on the conventional nature of interest rates and to the Monetary Theory of Distribution.

Specifically, Aspromourgos' scheme elaborates on the closure proposed by Panico (1988) and Pivetti (1991), who argue that the normal rate of profit follows the pace of the interest rate. How is the interest rate determined? There seems to be a consensus that it is set by authorities based on what they think is the more appropriate reaction function, given how they think the world works.

To avoid clutter, the model presented by Aspromourgos (2007) is spelled out in the appendix. The structure can be summarized as follows. Prices are determined by the monetary costs of production, which entail a negative rate between the real wage and the profit rate (given the technique). The level of output is derived from a supermultiplier framework for a closed economy with a government sector. Asset markets describe the equilibrium yield for money, bonds, and shares on physical capital. The interaction of the demands, given the existing supplies, ensures that the private sector is willing to hold the existing stocks.

The model can be closed once we determine fiscal and monetary policy. The government controls the rate of growth of output through the rate of growth of fiscal spending.

While the Central Bank sets the supply of money and bonds, which influences the price of assets and sets the interest rates. Finally, if there is a positive inflation rate in the long run, nominal wages grow at the same rate, consistently with the real wage that emerges from prices and distribution.

How is the interest rate determined? The Taylor Rule, which defines the natural interest as a function of the weighted average of the real interest rates (considering a period where inflation was equal to the target), targets the rate of inflation, which is a function of the past changes of the real interest rate.

Aspromourgos then claims that the model admits multiple trajectories for the interest rate and inflation. The two proposed solutions are: (a) when the Central Bank keeps its estimation of the natural interest rate based on its historical average, excluding the higher level during the period where the inflationary shock takes place; (b) when the Central Bank incorporates in the estimation of the natural rate the level of the interest rate during the adjustment, and consequently the natural rate increases above its historical average.

If many values of the natural rate are consistent with some inflation target, then the Central Bank's reaction function and its beliefs influence interest rates in the resting position. In the next section we show that this result is far from obvious and cannot be taken for granted.

3. Quantities and prices. A basic framework

In this section we explore Aspromourgos' (2007) results under different assumptions about the connection between prices and quantities; since relevant parts of his argument and of the assumptions that underlie the model proposed are not the most common in the New Consensus literature he criticizes, this may make the communication with that literature difficult. To solve this potential drawback, we will consider alternative specifications that are closer to the New Consensus models but anyway consistent with Aspromourgos' claims, thus proposing a series of versions of the model based on different interrelations between quantities and prices.

At the risk of some simplification, these models can be subject to two main questions: a) Are quantities and prices determined independently (at least as a first approximation, as in the surplus approach)? b) Is there a unique resting position?

Regarding a), we argue that Aspromourgos' assumption that aggregate demand does not depend on interest rates ensures that distribution and prices are not related in a mechanical way to quantities. However, the result breaks down once we incorporate the standard assumptions on how demand and distribution are determined in traditional models. Specifically, if the level of the interest rate (and not its rate of change) affects demand or if output influences distribution (for instance, affecting the workers' bargaining position), quantities and prices *cannot* be determined independently. This point is tackled in sections 3.1, 3.2, and 3.3.

To clarify, we do not claim that there is a mechanical connection between quantities and prices. However, to accept that this interaction is not subject to general rules (*i.e.* it is not part of the "core", to use a terminology adopted by Garegnani, 1984), does not mean that, under more specific circumstances, the connection cannot be addressed. And since the above-mentioned assumptions are standard in the literature, it is much better to take them for granted to provide a critique – which we argue is possible, anyway. However, regarding b), we claim that, *even* if this connection exists, Aspromourgos main take-home message is still sound. This shows that it is necessary to specify the conditions that ensure that the resting position is consistent with different combinations of the interest rates and output, which is not straightforward. This provides a robust interpretation of Aspromourgos' examples of path dependence, which is tackled in section 4.

3.1. The Basic Framework (quantities and prices independently determined)

Let us simplify a little bit and assume that the economy is vertically integrated and produces one single good. In logs, the price level p is equal to the sum of the rate of profit r plus the wage minus labor productivity a:

$$p = r + w - a \tag{1}$$

Equation (1) determines a "Distribution Curve", which we write as $r = a - (w - p)$, showing that there is a negative relation between the wage share and the rate of profit. Because the private sector can substitute between money, bonds, and shares, a change in the interest rate will affect the rate of profit in the same direction. For example, a reduction in the rate of interest will bid up the price of shares, reducing the rate of profit. To simplify, let us assume that $r \approx i - p^e$ stands for the rate of real interest (approximately the nominal interest rate minus expected inflation). This is equivalent to the assumption that shares and the price of capital adjust one by one with the general price level.

There is a maximum level that the rate of interest rate can take (given expected inflation), given by technical conditions $i \leq r^{max} = a$ and most likely there is a floor for the real wage $\omega = w - p$, thus $i \leq r^{max} = a - \omega^{min}$.

The other equation specifies how aggregate demand is determined. According to Aspromourgos, the level of output and income (or their growth rates) are negative functions of the change in the real interest rate:

$$y = \beta - \rho\Delta(i - p^e) = \beta - \rho\Delta r \qquad \beta, \rho > 0 \tag{2}$$

Setting $\Delta r = 0$ determines the "Demand Curve": output equal to autonomous expenditures $y^* = \beta$. The model composed by (1) and (2) allows determining output independently of prices. This is represented in Figure 1.

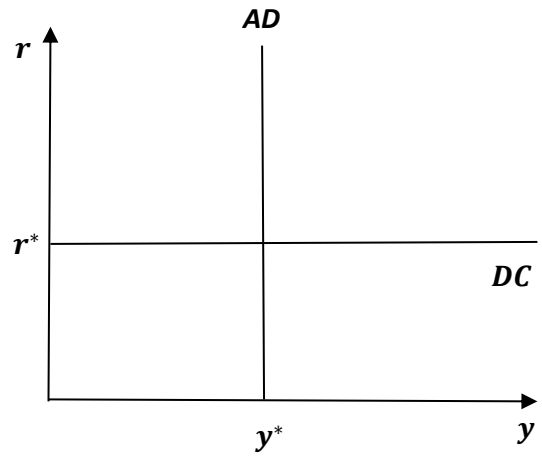

Figure 1 – Full independence between prices and quantities.

In order to understand how the model works, let us assume that the adjustment process is represented by the following process:

$$\Delta r = \emptyset(r^* - r) \qquad \emptyset > 0 \tag{3}$$

Aggregate demand is then defined as:

$$y = \beta - \rho\emptyset(r^* - r) \tag{4}$$

Notice that in a resting position, $r^* = r$ and demand does not depend on the interest rate. Consider now what happens if the Central Bank re-estimates the natural real interest rate (let us assume that it is deemed to be higher). The DC curve shifts up, without changing aggregate demand in the long-run. In the short-run, there is a negative effect on output, but once the real interest rate settles at its new level, output returns to its long-run level (determined by autonomous expenditures).

In this set-up, quantities and prices are independent of each other, while there are multiple real interest rates compatible with the same level of output (equilibrium levels, which of course need not imply full employment). However, it could be argued that this simple framework does not accurately capture the way modern Central Banks operate, because it is not standard to assume that the change in the real interest rates is what affect the level of output.

3.2. Interest-sensitive expenditures (quantities and prices not independently determined)

Equations (2) and (4) are uncommon in the literature. The typical assumption is that demand depends, not on the *rate of change* of the interest rate, but on its *level*:

$$y = \beta - \rho r \tag{5}$$

Now the aggregate demand curve has a negative slope. This is shown in Figure 2.

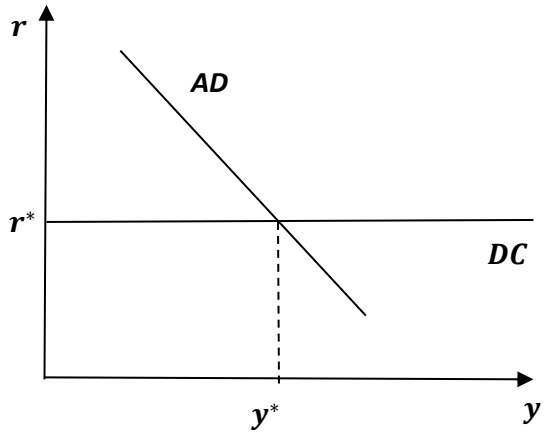

Figure 2 – Interdependence between prices and quantities through the AD curve.

It is hardly deniable that the usual argument adduced by NCM to defend the interest elasticity of the AD curve is based on the principle of factor substitution, which we know is not generally valid[2]. However, as argued in the introduction, heterodox literature has also identified several channels though which income distribution may affect aggregate demand (Pivetti, 2023; Barba and Pivetti, 2012, 2009). A low-interest-rate policy, for instance, may contribute to boost consumption spending through its effect on the real wage, or by decreasing the burden of household debts or increasing the value of assets, thus causing positive wealth effects that may increase aggregate spending. Barba and Pivetti (2009) also document that, before the Global Financial Crisis, several advanced countries developed a growth strategy based on a process of substitution of loans for wages. Finally, in Barba and Pivetti (2012) the potential role of changes in income distribution on the inducement to invest is also examined. Importantly, no matter how general they are, none of these mechanisms imply a tendency towards full employment of resources, and therefore are compatible with the possibility of equilibrium with unemployment that can be changed with persistent changes in aggregate demand.

For our purposes, what is relevant here is that, under this set-up, monetary policy is unable to determine the natural interest rate independently of the level of output. Presumably, the Central Bank holds some beliefs about this equilibrium level (y^*), but then, prices and quantities cannot be determined independently. It is still true, however, that there are multiple equilibrium interest rates, provided that there are multiple equilibrium levels of output too.

3.3. Workers' reaction function (quantities and prices not independently determined)

As Garegnani (1979) and Pivetti (1991) argue, even if the interest rate is regarded as the *primum movens* in the determination of income distribution, the fact is that interest policy is not determined in a vacuum. This suggests that there are certain requirements for the

[2] See Dvoskin and Petri (2017) for a critique of the working of the factor substitution mechanisms in a neo-Walrasian context, which is the alleged micro-foundation of NCM.

Central Bank to uniquely determine income distribution. Consider what happens if workers become more militant as output (and unemployment) increase. For instance, let the workers' target wage be defined by:

$$w^T = p^e + \sigma y \qquad \delta, \sigma > 0 \tag{6}$$

Now the distribution curve becomes:

$$r = a - (\sigma y + p^e - p) \tag{7}$$

With a negative slope in the real interest rate and output space. Figure 3 illustrates this.

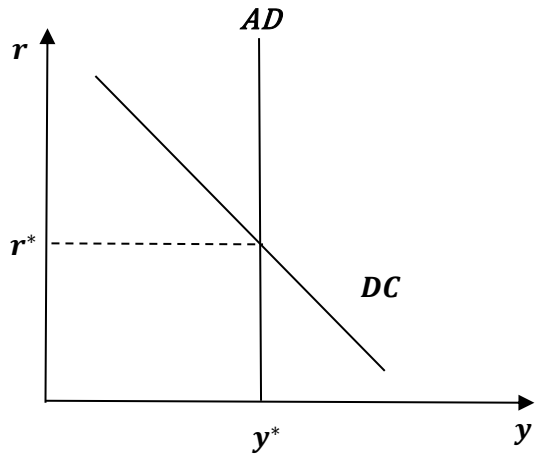

Figure 3 – Interdependence between prices and quantities through the DC curve.

This could add additional restrictions to the model. For example, assuming that eventually expectations are correct, $p^e = p$, then the Distribution Curve is:

$$r = a - \sigma y \tag{7'}$$

If the Central Bank is convinced that there is a unique equilibrium level of output, $y = y^*$, and acts accordingly, then the real interest rate is given by $r^* = a - \sigma y^*$. But now it is impossible to find the "natural rate" independently of y^*.

However, unless y^* is determined independently of policy variables, by itself, the connection between r and y given by (7') does not imply that that there cannot be "self-validating beliefs", using Aspromourgos expression. These self-validating beliefs may occur, for instance, if potential output exhibits "hysteresis". The logic behind this case is detailed in the next section.

4. A full model with hysteresis

So far, we have shown that our basic model needs particular assumptions to determine output and prices independently of each other. While we do not believe that there are general laws, we think that even under the common assumptions found in the literature –

where the independence is broken down – one can still get interest rates as artifacts of the Central Bank beliefs.

The model proposed by Aspromourgos follows the literature and assumes that the Central Bank targets inflation using a Taylor Rule. More precisely, let us assume that the interest rate is determined by:

$$i = r^* + p + \alpha(\Delta p - \Delta p^T) + \theta(y - y^*) \qquad \alpha, \theta > 0 \tag{8}$$

Because the Central Bank does not know r^*, it changes its policy stance if inflation or output deviates from its targets (notice that y^* is also an estimation):

$$\Delta r = i - r^* + p = \alpha(\Delta p - \Delta p^T) + \theta(y - y^*) \tag{9}$$

Hence, the demand curve becomes:

$$y = \beta - \rho[\alpha(\Delta p - \Delta p^T) + \theta(y - y^*)] \tag{10}$$

In equilibrium, the level of output depends on the Central Bank's estimate of y^*. The evolution of inflation is $\Delta p = \Delta r + \Delta w - \Delta a$. Substituting into equation (9):

$$\Delta r = \frac{\alpha(\Delta w - \Delta a - \Delta p^T) + \theta(y - y^*)}{1 - \alpha} \tag{11}$$

To illustrate the adjustment, let $\Delta w = \Delta a + \Delta p^T$ and let $\alpha < 1$. Then the adjustment process is depicted in the following Figure 4[3].

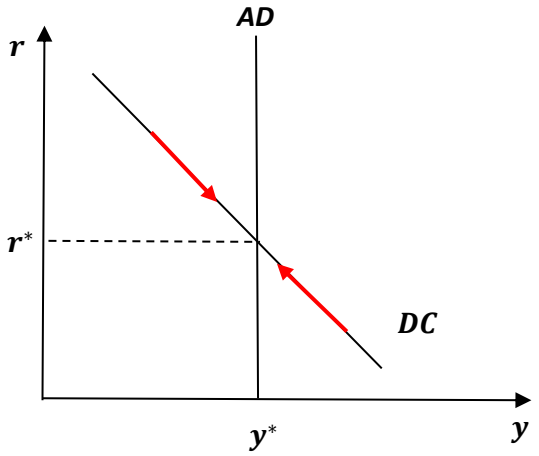

Figure 4 – Unique equilibrium interest rate without hysteresis.

It follows that there is a unique natural rate of interest which is consistent with the equilibrium level of output. If output exhibits hysteresis we obtain the case discussed in Aspromourgos (2007). In fact, following Barbosa Filho (2022), let potential output evolve according to:

$$\Delta y^* = \varphi(y - y^*) \tag{12}$$

[3] Alternatively, we can assume that the change in the expected wage is a function of the output gap (which does not change the structure of equation 11).

Then, in equilibrium $\Delta y^* = 0$ and $y = y^* = \beta$, thus production depends on the dynamics of autonomous expenditures as in Aspromourgos (2007).

It is possible to conceive at least two different cases under hysteresis. Suppose that the dependence on output on its past values can be considered as largely independent of the action of monetary policy – for instance, if output growth increases productivity, and this increases exports and consumption in a virtuous circle – then, the connection between the interest rate and output occurs through the DC curve. In this case, beliefs could be self-validating if the Central Bank considers that it is necessary to pursue an accommodative monetary policy to achieve stability because it realizes that equilibrium real interest rate is now lower; the rate of interest is the endogenous variable in the $r - y$ relationship. This is shown in Figure 5.

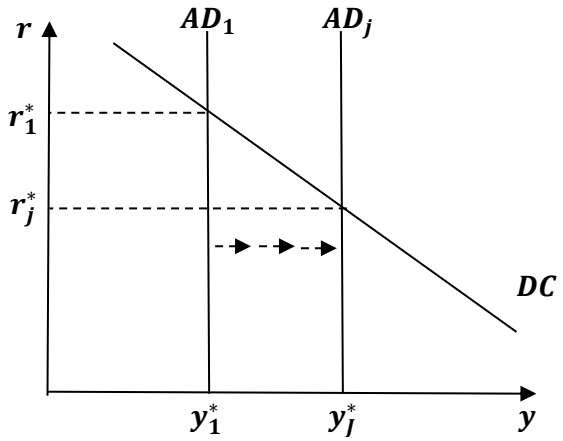

Figure 5 – Multiple equilibria under hysteresis.

But the other polar case is also likely, when monetary policy affects output directly through the negative slope of the aggregate demand curve. In this scenario, while in principle any level of output is sustainable, the commitment of the Central Bank to set a specific level of the interest rate will ensure that output will remain there (the interest is the exogenous variable, while the level of y^* is endogenously determined) (see figure 2).[4]

Now, the moment a connection between interest rate and output is admitted, tensions between fiscal and interest rate policy may emerge. For instance, although the expansionary policy eventually creates additional productive capacity, which in turn will make the higher level of output sustainable, it could be the case that the Central Bank tries to offset what it believes is inflationary pressure. Then, it is possible that, if the Central Bank ends up establishing its position, aggregate demand falls and the economy remains with the same output but with a higher real interest rate. Or alternatively, the fiscal pressures to

[4] A similar result holds if demand depends on the level of real interest rate (and not its rate of change). Now the change in demand is given by $\Delta y = -\rho[\alpha(\Delta p - \Delta p^T) + \theta(y - y^*)]$. Which gravitates around $\Delta p = \Delta p^T$ and $y = y^*$, if expectations are -on average- correct.

boost aggregate demand may be stronger, and the Central Bank gets convinced that equilibrium output is higher and acts accordingly. We must recall once more that macroeconomic policies are not conducted in a vacuum, and therefore, their ultimate result cannot be assessed in general terms. But either when the original beliefs held by the Central Bank are sufficiently strong as to be unaffected by the expansion of aggregate demand, or if they eventually endogenously adjust to experience, there is nothing natural about the (unique) level of the interest rate that is consistent with output. It depends on the beliefs held by the Central Bank about, among other things, the most suitable combination of $r - y$ based on its macroeconomic policy objectives, but also on the relative power of the institution to impose its views on the macroeconomic policy-making process.

5. Open Economy

The type of indeterminacy that surrounds the level of the interest rate would not be present in the case of exchange rate determination, as a result of the existence of objective limits (for example, the performance of the balance of payments), which restrict the margin of maneuver of CBs to alter the equilibrium value of the exchange rate.

> "In short, objective conditions more stringently govern feasible exchange rates than feasible interest rates; in general, there are not multiple exchange rate equilibria." (Aspromourgos, 2007, p. 531)

Fully accepting these limits, this section shows, first, that they also remove degrees of freedom for the monetary authority to set the interest rate and, second, that even within these limits, there is also indeterminacy in the exchange rate (Vernengo, 2001). When considering an economy open to capital flows and trade, we can imagine that there is an additional balance of payments (BP) constraint that lists the combinations of output and the interest rate (and hence the rate of profit) that are consistent with external equilibrium. In principle, higher levels of activity are associated with an increase in the current account deficit, which may require financing at higher rates. This can be represented as a minimum level for the rate of profit, given a certain level of output as in Figure 6.

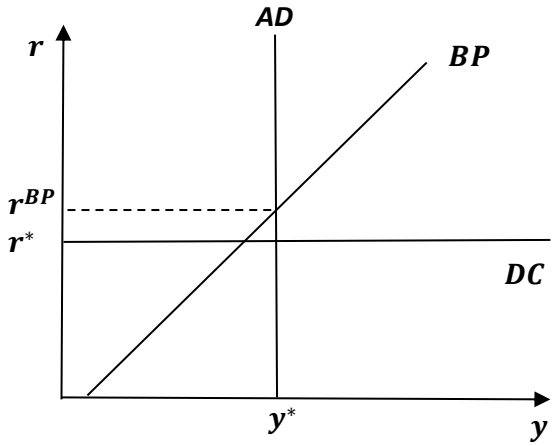

Figure 6 – External equilibrium and interest policy.

In the example we plotted in Figure 6, the equilibrium interest rate determined by the Central Bank's beliefs (r^*) is below the rate that is consistent with the balance of payments constraint, r^{BP}, for that level of output (y^*). It is difficult, however, to imagine that this situation can last over time. Competition will not take long to make its effects felt, generating an outflow of capital that will eventually put pressure on the Central Bank's reserves and force a devaluation.

This suggests, first, that in an open economy these objective limits also restrict the monetary authority's room for maneuver in setting the interest rate. Now, it does not follow from this result that any level of output (*i.e.* trade deficit) that the monetary authority deems to be desirable can be validated by an appropriate level of the interest rate. Presumably, if the level of external deficit increases, external investors will doubt the ability to repay the debt and will cease to provide financing. Graphically this can be represented by assuming that the BP curve becomes vertical at a given level of output as in Figure 8 (Serrano and Summa, 2015; Dvoskin et al. 2024), which becomes the maximum level attainable by this economy under given conditions. The part of the BP beyond y^{MAX} becomes purely notional and therefore levels such as y^* are not achievable. That is, as suggested by Lavoie (2001), there is an asymmetry between external surplus and deficit situations, for the ability of the monetary authority to set the interest rate.

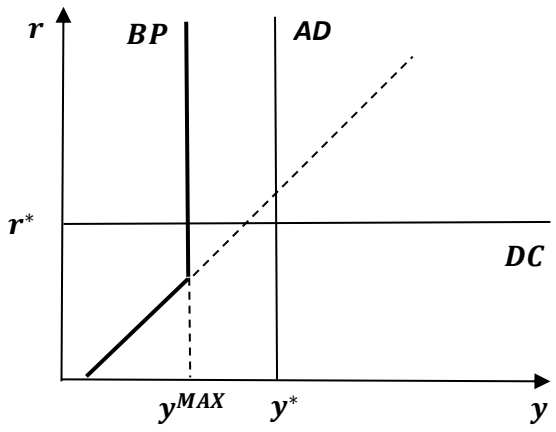

Figure 7 – Maximum output under external credit constraints.

Let us finally consider the case depicted in Figure 8, where the monetary authority sets the interest rate at a level r^* that is consistent with the current account surplus for that level of output (y^*) , and is also higher than the rate demanded by international investors, so that this rate of interest is in principle sustainable.

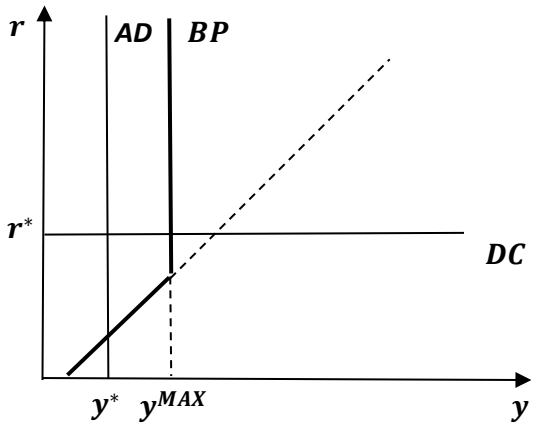

Figure 8 – Exchange rate indeterminacy.

Nor does it follow that the exchange rate is fully determined. To see this, consider the price equation when we introduce imported inputs:

$$p = r + \gamma(w - a) + (1 - \gamma)(e - b) \qquad (1')$$

Where γ is the weight of wage costs in total cost and $1 - \gamma$ is the cost of imported inputs, while b is the productivity of those inputs and e is their price in domestic currency or $e = s + p^*$ (equal to the exchange rate plus the world market price). It follows then, after manipulating (1'):

$$p - s + p^* = r + \gamma(w - a - s + p^*) - (1 - \gamma)b \qquad (1'')$$

The real exchange rate is determined *only* once the two distributive variables, r and w, are determined. In other words, given money wages, if the interest rate is an artifact of Central Bank's beliefs (within the limits imposed by the balance of payments constraint) then the exchange rate is too, *i.e.* there is also a range of indeterminacy for the real exchange rate. The monetary authority can always choose the target exchange rate level (as long as that level is not incompatible with the external surplus – or equilibrium), and intervene in the exchange market to sustain it if the resulting s and r configuration generates capital inflows encouraged by portfolio motives.

6. Conclusion

In this note, we have revisited the question of the separation between quantities and prices, taking as a starting point Keynes and the recent contribution of Aspromourgos (2007). His contribution seems to be one the most important references in the literature that relates modern central bank practices with the Monetary Theory of Distribution. More importantly, we have provided a full taxonomy of cases where interest rates are, in fact, an artifact that can self-validate the Central Bank's beliefs.

We showed that there are in fact two separate questions. First and foremost, are quantities and prices independent (at least as a first approximation, as there are no general laws that govern their interactions)? Secondly, is there a unique resting position for output independent of monetary policy? We have shown that the answer to the second question is negative. Moreover, this occurs even when considering the possibility that quantities and prices are not determined independently of each other via context-specific mechanisms under which the separation of prices and quantities, correct at the level of pure theory, is broken down.

Finally, when open economy issues are considered, there are objective restrictions that may reduce the monetary authority's degrees of freedom, both in setting the interest rate and the exchange rate. However, there is still room for maneuvering in the determination of both variables.

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Appendix

The model proposed by Aspromourgos can be described as follows. The equations (A1) to (A3) define prices and distribution. While (A1) determines the general price level from normal monetary costs of production, (A2) shows the negative relation between the real

wage (w/p) and the profit rate (r) for a given technique (v, l). Equation (3) sets an upper bound for the rate of profit, which is associated with technological factors and the minimum real wage that workers can tolerate.

$$P = wl/[1 - (1 + r)v] \quad \text{(A1)}$$

$$w/P = [1 - (1 + r)v]/l \quad \text{(A2)}$$

$$[(1 - v) - cl]/v \geq r \geq 0 \quad \text{(A3)}$$

Equations (A4) to (A7) help to determine the normal level of output (Q) from a supermultiplier framework. Private investment depends on expected growth of demand, g_e (equation (A4)); the level of activity is determined by autonomous spending G and the supermultiplier (equation (A6)), with s being the marginal propensity to save (A7), assumed to be smaller than one to ensure an economically meaningful – stable-solution.[5]

$$I = v(1 + g_e) \quad \text{(A4)}$$

$$Q = C + I + G = (1 - t)(w/p\ )lQ + v(1 + g_e)Q + G \quad \text{(A5)}$$

$$Q = G/[s - v(1 + g_e)] \quad \text{(A6)}$$

$$s = 1 - (1 - t)[1 - (1 + r)v] \quad \text{(A7)}$$

The model is closed once we define government fiscal and monetary policy. The government controls the rate of growth of output through the rate of growth of fiscal spending (g), which is limited by the maximum growth rate that is consistent with full employment, but it could be well below that level. The government also sets the supply of money and bonds, which (together with Central Bank policies) influences the price of assets and sets the interest rates. The remaining equations of Aspromourgos' model, not reproduced here for simplicity, capture the interaction between fiscal and monetary policy and the price of assets.

How is the interest rate i determined? Barring some limitations associated with technology (*i.e.*, the maximum rate of profit) and the degree of capital account openness, the monetary policy regime needs to be specified. It is assumed that the central bank has a reaction function which depends on the regime. Typically, there is a Taylor Rule according to which the interest rate is adjusted to minimize deviations of inflation and output from their targets.

More precisely, to determine i Aspromourgos proceeds in three steps: (1) the Taylor Rule, which defines i as a function of i^* and p^*, excluding output to simplify; (2) $i^*$is defined as a weighted average of the real interest rate considering a period where there was nominal stability (*i.e.* inflation was equal to the target)); and finally, (3) p is a function of the past changes of the real interest rate, to capture a Phillips curve type relation.

[5] Aspromourgos' (2007) model has three more equations to establish the equilibrium yield for the three assets – money, bonds, and shares on physical capital, ensuring that the private sector is willing to hold the existing supplies. These are not discussed here because they beyond the scope of the article.

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