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# Disinflation, external vulnerability, and fiscal intransigence: some unpleasant Mundellian arithmetic

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## ABSTRACT

This paper examines the policy challenges that a country faces when it wants to both reduce inflation and maintain a sustainable external position. Robert Mundell's policy assignment framework suggests that these two goals may be mutually incompatible unless monetary and fiscal policies are properly coordinated. Unfortunately, if the fiscal authority is unwilling to cooperate – a case of *fiscal intransigence* – and central banks pursue a disinflation on a “go it alone” basis, their country's external position may further deteriorate. A dynamic analysis shows that if the central bank itself lacks credibility, it must rely even more on cooperation from the fiscal authority. The paper thus extends Sargent and Wallace's “unpleasant monetarist arithmetic” to an open economy: a central bank's efforts to stabilize prices and output using a “go it alone” strategy (no help from the fiscal) may be thwarted by external factors: more external debt, higher risk premia and exchange rate passthrough.

## ARTICLE HISTORY

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External vulnerability;  
assignment problem; risk  
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## 1. Introduction

In an open economy, macroeconomic stabilization – the elimination of imbalances, both external and internal – is a fundamental goal. Externally, the current account should be at a sustainable value – neither an excessive deficit nor an excessive surplus. Internally, output should be close to its potential level and inflation at or near its desired (target) rate; neither recession nor overheating is desirable.

Economists have long recognized that both monetary and fiscal policies may be used to achieve that goal in a *coordinated* manner. Our thinking has largely been guided by the work of Robert Mundell. In a seminal (1962) paper, he suggested that policymakers need to combine fiscal and monetary adjustments in a proper way so as to achieve macroeconomic stabilization – the *assignment problem* paradigm.

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In some cases, both fiscal and monetary policy should move in the same direction. Consider first a country with a domestic expansion and an excessive external surplus. Tighter fiscal policy will help close the domestic gap. At the same time, an appreciation of the real exchange rate – the consequence of a monetary tightening – will help bring about the decrease in the external surplus that is required to close that gap. Thus, in this case, a tightening of both fiscal and monetary policy may be required. As a converse case, consider a country that jointly runs a domestic recession and an external deficit. A fiscal tightening will help close the external gap but will worsen the domestic recession; depreciation of the real exchange rate – looser money – will both reactivate the economy and help reduce the external deficit. In this sense, looser money may reduce the need for a fiscal tightening – and may even permit a fiscal loosening as well.

Arguably, the most “toxic mix” of economic imbalances is an unsustainable external deficit combined with domestic overheating and/or inflationary pressures. Fiscal tightening will reduce both the external deficit and domestic demand.

At the same time, a depreciation of the currency – the consequence of a monetary loosening – will also help close the external deficit (a pure price or “expenditure switching” effect). In this sense, it is possible that a fiscal tightening should be combined with a monetary *expansion*.

Moreover, countries with such a “toxic mix” of imbalances are the most vulnerable to adverse external financial pressures – a forced adjustment by the market. Investors are more likely to take their money out of a country – sometimes rapidly and unexpectedly – if its external deficit is unsustainable *and* domestic inflationary pressures are excessive.

For example, consider the cases of Brazil, India, Indonesia, South Africa, and Turkey – the so-called “fragile five.”<sup>1</sup> Data for these countries 2012–13, as shown in Table 1, suggest that all countries had, to varying degrees, both external and internal imbalances that made them vulnerable. All of these countries were running current account and net export deficits. Their external debt obligations, which range from 15% of output in Brazil to 43% of output in Turkey, were growing. International reserves were falling during the previous year in Brazil, Indonesia, and Turkey – a sign that the central bank was attempting to maintain an overvalued exchange rate. In terms of internal balance, the inflation rate in all countries was higher than desirable.

However, casual observation alone cannot tell us whether internal politics have obstructed an adjustment. For example, if a country resisted a fiscal adjustment, the

**Table 1.** External vulnerability and inflation: selected emerging market countries.

Country	External Debt	Current Account	Net Exports	Change in Reserves	Inflation	Inflation Target
Brazil	15.0%	–3.2%	–2.1%	–0.3%	6.0%	4.5%
India	20.0%	–5.0%	–7.5%	0.2%	10.0%	7.0%
Indonesia	30.0%	–3.2%	–0.6%	–0.8%	7.0%	4.5%
S. Africa	35.0%	–6.5%	–3.5%	0%	6.0%	5.0%
Turkey	43.0%	–6.2%	–5.4%	–3.1%	7.5%	6.0%

Notes: Flow data are for 2013/14 average; Debt stocks are end-2013. Sources: Central banks of Brazil, India, Indonesia, South Africa, Turkey; Haver Database; IMF Country Staff reports. Inflation targets of India, South Africa are indicative only.

<sup>1</sup>Around the time of the May 2013 “tapering” announcement, the popular financial press coined this moniker.

real exchange rate depreciation required to close the external gap may be even more severe than otherwise. In this sense, countries that appear unlikely to make a *coordinated* adjustment of both fiscal and monetary policy may be even more vulnerable to adverse pressure in external financial markets.

The purpose of this paper is to reconsider some issues related to external and internal stabilization. It focuses mainly on “toxic” or “fragile” cases where the external deficits and domestic demand/inflationary pressures are both too high. The paper’s analysis includes a policy assignment framework like Mundell’s but with some new elements. Specifically, we compare outcomes under a coordinated monetary/fiscal adjustment with those cases where the fiscal authority refuses to cooperate – *fiscal intransigence*.<sup>2</sup>

In such a case, an independent central bank may choose to “go it alone” and to pursue one of the two goals. At one extreme, a central bank may focus exclusively on internal stabilization (IS) only – consistent with a traditional mandate. However, as a polar opposite, we also consider that country authorities instead focus exclusively on external stabilization (ES). The purpose of such a calculation is to show the adjustment of the real exchange rate that is required to eliminate the external imbalance *without the help of a corresponding fiscal adjustment*. (See also Blanchard, 2005, on this point.)

At first blush, such an exercise may seem uninteresting, since it assumes that the central bank has essentially abandoned its traditional goal of internal stability. However, the exercise helps us to more correctly interpret an exchange rate assessment tool that is currently used by the International Monetary Fund, namely its External Balance Assessment (International Monetary Fund, 2013). That exercise is similar to the one considered in this paper: in both exercises, the fiscal adjustment is *exogenously* determined. In this paper, that adjustment is assumed to be zero.<sup>3</sup>

The remainder of the paper is structured as follows. In Part 2 we extend the external sustainability/real exchange rate calculation by including both a monetary (exchange rate) and a domestic absorption (fiscal) component. We combine this equation with a similar one-shot or static “back of the envelope” expression for internal imbalances (inflation, output gap). We solve jointly for the monetary (exchange rate) and fiscal adjustments required to simultaneously eliminate the external and internal imbalances.

As part of that analysis, we examine the effect of monetary policy on the trade balance. A monetary tightening will have two opposing effects on net exports: the appreciation of the real exchange rate will cause net exports to deteriorate while the reduction in output will mean lower imports – an improvement in net exports. We may say that an expanded Marshall-Lerner (EML) condition holds if the price effect dominates the income effect; in this case, the *net* effect of a monetary tightening would be to decrease net exports. In Part 3, to aid the analysis, we revisit Mundell’s (1962) graphical exposition of the assignment problem solution. We also consider cases where the fiscal authority refuses to adjust, and the monetary authority pursues either the internal or external stabilization goals on a “go it alone” basis.

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<sup>2</sup>We use the term “*fiscal intransigence*” rather than the more frequently used term “*fiscal dominance*,” since the latter typically applies to a more fully fleshed-out model of intertemporal solvency, as discussed in Tanner and Ramos (2003) or Woodford (2001).

<sup>3</sup>A non-zero fiscal adjustment that is exogenously determined will be the correct one *only by chance*. If that adjustment is more timid than the coordinated (Mundell) solution, the remaining burden of adjustment to close the external gap falls on monetary policy – the real exchange rate.

This static analysis yields three key findings. First, whether or not the EML condition holds, coordination between fiscal and monetary policy is essential. Second, if the EML condition does hold, the depreciation of the real exchange rate required to close an external deficit will be more severe in the case of fiscal intransigence than otherwise. Third, if the EML condition does not hold, the monetary tightening required to close the external deficit would also cause an extraordinarily harsh recession – an unlikely policy choice.

In Part 4 we take the analysis from a static to a dynamic setting that yields simulated time paths for the output gap, inflation, net exports, and external debt accumulation. In this framework, inflationary expectations are initially above the inflation target but ultimately converge to that target. The framework includes a risk premium which is modelled as penalty for higher external debt (following Schmitt-Grohé & Uribe, 2003).

In this framework, the central bank's mandate is limited to internal stability (IS): its goal is to bring the inflation rate down to a target rate over the medium term. We compare outcomes with and without cooperation from the fiscal authority. A key result thus concerns the relationship between disinflation and external debt accumulation. If the fiscal authority does not cooperate, the central bank will have to tighten even more to reach its inflation objective than otherwise. This brings on a perverse dynamic: more real exchange rate appreciation, more deterioration of the net export deficit (EML holds), and higher external debt. At some point, the risk premium on external debt, which is transmitted to both domestic inflation (exchange rate passthrough) and interest rates will squeeze out domestic expenditures. Such adverse effects can be avoided if the fiscal authority bears some of the burden of adjustment. Part 5 summarizes: the key lesson from Mundell's static assignment framework, namely the importance of coordination between the fiscal and monetary authorities, is now extended to a dynamic framework as well. Also, note that the risk premium has been modelled *as if* it was predictable. Empirically, the literature on “sudden stops” (see, for example, Calvo & Reinhart, 2000) suggests that severe increases in the risk premium may occur abruptly and unexpectedly. In this case, macroeconomic stabilization becomes even more difficult.

## 2. A static open economy macroeconomic model

A New Keynesian model of an open economy has three key elements. An IS curve summarizes equilibrium in the market for goods and services; a real interest parity condition pins down the composition of demand – domestic versus external – through a real exchange rate; a Phillips curve summarizes the output/inflation tradeoff in terms of a capacity constraint.

The demand side of an open economy is summarized by the following IS curve:

$$y = \frac{1}{(\alpha_1 + \alpha_3)} * [\alpha_2 * (r - \bar{r}) + \eta * (q - \bar{q}) + \delta_D + \delta_{NX}] \quad (1)$$

Note that  $y$  is the output gap, measured in percent of potential GDP,  $\alpha_1$  and  $\alpha_3$  are the propensities to save and import, respectively, out of the output gap,  $r$  and  $\bar{r}$  are, respectively, the observed and natural domestic real interest rates,  $q$  and  $\bar{q}$  are, respectively, the observed and long-run real exchange rates (foreign currency per home currency – appreciation plus),  $\alpha_2$  and  $\eta$  are demand response parameters for domestic expenditures and net exports, respectively, and  $\delta_D$ ,  $\delta_{NX}$  are demand shift parameters for

domestic and net export components, respectively. Note that  $0 < \alpha_1 < 1$ , and  $0 < \alpha_3 < 1$  while  $\alpha_2 < 0$  and  $\eta < 0$ .

The real interest parity condition is written:

$$q = r - r^{EXT} + \bar{q} \quad (2)$$

where  $r^{EXT}$  is the external real interest rate. That is, the parity condition implies that the interest differential and the real exchange rate gap in natural logarithms move with one another, one-to-one:  $r - r^{EXT} = q - \bar{q}$ , so tighter domestic money/higher domestic interest rates bring about an appreciation of the currency from the domestic perspective in relation to long-run equilibrium. We may rewrite the IS curve by substituting the parity condition (2) into Equation (1):

$$y = \frac{1}{(\alpha_1 + \alpha_3)} * [\alpha_2 * (r - \bar{r}) + \eta * (r - r^{EXT}) + \delta_D + \delta_{NX}] \quad (3)$$

Equations (1–3) imply that net exports of goods and services may be expressed as a fraction of potential output:

$$nx = -\alpha_3 y + \eta(q - \bar{q}) + \delta_{NX} = -\alpha_3 y + \eta(r - r^{EXT}) + \delta_{NX} \quad (4)$$

To derive Equation (4), assumptions must be made about the steady-state ratios of net exports to output. Such a derivation is shown briefly in [Appendix A](#) and in more detail in Tanner (2018). The interpretation of this equation is straightforward. When the output gap increases, the country imports more and the trade balance deteriorates. A real exchange rate appreciation discourages exports and encourages imports, causing the trade balance to deteriorate. The last term is an exogenous increase in net exports. Tanner (2018) shows that an increase in  $\delta_{NX}$  corresponds to an improvement in the external terms of trade.

The inflation rate is determined according to a standard Phillips curve:

$$\pi = \pi^e + \kappa * (y - z) \quad (5)$$

where  $\pi$  and  $\pi^e$  are observed and expected inflation, respectively, and  $z$  is an exogenous shock to short-run aggregate supply. As Walsh (2003, pp. 245–247) notes, the parameter  $\kappa$  reflects the proportion of agents that are free to adjust their prices in any period (for example, in an environment of Calvo price setting).<sup>4</sup>

## 2.1. Net exports and inflation: reduced form equations

The authorities have two policies which will have impacts on these variables: monetary policy (the real interest rate  $r$ ) and autonomous shifts in domestic demand (i.e., fiscal  $\delta_D$ ). To see these effects, we substitute IS Equation (3) into the expressions for net

<sup>4</sup>The equilibrium ex-post real interest rate is, of course, the nominal rate minus inflation  $r = i - \pi$ ,  $i$  = nominal interest rate. In this simple framework, we assume that the central bank raises (lowers) the nominal rate *vigorously enough* so that the real interest rate moves in the same direction. This idea is illustrated in greater detail in the dynamic model introduced in Section 4. Note also that there is a correspondence between the output gap in equation (5) and the gap between unemployment and its natural level,  $[u_t - u_t^*]$ . That correspondence may not be one-to-one, since changes in the real interest rate and real exchange rate may have impacted *both*  $u_t$  and  $u_t^*$ . For further details, see Salazar (2017).

exports and inflation, (4) and (5) respectively, and rearrange to isolate the policy components. The reduced form net export equation is:

$$nx = a_{11} * r + a_{12} * \delta_D + k_1 \quad (6)$$

where:

$$\begin{aligned} a_{11} &= \left[ \frac{-\alpha_3 * (\alpha_2 + \eta)}{(\alpha_1 + \alpha_3)} + \eta \right], \quad a_{12} = \frac{-\alpha_3}{(\alpha_1 + \alpha_3)}, \quad k_1 \\ &= \left[ \frac{\alpha_3 \alpha_2}{(\alpha_1 + \alpha_3)} \right] \bar{r} + \left[ \frac{\alpha_3 \eta}{(\alpha_1 + \alpha_3)} - \eta \right] r^{EXT} + \left[ 1 - \frac{\alpha_3}{(\alpha_1 + \alpha_3)} \right] \delta_{NX} \end{aligned}$$

The coefficient  $a_{11}$  tells us the impact of a change in monetary policy on the net export balance. International macroeconomists have inherited as part of their toolkit a way to think about such a coefficient: the Marshall Lerner (ML) condition. If the ML condition holds, a depreciation of the (real) exchange rate should cause exports to increase, imports to decrease, and hence an improvement in the trade balance. In this model, the counterpart to the traditional – and narrowly interpreted – ML condition is simply  $\eta < 0$ . However, the interest rate/exchange rate nexus summarized by Equation (2) adds a new wrinkle to the story. When the central bank raises the interest rate, it squeezes off domestic demand and output; this must be so because  $\alpha_2 < 0$ .

Repeating from above for convenience, the reduced form coefficient for the effect of monetary policy on the trade balance is:

$$a_{11} = \left[ \underbrace{\frac{-\alpha_3 * (\alpha_2 + \eta)}{(\alpha_1 + \alpha_3)}}_{\text{Output gap impact on imports.}} + \underbrace{\eta}_{\text{'Pure' price effect}} \right]$$

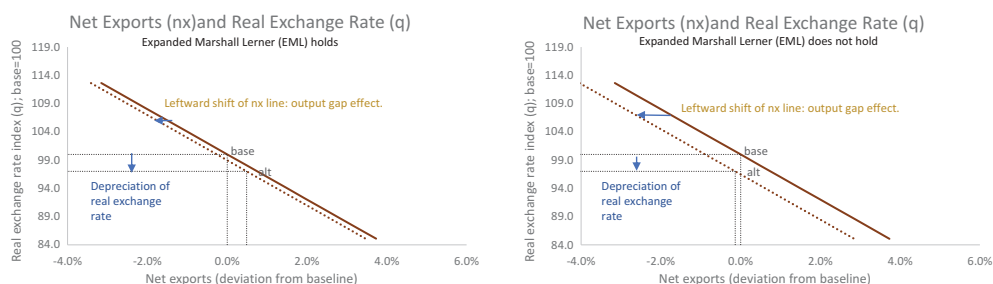
We may sign the output-gap effect (first element on the right-hand side) as positive, while the price effect  $\eta$  is negative.

The key question is thus: “Which of these two effects dominates?” In this sense, we may say that an expanded Marshall-Lerner condition (EML) holds if  $a_{11} < 0$ . Evidence supporting this proposition may be found in Kim (2001). However, for the purposes of understanding policy coordination, we will investigate both cases: where EML holds, and where it does not.

Figure 1 illustrates the effect of a monetary loosening – when the EML holds and when it fails to hold. In the left-hand panel, the alternative scenario (alt) shows the effect of a monetary loosening relative to the baseline, when the Expanded Marshall-Lerner (EML) condition holds. The depreciation of the real exchange rate, which is reflected as a downward movement along the tan lines dominates the output-gap effect which is reflected in a leftward shift of the tan line, from solid to dotted. Thus, since the EML condition is satisfied, a monetary loosening causes net exports to increase.

In the right-hand panel, the alternative scenario shows the effect of a discretionary monetary loosening relative to the baseline, when the Expanded Marshall-Lerner (EML) condition fails to hold.





**Figure 1.** The Expanded Marshall Lerner (EML) condition.

The depreciation of the real exchange rate, which is reflected as a downward shift along the tan lines is dominated by the output-gap effect which is reflected in a leftward shift of the tan line, from solid to dotted. In this case, a monetary loosening causes net exports to decrease.

For the inflation rate, the corresponding reduced form equation is:

$$\pi = \pi^e + a_{21} * r + a_{22} * \delta_D + k_2 \quad (7)$$

where

$$a_{21} = \frac{\kappa * (\alpha_2 + \eta)}{(\alpha_1 + \alpha_3)}, \quad a_{22} = \frac{\kappa}{(\alpha_1 + \alpha_3)}, \quad k_2 = \kappa \left( \frac{1}{(\alpha_1 + \alpha_3)} [-\alpha_2 \bar{r} - \eta r^{EXT} + \delta_{NX}] - z \right)$$

### 3. Economic stabilization: eliminating external and internal imbalances

The Mundellian assignment framework emphasizes that policymakers must address issues related to macroeconomic imbalances – both external and internal. We may think of an external imbalance as a situation where net exports deviate from some reference level  $nx^*$ . For example, consistent with the external sustainability (ES) approach of the International Monetary Fund's External Balance Assessment (International Monetary Fund, 2013)  $nx^*$  may be that level of net exports that stabilizes external debt (or net foreign assets) relative to GDP. Alternatively, we might interpret  $nx^*$  as the non-policy or “norm” level relative to comparator countries (based on multiple regression analysis). Hence,  $nx < nx^*$  might reflect a deficit that is either unsustainable or larger than the comparative norm, while  $nx > nx^*$  might represent a surplus that is unsustainable or higher than the comparative norm.

In the same vein, we may portray internal imbalances in terms of the inflation rate. Assume that the country's inflation target is  $\pi^*$ . A country has an inflationary imbalance if  $\pi > \pi^*$  and a deflationary imbalance if  $\pi < \pi^*$ .<sup>5</sup>

We may evaluate Equations (6) and (7) at target values for  $nx^*$  and  $\pi^*$  and then subtract off those same equations expressed for actual values of  $nx$  and  $\pi$ . Thus, we obtain expressions for net exports and the inflation rate as *deviations* from their reference levels:

<sup>5</sup>Alternatively, the internal balance criteria could be rephrased in terms of the output gap:  $y = 0$ . The two goals are identical only if expected inflation equals actual inflation ( $\pi^e = \pi$ ) and the supply disturbance term equals zero ( $z = 0$ ). Such a condition is similar to the idea of “divine coincidence” that is developed by Blanchard and Gali (2007). However, even if this condition does not hold in the short run, it will in the long run – as expected inflation converges to the target and the expected supply disturbance vanishes. For this reason, a dynamic framework, such as the one discussed in Part 4 of the paper, is required.

$$\begin{bmatrix} nx^* - nx \\ \pi^* - \pi \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} \Delta r \\ \Delta \delta_D \end{bmatrix} \quad (8)$$

Then, we may solve out for the policy adjustments required to achieve the internal and external targets – simultaneously:

$$\begin{bmatrix} \Delta r^* \\ \Delta \delta_D^* \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}^{-1} \begin{bmatrix} nx^* - nx \\ \pi^* - \pi \end{bmatrix} \quad (9)$$

Thus, we may think of (9) as a *general* solution to Mundell's (1962) assignment problem: adjustments to both monetary (exchange rate) and fiscal policies will each have a role to play in jointly addressing both external and internal imbalances. Implicitly, internal and external balances are given equal weight in the policymaker's objective function. Kydland (1976) discussed cases where two competing authorities (fiscal, monetary) attach different weights on these goals in a game theoretic framework.

### 3.1. Graphical treatment in the spirit of Mundell (1962) <sup>6</sup>

System (8) can be represented graphically – as Mundell did in his original article. Figure 2 shows the internal balance relationship (Equation (7)). Monetary policy adjustments  $\Delta r$  are shown on the horizontal axis: a movement to the right means tighter money (higher interest rates, more appreciated currency).

The red lines in the diagram reflect combinations of monetary and fiscal policy adjustments that are required to attain external balance. The lines are downward sloping: if there is a fiscal expansion, looser money (a reduction in interest rates) is required to maintain external balance.

Fiscal policy adjustments  $\Delta \delta_D$  are shown on the vertical axis. Looser fiscal policy – an increase in the fiscal deficit – is reflected in an upward movement along that axis.

The upward sloping solid blue line in the diagram reflects a combination of monetary and fiscal policy that is consistent with internal balance. This line passes through the origin; both the interest rate and fiscal stance are at their neutral levels. If there is a fiscal expansion, tighter money is required to maintain internal balance; in the case of a fiscal tightening, money must be loosened. Points along the dotted and dashed line represent the monetary and fiscal adjustments required to eliminate an expansion or a contraction, respectively. *Only by taking these policy measures can the economy return to the solid blue line internal balance line.*

Figure 3 shows the external balance line (Equation (6)) for the case where the EML condition holds.<sup>7</sup> The downward sloping solid-red line in the diagram reflects a combination of monetary and fiscal policy that is consistent with external

<sup>6</sup>Mundell's work builds heavily on previous discussions by Salter (1959) and Swan (1960). A spreadsheet-based tool which generates these charts is available online at: <http://www.evanctanner.com/mundell-arithmetic>.

<sup>7</sup>In this analysis, we focus on the case where EML holds. There is a good reason to do this: for any given imbalance, internal or external, EML yields the most likely combination of adjustments. For example, if EML holds and there is a positive internal imbalance (inflation above target), but net exports are in balance, the necessary adjustment would be a tightening of both fiscal and monetary policy. This makes sense: tightening fiscal alone without any monetary adjustment would reduce the output gap but increase the external surplus. As an offset, a monetary tightening, which appreciates the exchange rate, would help reduce the surplus. By contrast, if the EML fails, this model would recommend a combination of tighter monetary policy and looser fiscal policy (assuming that the IS line is steeper than the ES line). Such a policy corresponds to the intersection of the dotted blue and solid red line in Figure 5. It is a policy prescription that seems unlikely.

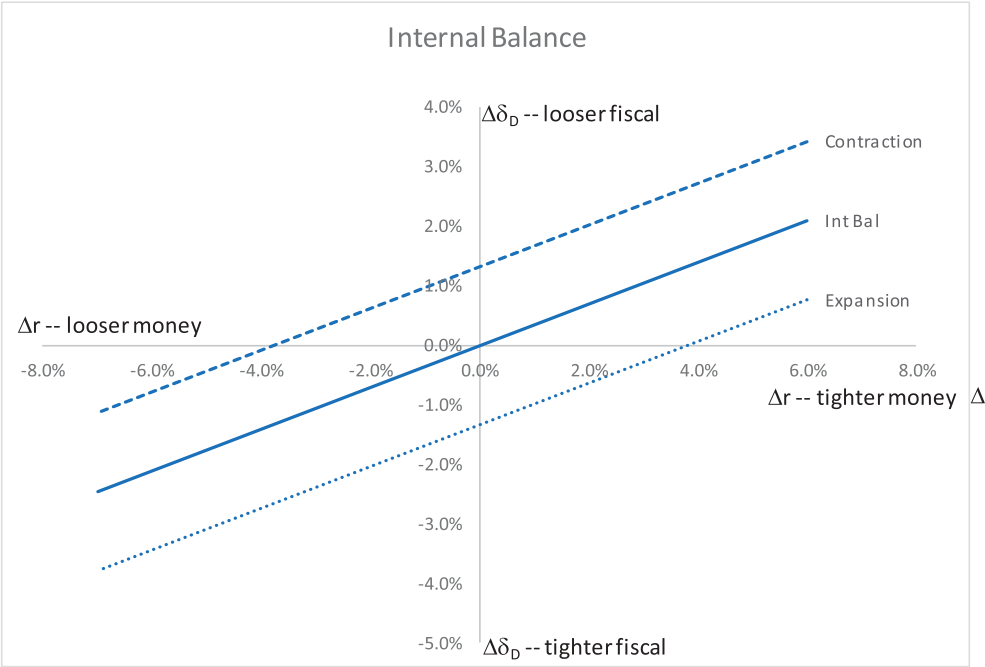


Figure 2. Required adjustments to attain internal balance ( $\pi = \pi^*$ ).

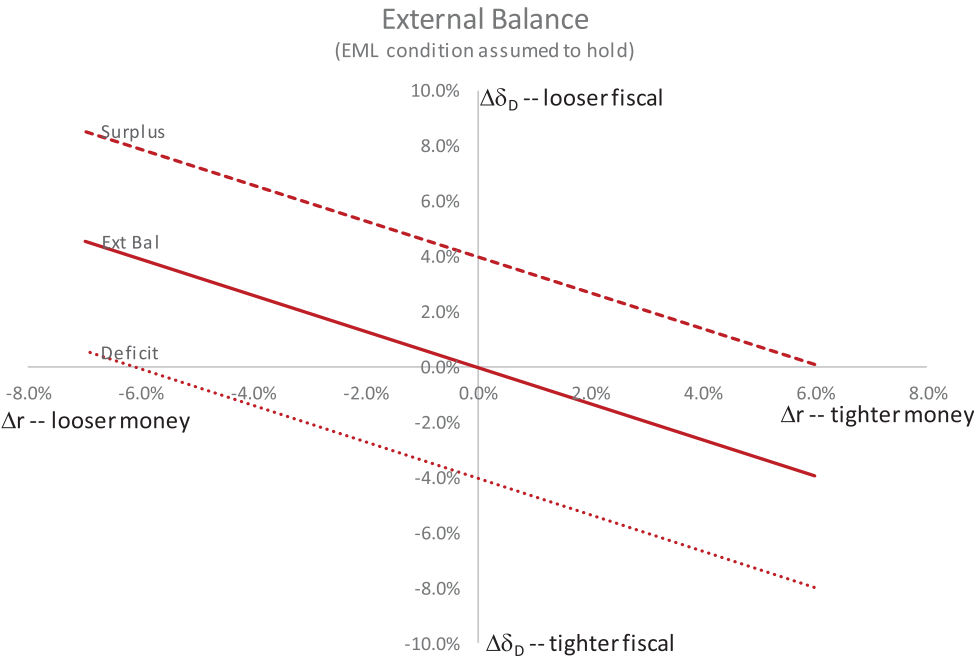
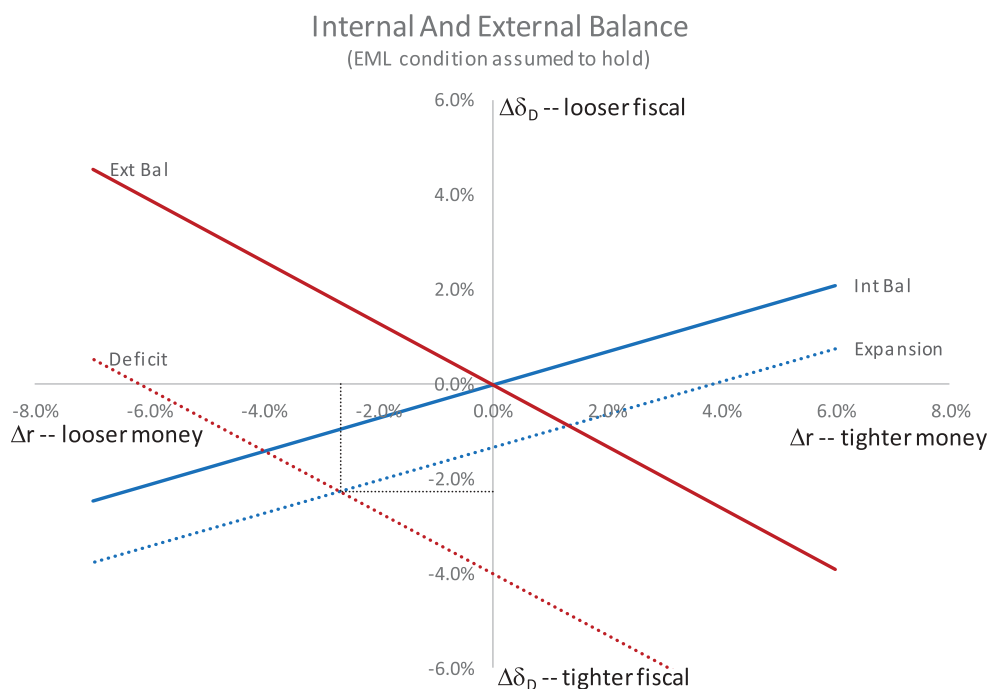


Figure 3. Required adjustments to attain external balance ( $n_x = n_x^*$ ).

balance. The line passes through the origin; both the interest rate and fiscal stance are at their neutral levels. If there is a fiscal expansion, looser money is required to maintain external balance; in the case of a fiscal tightening, money must be tightened as well. Points along the dotted and dashed line represent the monetary and fiscal adjustments required to eliminate an external deficit and an external surplus, respectively. *Only by taking these policy measures can the economy return to the solid-red external balance line.*

Figure 4 shows the adjustment solution implied by the system *when the EML condition holds*. The figure shows the fiscal and monetary adjustment that will jointly eliminate both internal and external imbalances (expansion, deficit) – the intersection of the red and blue dotted lines. In this case, the optimal policy couples a fiscal tightening with a monetary loosening.

Finally, Figure 5 shows the adjustment solution implied by the system *when the EML condition fails to hold*.<sup>8</sup> As before, the figure shows the fiscal and monetary adjustment that will jointly eliminate both internal and external imbalances (expansion, deficit) – the intersection of the red and blue dotted lines. Despite the failure of EML, the policy implication remains the same as in the previous case: a fiscal tightening combined with a monetary loosening.



**Figure 4.** Required adjustments for joint stabilization – EML holds.

<sup>8</sup>It is straightforward to show that, even if both the external balance (EB) and the internal balance (IB) lines slope upward, the IB line must be steeper than the EB line. To see this, note again that

$$\text{Slope}(IB) = \left[ \frac{-a_{21}}{a_{22}} \right], \text{Slope}(EB) = \left[ \frac{-a_{11}}{a_{12}} \right].$$

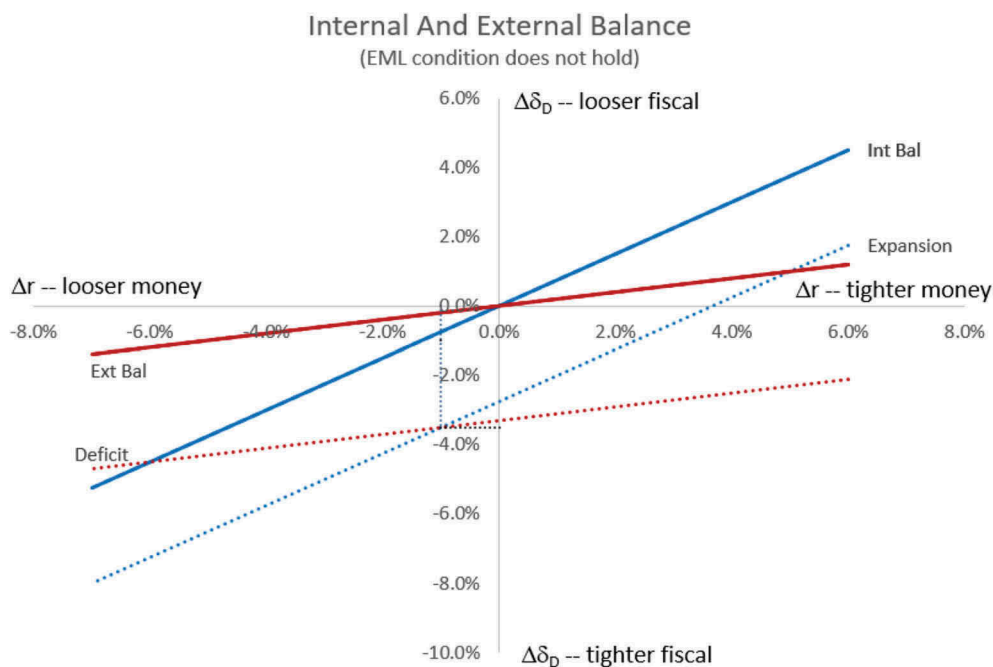


Figure 5. Required adjustments for joint stabilization – EML fails.

### 3.2. The perils of fiscal intransigence

The essence of the assignment problem is that the two independent authorities, the central bank and the government, coordinate their respective policy mandates. Often, the central bank is more nimble and able to adjust than the government; fiscal adjustments occur less frequently than monetary adjustments.

Thus, we compare the outcomes under a coordinated monetary/fiscal adjustment a case where the fiscal authority refuses to cooperate – *fiscal intransigence*. In this case, the central bank nonetheless chooses to “go it alone” and to pursue one of the two goals.

Consider first the case in which the monetary authority focuses entirely on issues related to internal stabilization (IS) rather than external sustainability, but the fiscal authority is uncooperative. In this case, the central bank adjusts the interest rate (and appreciates the currency) so as to bring inflation back to the target:

$$\Delta r^{IS} = \frac{\pi - \pi^*}{a_{21}}. \quad (10)$$

The impact of such a policy on net exports (combining income and expenditure switching effects) is:

$$nx^{IS} = nx + a_{11} * \Delta r^{IS}. \quad (11)$$

In this case, we may think of the difference  $nx^* - nx^{IS} < nx^* - nx$  as a *latent vulnerability*: it is the value of the external gap that we would observe if the central bank tightened monetary policy without the cooperative fiscal policy – the policy that is indicated in (9). Put differently, if the EML holds, and the net export deficit is initially

too high, such a policy will be destabilizing – it will further deteriorate the trade balance (since it further appreciates the real exchange rate).

Alternatively, consider first the case where the monetary authority focuses entirely on issues related to external stabilization (ES) rather than internal sustainability; again, the fiscal authority is uncooperative. In this case, the central bank adjusts the interest rate (and appreciates the currency) in order to bring net exports back to the target:

$$\Delta r^{ES} = \frac{nx - nx^*}{a_{11}}. \quad (12)$$

This special case arises when two elements are omitted from the more general analysis. First, the authority focuses entirely on solving the external sustainability issues and ignores any implication for inflation or the domestic output gap. Second, the case portrays a situation of fiscal intransigence: there is no fiscal adjustment ( $\Delta\delta_D = 0$ ). Equation (12) thus tells us the extent of real exchange rate misalignment – the growth in the real exchange rate required to eliminate the external balance – holding all else constant.

Of course, closing an external deficit gap will have implications for the inflation rate:

$$\pi^{ES} = \pi + a_{21}\Delta r^{ES}. \quad (13)$$

That is, if the authority chooses to loosen/devalue the exchange rate, inflation must rise. The difference between the new, higher inflation rate and the target is  $\pi^* - \pi^{ES} > \pi^* - \pi$ .

### 3.3. The IMF's external balance assessment (EBA)

We may now also see that the International Monetary Fund's template for diagnosing exchange rate misalignments, the External Balance Assessment (EBA, International Monetary Fund [IMF], 2013), is a special case of the assignment problem. That template first provides methods to calculate a “norm” for the current account.

That norm can then be adjusted to reflect a fiscal adjustment that is exogenously determined  $\Delta\delta_D$ . Thus, the required exchange rate adjustment implied by the EBA would be:

$$\Delta r^{ES/EBA} = \frac{nx - nx^*}{a_{11}} - \frac{a_{12}}{a_{11}} * \Delta\bar{\delta}_D. \quad (12a)$$

In this sense, the EBA may be thought of as a special case where policymakers care only about the external problem, with no weight placed on the inflation problem; the exogenously chosen fiscal adjustment  $\Delta\bar{\delta}_D$  would only *by chance* match the solution implied by (9).

### 3.4. What about monetary intransigence?

So far, this paper has focused on the perils of an intransigent fiscal authority. Theoretically, it is also possible that an economy faces a situation of monetary (rather than fiscal) intransigence. From an institutional perspective, the two cases may not be symmetric, so care must be taken to interpret the institutional context. An extreme case would be that of a pegged and unmovable exchange rate or currency union. This would mean that, even in situations where the joint stabilization would require both fiscal and monetary/exchange

rate adjustment, the burden falls entirely on fiscal. Such an example refers to countries within a currency union whose trade balances are inappropriate and/or unsustainable.

Ideally, a surplus country (“Germany”) should revalue its exchange rate relative to the deficit country (“Italy”). However, since institutions forbid adjustment of the “Germany/Italy” exchange rate, a recommended policy might be for “Germany” to expand its fiscal position and, in so doing, reduce its trade surplus with “Italy.” Another such example would be a country whose current account deficit is unsustainable (perhaps due to adverse movements in their commodity export price) and is a member of a currency union or otherwise refuses to devalue its exchange rate. Again, to restore external sustainability, fiscal consolidation would be required – even at the expense of a domestic recession.

### 3.5. Some illustrative examples (EML holds)

Table 2 presents six illustrative scenarios *assuming that EML holds*. (Assumed parameter values are presented in Appendix C, Table A1. Scenario (i) assumes a modest deficit-side gap on net exports,  $nx^* - nx = 0.5\%$  of output, but the inflation target is met  $\pi^* - \pi = 0$ . The “general case” refers to one where the fiscal and monetary authorities cooperate – each do their part. For scenario (i), that general policy combines some monetary easing/real depreciation with some fiscal tightening:  $\Delta r^* = -2\%$ ,  $\Delta \delta_D^* = -0.7\%$  of output. The external sustainability (ES) objective would indicate even more monetary loosening and exchange rate depreciation,  $\Delta r^{ES} = -2.5\%$ , at the expense of boosting inflation above the target  $\pi^* - \pi^{ES} = -0.8\%$  (i.e., an increase in the inflation rate of 0.8%).

Scenario (ii) assumes a net export gap identical to that in (i) 0.5% of output, but the inflation rate is above the target  $\pi^* - \pi = -1.5\%$ . Unsurprisingly, since above-target inflation is also treated as a problem that needs to be addressed, the policy solution suggested by (9) relies less on monetary easing/real depreciation and puts more substantially more emphasis on fiscal tightening than in scenario (i):  $\Delta r^* = -1\%$ ,  $\Delta \delta_D^* = -2.1\%$  of output. That is, when inflation exceeds the target, the central bank has less monetary space for policy loosening; the burden of adjustment will thus be shifted to the fiscal authority.

Since the external sustainability (ES) calculation does not consider inflation, the monetary policy prescribed therein is identical to that in scenario (i). Instead, the internal stabilization (IS) calculation differs from scenario (i). To bring the inflation rate back to its target under the assumption of no fiscal adjustment, interest rates must

**Table 2.** Adjustments required for external and internal stabilization; alternative scenarios.

		Scenarios:					
		(i)	(ii)	(iii)	(iv)	(v)	(vi)
External gap (deficit +)	$nx^* - nx$	0.5%	0.5%	1.5%	1.5%	-1.5%	-1.5%
Internal (inflation) gap	$\pi^* - \pi$	0.0%	-1.5%	0.0%	-1.5%	0.0%	-1.5%
Required monetary adjustment, general case	$\Delta r^*$	-2.0%	-1.0%	-6.0%	-5.0%	6.0%	7.0%
Required fiscal adjustment, general case	$\Delta \delta_D^*$	-0.7%	-2.1%	-2.1%	-3.5%	2.1%	0.7%
Required monetary adjustment, ES/Fiscal Intran.	$\pi^* - \pi^{ES}$	-2.5%	-2.5%	-7.5%	-7.5%	7.5%	7.5%
Internal inflation gap	$\Delta r^{IS}$	-0.8%	-2.3%	-2.3%	-3.8%	2.3%	0.8%
Required monetary adjustment, IS/Fiscal Intran.	$nx^* - nx^{IS}$	0.0%	5.0%	0.0%	5.0%	0.0%	5.0%
External gap	$\Delta r^{ES}$	0.5%	1.5%	1.5%	2.5%	-1.5%	-0.5%

Note: Net exports (nx) and fiscal adjustment ( $\delta_D$ ) are expressed as a percent of output.

Source: Author's calculations.

rise – and the real exchange rate must *appreciate* – by 500 basis points. While the inflation rate returns to the target, the trade balance deteriorates by 1 ½ percent of GDP –  $nx^* - nx^{IS} = 1.5\%$ .

As we illustrate in the next section, such a policy implies that the country's net foreign asset position will deteriorate precisely because the central bank has diligently attacked the inflation problem – but on a “go it alone” basis, without any help from the fiscal authority.

The implications of a higher trade balance deficit are clear: at some point in the future, the country will have to run an even higher trade balance *surplus* to service its obligations.

Foreign investors will likely view both excess inflation and fiscal intransigence unfavourably – *even though these are not external sector factors per se*. They will see that, as a result of the central bank's “go it alone” disinflation policy, the deficit will be larger than otherwise by the amount  $nx^{IS} - nx = 1\%$  and the real exchange rate will be even more overvalued than otherwise by the amount  $\Delta r^{IS} - \Delta r^* = 7.5\%$  (5% plus 2.5%). Thus, the calculation developed herein permits us to quantify the *latent* external vulnerability brought about by excess inflation and fiscal intransigence.

We can also apply this framework to surplus countries. Scenario (v) assumes a moderate *surplus* (negative gap) on net exports,  $nx^* - nx = -1.5\%$  of output – the country is acquiring claims on the rest of the world on an unsustainable basis. At the same time, the inflation target is met  $\pi^* - \pi = 0$ . Unsurprisingly, under the general (cooperative) policy, the monetary tightening/real appreciation is combined with a more expansionary fiscal policy:  $\Delta r^* = 6\%$ ,  $\Delta \delta_D^* = 2.1\%$  of output. The external sustainability framework would indicate even more monetary tightening and exchange rate appreciation,  $\Delta r^{ES} = 7.5\%$ ; such a policy would bring on a recession and pull inflation substantially *below* the target:  $\pi^* - \pi^{ES} = 2.3\%$ .

In the same vein, scenario (vi) maintains the *surplus* assumption from the above: as before the country is acquiring foreign assets. At the same time, the country's inflation rate exceeds its target:  $\pi^* - \pi = -1.5\%$ . Now, under the general (cooperative) policy, the monetary authority must tighten even more while there is less room for a fiscal expansion:  $\Delta r^* = 7\%$ ,  $\Delta \delta_D^* = 0.7\%$  of output. The external sustainability (ES) objective again indicates that monetary policy should be tightened and the real exchange rate should appreciate:  $\Delta r^{ES} = 7.5\%$ ; such a policy will bring the inflation rate closer to its target  $\pi^* - \pi^{ES} = 0.8\%$  – modestly below target. Importantly, using monetary policy exclusively to reduce inflation would mean a monetary tightening of  $\Delta r^{IS} = 5\%$ ; doing so would also bring net exports closer to their target value:  $nx^* - nx^{IS} = -0.5\%$ .

### 3.6. Coordination versus fiscal intransigence if the EML fails

The previous analysis confirmed that, if the EML condition holds ( $a_{11} < 0$ ) and the country's external imbalance is one of a deficit (i.e., scenarios (i)–(iv) in Table 1, above), a monetary loosening is required. Without a corresponding fiscal tightening, the monetary loosening (and hence exchange rate depreciation) required to close the gap will be even higher; this means higher inflation. Put differently, if the EML holds, the external gap can *never* be closed with a tighter monetary policy.

However, a failure of the EML does not mean that monetary and fiscal policy do not need to be coordinated. Rather, even if the EML fails, a fiscal adjustment may still be an



important component of a strategy to close an external deficit and bring inflation back to its target. It is possible that, without the fiscal adjustment, the monetary adjustment required to close the external gap will be severe – enough so as to generate a recession. To see how this might happen, insert Equation (12) into Equation (13):

$$\pi^{ES} = \pi + a_{21}\Delta r^{ES} = \pi + a_{21} \left[ \frac{nx - nx^*}{a_{11}} \right] = \pi + \frac{a_{21}}{a_{11}} (nx - nx^*). \quad (13a)$$

Note that  $a_{21} < 0$ . If EML fails to hold,  $a_{11} > 0$ . Therefore, the monetary tightening required to reduce the net export gap will reduce the inflation rate (i.e., the ratio of  $a_{21}$  to  $a_{11}$  is negative). Note also that this ratio is proportional to the ratio of the Phillips curve parameter  $\kappa$  to the import response parameter  $\alpha_3$ . A relatively low value for the latter will rise in absolute terms the impact on inflation. The intuition on this is clear: for a given deficit on net exports, the less responsive are imports to output ( $abs(\alpha_3)$  small) implies that the required interest rate adjustment is more severe – as is the recessionary impact of that adjustment. Conversely, under the general cooperative policy implied by Equation (9), the interest rate adjustment will be less severe than the restricted policy implied by Equation (12) – precisely because the fiscal authority is shouldering part of the adjustment burden.

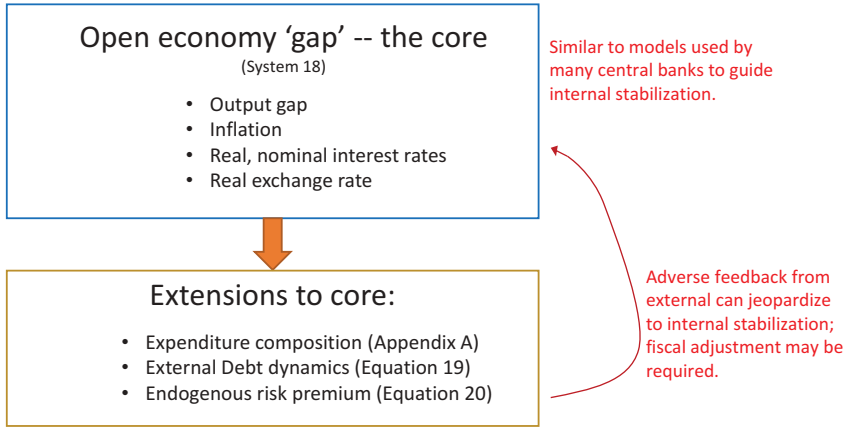
#### 4. Disinflation, the external position, and credibility: a dynamic analysis

The static calculations in the previous section are designed to convey a sense of an economy's imbalances and external vulnerabilities as a static snapshot – a “back of the envelope” assessment. While this method can be a powerful communication tool, it suffers from several limitations. First, inflation is in part determined by expectations which can change over time. In the calculations above, expected inflation is assumed to remain constant – clearly an unrealistic assumption. Second, the idea of external sustainability cannot be properly illustrated in such a static framework: as external obligations are accumulated (holding all else constant), the target (or debt stabilizing) net export ratio must also change. Third, the policy adjustments required to stabilize the economy might be too draconian to take place on a one-shot basis.

For this reason, we conduct a dynamic analysis – multiple periods. In this way, we can track the key variables such as inflation and external debt, under alternative disinflation scenarios, *over time*. Increasingly, dynamic models which rely on a New Keynesian framework (see Walsh, 2003, pp 245–247) have become an important part of the policy toolbox, including by the International Monetary Fund (see, for example, Berg, Karam, & Laxton, 2006; International Monetary Fund, 2016).

As Figure 6 suggests, such models closely resemble the *core* of the model presented here. However, we *extend* that core model to show the evolution of the external sector (net exports, external debt) and *domestic* fiscal–monetary interactions (discussed in Appendix D online).

Figure 6 thus summarizes our dynamic analysis – multiple periods. In this way, we can track the key variables such as inflation and external debt, under alternative disinflation scenarios, *over time*. Increasingly, dynamic models which rely on a New Keynesian framework (see Walsh, 2003, pp 245–247) have become an important part of the policy toolbox, including by the International Monetary Fund (see, for example, Berg et al., 2006; International Monetary Fund, 2016).



**Figure 6.** Dynamic model – core and extension.

#### 4.1. A dynamic new keynesian model: core and extension

As is true with most New Keynesian models, we focus on the demand side.<sup>9</sup> However, the model does extend current literature insofar as it is augmented with several hybrid elements.

The dynamic IS curve is written:

$$y_t = \frac{\theta E y_{t+1} + \alpha_2 (i_t - E\pi_{t+1} - \bar{r})) + \eta(q_t - \bar{q}) + \rho y_{t-1} + \alpha_{2L} (i_{t-1} - E\pi_t - \bar{r}) + \delta_t}{(1 + \alpha_D)}, \quad (14)$$

where  $\alpha_D$  represents the sum of the saving and import parameters  $\alpha_1$  and  $\alpha_3$  as discussed above,  $E$  is the expectations operator, and  $\theta$  links current and expected future expenditures ( $0 \leq \theta \leq 1$ ).<sup>10</sup> Note also that  $\delta_t = \delta_{D,t} + \delta_{NX,t}$  is the demand shift parameter,  $q_t$  is the logarithm of the real exchange rate index,  $\bar{q}$  is the natural value thereof (assumed to be zero). Finally, as is common in such models (see, for example, Berg et al., 2006), lagged terms for output  $\rho y_{t-1}$  and the real interest rate  $\alpha_{2L} (i_{t-1} - E\pi_t - \bar{r})$  are also included in the IS curve.

Note that the real exchange rate remains linked to the real interest differential minus a time-varying risk premium  $rp_t$ . In its log-level form, the real interest parity condition links the current real exchange rate to its expected future value  $Eq_{t+1}$  according to the forward-looking relationship:

$$q_t = i_t - E\pi_{t+1} - i_t^{EXT} + E\pi_{t+1}^{EXT} - rp_t + Eq_{t+1}, \quad (15)$$

<sup>9</sup>An interesting extension would be to also incorporate supply side effects of fiscal policy. This is left for another paper.

<sup>10</sup>As shown in Appendix B, the parameter  $\theta$  may be interpreted as the fraction of households whose expenditures obey an intertemporal (Euler) relationship. If  $\theta = 1$ , all households are "Ricardian" in the sense that their expenditures obey an intertemporal (Euler) relationship. In a more general case,  $0 < \theta < 1$ , the economy is assumed to include both "Ricardian" and "Non-Ricardian" households that follow a "rule-of-thumb" expenditure function. The importance of distinguishing between these two kinds of households for monetary policy is discussed in several papers, including Mankiw (2000) and Gali et al. (2004). In this paper, and as shown in Appendix B, under the general case,  $\alpha_D$  captures the induced component of domestic expenditures when both kinds of households are present.

where  $\pi^{EXT}$  is the external (exogenous) rate of inflation. The interpretation of all other parameters is identical to that of the static model of the previous section. Monetary policy is expressed in terms of a Taylor-type reaction function:

$$i_t = \bar{r} + E\pi_{t+1} + \beta_\pi(\pi_t - \pi^*) + \beta_y y_t + i_t^{DISC}, \quad (16)$$

where  $i_t$  is the nominal interest rate,  $\beta_\pi$  and  $\beta_y$  reflect the central bank's dual mandate of both price and output stability, and  $i_t^{DISC}$  captures any discretionary deviation from the rule.

Next, the Phillips curve is modified to read:

$$\pi_t = \psi E\pi_{t+1} + (1 - \psi)\pi_{t-1} + \kappa * (y_t - z_t) + \theta_{rp} r p_t. \quad (17)$$

Following Gali and Gertler (1999), we may think of the Phillips curve as a *hybrid* one that includes both a forward-looking element to expectations  $\psi E\pi_{t+1}$  and an inertial or backward-looking component  $(1 - \psi)\pi_{t-1}$ , where  $0 < \psi < 1$ .

In this context,  $\psi$  has a commonsense interpretation: *internal credibility*. If  $\psi$  equals unity, forward-looking agents incorporate the fact that the central bank will bring inflation to its target level – with full credibility. For lower values of  $\psi$ , economic agents doubt the central banks' intentions or its willpower; instead, such agents take a sceptical or “show-me” attitude: they do not fully believe in the central bank's ability to bring inflation to the target – until it finally happens. This interpretation of the hybrid Phillips curve has come to be a standard one (see, for example, Berg et al., 2006). *This paper adopts such an interpretation as the correct one.*

Also, the Phillips curve permits the model to incorporate *the exchange rate pass-through* through the risk premium, insofar as  $\theta_{rp} > 0$ . Evidence provided by Campa and Goldberg (2005) and Cook and Choi (2008) suggests that such a parameter be included. The interpretation of this formulation is that a depreciation of the real exchange rate will boost the inflation rate *above and beyond* any demand effect (which works endogenously through the output gap).<sup>11</sup>

Jointly, these equations are combined to form a system – the *core* of the model:

$$A \begin{bmatrix} y_t \\ \pi_t \\ q_t \end{bmatrix} = B \begin{bmatrix} Ey_{t+1} \\ E\pi_{t+1} \\ Eq_{t+1} \end{bmatrix} + C \begin{bmatrix} i_t^{DISC} \\ r p_t \\ \delta_t \\ \pi^* \\ \bar{q} \\ \pi_{t-1} \\ z_t \\ (r_t^{EXT} - \bar{r}) \\ y_{t-1} \\ (i_{t-1} - E\pi_t - \bar{r}) \end{bmatrix}, \quad (18)$$

where:

<sup>11</sup>Since the risk premium appears in the Phillips curve, the central bank will raise domestic interest rates when the external risk premium rises. Beyond inflation, such a linkage may reflect central bank concerns about the balance sheet effects of exchange rate movements, as suggested by Calvo and Reinhart's (2002) discussion of “fear of floating”. See also Berg et al. (2006), Elekdag and Tchakarov (2007), and Vegh, Morano, Friedheim, and Rojas (2017), and Tanner (2018).

$$A = \begin{bmatrix} [(1 + \alpha_D) - \alpha_2 \beta_y] & -\alpha_2 \beta_\pi & -\eta \\ -\kappa & 1 & 0 \\ -\beta_y & -\beta_\pi & 1 \end{bmatrix}, B = \begin{bmatrix} \theta & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix},$$

and

$$C = \begin{bmatrix} \alpha_2 & 0 & 1 & -\alpha_2 \beta_\pi & -\eta & 0 & 0 & 0 & \theta_L & \alpha_{2L} \\ 0 & \theta_{rp} & 0 & 0 & 0 & (1 - \psi) & -\kappa & 0 & 0 & 0 \\ 1 & (\beta_{rp} - 1) & 0 & -\beta_\pi & 0 & 0 & 0 & -1 & 0 & 0 \end{bmatrix}.$$

Thus, system (18) forms the *core* of the model. Importantly, after all of the impacts of economic shocks die out, the economy returns to a steady state according to the terminal conditions for output, inflation, and the real exchange rate, namely  $\lim_{t \rightarrow \infty} E y_t = 0$ ,  $\lim_{t \rightarrow \infty} E \pi_t = \pi^*$ , and  $\lim_{t \rightarrow \infty} E q_t = \bar{q}$ , where  $\bar{q}$  is the long-run equilibrium real exchange rate that is consistent with both internal and external balance.

We next *extend* this dynamic model so as to track the evolution of foreign obligations; for simplicity, we assume that all foreign obligations take the form of debt whose interest rate is  $r^{EXT}$ . We assume that the *initial* ratio of debt to output is:  $d_0^F = D_0^F / Y_0$ . In subsequent periods, external debt evolves according to a standard dynamic equation:

In subsequent periods, external debt evolves according to a standard dynamic equation:

$$d_t^F = d_{t-1}^F \frac{(1 + r^{EXT} + r p_t)}{(1 + \hat{y})(1 + \hat{q})} - n x_t, \quad (19)$$

where  $\hat{y}$  and  $\hat{q}$  are growth rates of real domestic output and the real exchange rate, respectively. Note that Equation (19) corresponds to a simplified relationship between the current account and the net international investment position – under the assumption that primary and secondary income are both zero and deficits are financed exclusively by debt flows. The derivation of net exports is shown in [Appendix A](#).

*External balance redux: stabilizing foreign debt.* Schmitt-Grohé and Uribe (2003) note that in open economy models which include permit cross-border trade in assets, care must be taken to ensure that the key variables of the model return to their steady state. This cautionary note applies here since the model includes foreign debt accumulation.

As suggested by Schmitt-Grohé and Uribe (2003), we must build into the model an assumption that prevents foreign debt from growing boundlessly. To do so, we implement one of the suggestions found in their paper, namely to include a debt-elastic risk premium, which is written here as:

$$r p_t = \begin{cases} v * (d_{t-1}^F - \bar{d}^F) & \text{if } d_{t-1}^F - \bar{d}^F > 0 \\ 0 & \text{otherwise} \end{cases} \quad (20)$$

where  $v > 0$  is the elasticity of the risk premium to debt. That is, the risk premium increases when external debt rises above some critical value  $\bar{d}^F$  but remains zero otherwise. In this paper,  $\bar{d}^F$  is assumed to be the initial value. We may think of  $v$  as an indicator of *external* credibility. A larger value for  $v$  indicates lower external credibility: market participants require compensation for the risk that the country will not be able to generate the net export surpluses require to repay the debt by

imposing upon itself the amount spending discipline required to repay the debt. Instead, with a positive value of  $v$  the country is forced to recompose its spending and increase net exports – the consequence of a more depreciated real exchange rate.<sup>12</sup>

Thus, a dynamic model permits us to define the concept of *external balance* in a more nuanced and sophisticated way than in a static model. In the static model from the previous section, an external balance was satisfied if its net export/GDP ratio was equal to some appropriate (norm) value at one point in time:  $nx_t = nx^*$ . By contrast, the dynamic model permits a more flexible definition, namely that the foreign debt ratio  $d_t^F$  is stabilized *over time*.

However, the element of exchange rate passthrough –  $\theta_{rp} > 0$  in Equation (17) – is a factor that may undermine debt sustainability. Why must this be so? The channels of transmission from exchange rate passthrough to external debt are indirect but should be straightforward: more passthrough means higher inflation that the central bank must resist – by raising interest rates. In so doing, however, the real exchange rate appreciates. Accordingly, and so long as the extended Marshall–Lerner condition holds (as discussed below), domestic monetary tightening will further push down on net exports – and will further boost foreign debt.

Consider the context of a disinflation where the initial rate of inflation is substantially above the target level. In such a context, such a feedback channel may be very important. If this effect is strong enough, foreign debt will not return to its long-run value but instead may return to a new, higher value, or even continue to drift upward in an unstable fashion. Thus, in such a context, a question arises: will a debt-elastic risk premium ( $v > 0$ ) be *sufficient* to ensure that the debt does grow boundlessly if exchange rate depreciation is passed through to inflation – i.e., if  $\theta_{rp} > 0$ .

In the previous section, the issue of macroeconomic stabilization was introduced in a static framework. However, this discussion suggests that the definition of stabilization needs to be modified for a dynamic setting. Specifically, in this dynamic context, internal balance means bringing output back to potential and inflation back to its target over time. The dynamic counterpart to external balance means stabilizing the external debt at its original steady-state level. However, as we will show, in the dynamic context – as in the static one – *both fiscal and monetary adjustments may be required to fully stabilize the economy – both internally and externally*.

*Calibration Issues:* The calibration in this paper is meant to reflect a hypothetical or representative country, rather than any specific country. However, there are certain key responses in the model which should correspond, in rough terms, to established standards which have been already proposed and accepted in the extant literature on New Keynesian monetary models. A summary of assumed parameters for the dynamic model is shown in [Appendix C, Table A2](#).

*Interest rate impacts on output and inflation.* One of the main objectives of models like the one used in this paper is to evaluate the impact of monetary policy. In this vein, any such model will require assumptions regarding the impact of a monetary policy shock. Since this element is a common one across models, the aim here is to ensure that

<sup>12</sup>According to Schmitt-Grohé and Uribe (2003) assumptions, the risk premium is assumed to be a predictable function of external debt. As a matter of empirics, the risk premium may not behave in such a predictable fashion. The literature on “sudden stops” (see, for example, Calvo & Reinhart, 2000), suggests that severe increases in the risk premium can occur on an abrupt and unexpected basis. If movements in the risk premium are abrupt and unpredictable, internal macroeconomic stabilization will likely be *even more difficult*.

a discretionary shock to the interest rate results in reactions to output and inflation whose magnitude and duration are not inconsistent with other such models. However, much of the extant literature examines advanced economies (i.e., the United States and Europe) where more financial development would likely mean that monetary transmission is more robust than in emerging or frontier economies, where financial markets may be less developed.

Two widely cited studies of monetary transmission are Christiano, Eichenbaum, and Evans (2005) and Smets and Wouters (2007). Results in these studies suggest that the impact of a change in the interest rate on the output gap could be in the vicinity of minus one-to-one – i.e., a 0.5% increase in the interest rate would bring about an output drop of 0.5% below potential. Regarding inflation, their estimates, which reflect the presence of short-term price rigidities, suggest that the response of inflation to interest rates is considerably less, on the order of  $-1/2$  (i.e., a 0.5% increase in the interest rate might bring about a decrease of prices on the order of  $-0.25\%$ ).

On these key responses, our assumptions are considerably more conservative and more closely aligned with Berg et al. (2006) and International Monetary Fund (2016). Such assumptions reflect the fact that in emerging and frontier markets, the monetary transmission may be less robust than in industrialized countries. For example, their response of output gap to the interest rate is  $-0.1$  and to the real exchange rate at  $-0.05$ . In our model, these two terms are combined (corresponding to parity condition 15). Thus, our parameter estimate of  $-0.12$  (which includes impacts on both domestic and external sectors) is close to theirs. Our model also reflects price stickiness that is in line with these models: a one-percent increase in the interest rate will, in the short term, bring inflation down by  $.015$  percent.

#### **4.1.1. Interest rate impacts on the trade balance**

Surprisingly, the relationship between the trade balance and monetary policy has received less attention in the economics literature than the output-gap relationships. In this paper, the baseline calibration assumes that the expanded Marshall–Lerner condition, as discussed in the previous section, holds in the short run. Studies by Kim (2001), and more recently, Adler and Osorio Buitron (2017), suggest that such an assumption is justifiable, based on empirical evidence; however, as with other calibrations, our assumed impacts are somewhat more conservative than this most recent study.

#### **4.1.2. Response of risk premium to changes in Foreign debt**

The relationship between the interest rate and foreign debt is also one that has been difficult to empirically determine. We follow Hostland and Karam (2005) who assume a relatively modest response – 0.1% increase in the interest rate for a 1% increase in debt above the threshold value. (Note that estimates of an appropriate threshold value for external debt are also fraught with uncertainty, can vary dramatically across the country, and can be path dependent, as research on “debt intolerance” by Reinhart, Rogoff & Savastano, 2003, demonstrated).

### 4.1.3. Exchange rate passthrough

Regarding the degree of exchange rate pass-through, the calibration in this paper draws on work by Choudhri and Hakura (2006) who show that the degree of pass-through, while uncertain and country-specific, tends to be higher in moderate- or high-inflation countries than in low-inflation countries. In this paper, the main policy experiment contemplates a reduction of inflation from moderate (about 9%) to low (about 4.5%). Accordingly, and based on evidence in their paper, our assumed value of  $\theta_{rp} \approx 1/3$  roughly corresponds to their estimates.

## 4.2. The toxic mix again: high inflation, external deficits, and low credibility

The analysis focuses on what is arguably the most toxic mix of circumstances: inflation above the target and external deficits. The analysis suggests that if central bank enjoys high credibility – as reflected in greater weight on the forward-looking component of inflation forecasts (higher values of  $\psi$ ) – it is better poised to reduce inflation while also keeping external debt stable under a “go it alone” strategy – *without* a fiscal adjustment. By contrast, if some members of the public take a sceptical or “show-me” attitude towards disinflation, despite the declared inflation target, the assumption of forward-looking expectations may be “unjustifiably strong” (Woodford, 2013). Instead, in an environment where such a “show me” attitude is more prevalent, values of  $\psi$  will be lower than otherwise, suggesting that expectations will have an adaptive component – they are “sticky.” Importantly, Gali and Gertler (2007) explore a comparison that is similar to the one presented here – *a contrast between a high-credibility and a low-credibility environment*.

Even though the interpretation of the Galí/Gertler hybrid curve is standard, the question remains: which value of  $\psi$  is appropriate? In answering this question, it is natural to refer to evidence relevant to emerging market countries. Even though estimates of  $\psi$  tend to be near unity for industrialized countries (estimates of  $\psi$  for the United States of 0.7 or higher were reported by Galí/Gertler themselves), there may be more inflationary inertia in emerging markets. For example, in several transition economies, Basarać, Škrabić, and Sorić (2011) find that there is substantial weight on the backward-looking component of inflation ( $\psi$  close to zero). Likewise, Cerisola and Gelos (2009) note that, in Brazil, there is a positive and statistically significant relationship between survey data for  $E\pi_{t+1}$  and  $\pi_{t-1}$ .

Importantly, Cerisola and Gelos (2009) also present evidence that  $\psi$  is time-varying: it rises when the inflation rate itself rises. Such a finding brings to mind what might be a broader question to ask when choosing a value for  $\psi$ : Are inflation expectations in these countries tightly anchored to their target or are they sensitive to short-term economic developments. On this broader question, De Pooter, Robitaille, Walker, and Zdinak (2014) do provide evidence that short-term economic developments can indeed unhinge inflationary expectations away from the target. If so, and if those short-term developments are reflected in the observed inflation rate, *a lower value of  $\psi$  is justified, as is the cross-regime comparison proposed by Gali and Gertler (2007)*.

We examine results for several scenarios where the value of  $\psi$  for several alternative values that range from zero to unity:  $\psi = (0.01, 0.1, 0.2, 0.4, 0.6, 0.8, 0.9)$ . In all scenarios, the country's initial debt ratio is 15% of GDP, the initial inflation rate is 9%, and the final target

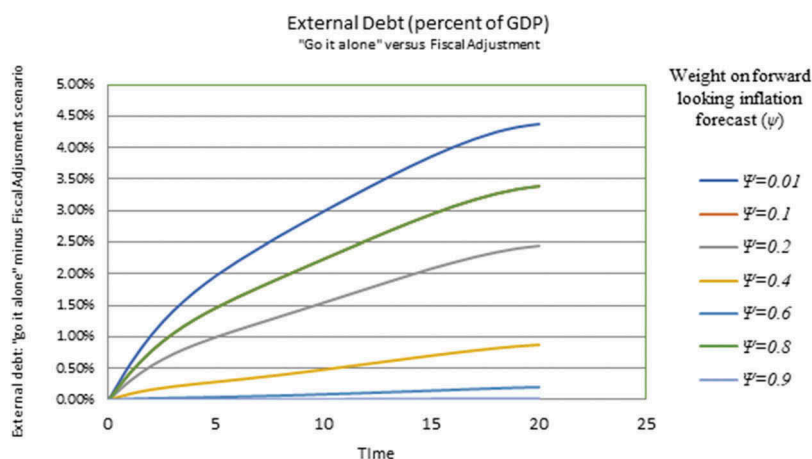


is 4.5%. All scenarios satisfy the same policy goal, inflation is brought back to the target in 5 years (20 quarters). The results are summarized graphically in Figure 7 through 12.<sup>13</sup>

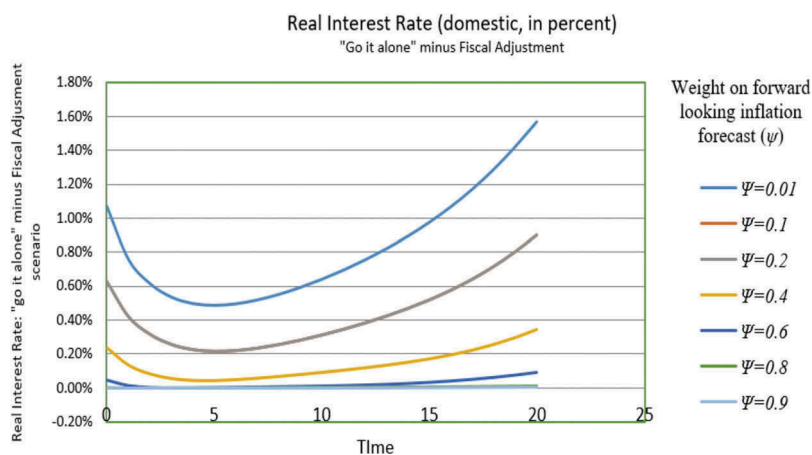
Figure 7 shows the trajectory of external debt (as a ratio to GDP) over the disinflation period under a “go it alone” (no fiscal adjustment) scenario, for alternative values of  $\psi$ . The debt ratio rises more rapidly for lower values of  $\psi$  – if inflation forecasts are less forward looking.

If inertial inflation is assumed to take on only moderate values –  $\psi = 0.4$ , debt accumulation is modest but non-trivial. However, as the value of  $\psi$  near unity, impacts on the debt ratio vanish.

Figure 8 compares trajectories for real interest rates between a “go it alone” scenario and a fiscal adjustment scenario. Under the “go it alone” scenario the central bank must



**Figure 7.** External debt (percent of output).



**Figure 8.** Real interest rate (Domestic, in percent).

<sup>13</sup>A spreadsheet-based tool which generates these results is available online at: <http://www.evanctanner.com/mundell-arithmetic>.



raise interest rates more severely than if fiscal adjustment takes place as well. The gap between these scenarios is higher for scenarios where inflation forecasts are less forward looking – low values of  $\psi$ . As  $\psi$  approaches unity, the gap between interest rates under the two scenarios nearly vanishes.

Figure 9 shows the fiscal adjustment required to stabilize debt (keeping the inflation target constant). The fiscal adjustment is assumed to be spread equally over time. The figure shows that the required fiscal adjustment is higher for cases where inflation forecasts are less forward looking – low values of  $\psi$ . As  $\psi$  approaches unity, the required fiscal adjustment becomes small.

Figure 10 compares trajectories for the real exchange rate between a “go it alone” scenario and a fiscal adjustment scenario. In the *initial* periods, for lower values of  $\psi$ , under a “go it alone scenario” the central bank must keep the real exchange rate at a more appreciated level than under a comparable fiscal adjustment scenario where debt is stabilized.

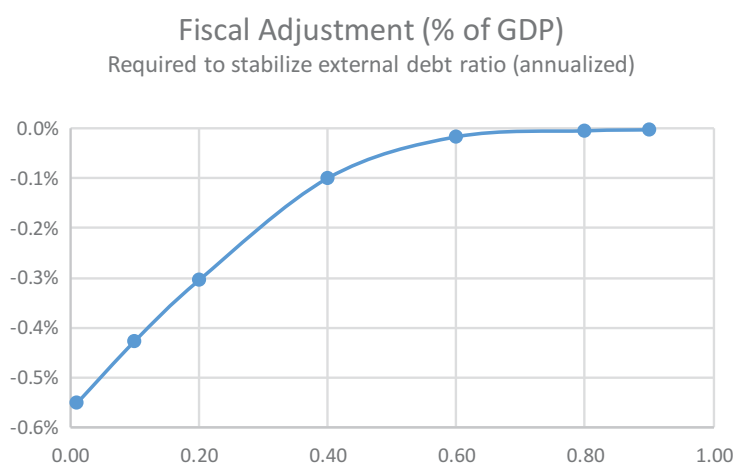


Figure 9. Fiscal adjustment (% of GDP).

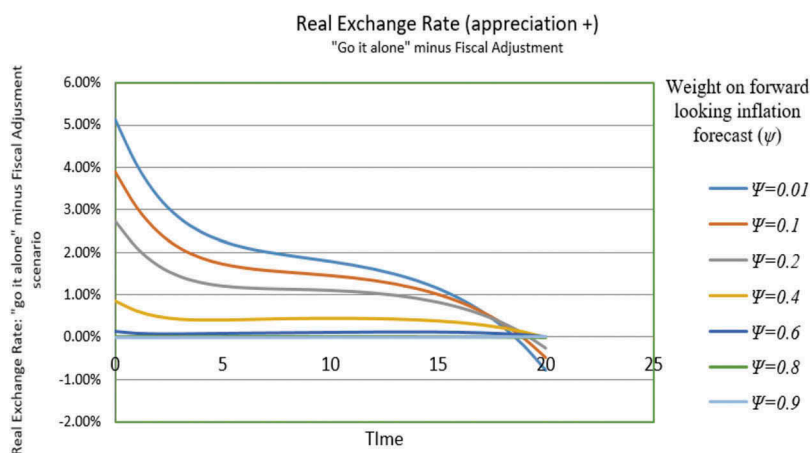


Figure 10. Real exchange rate (Appreciation +).

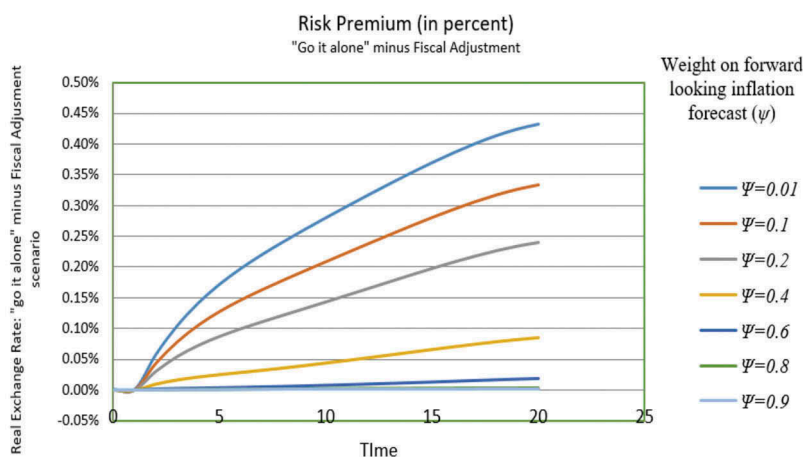
To a large degree, the gap for the additional appreciation under the “go it alone” scenario reflects the additional monetary tightening that the central bank must make if it does not enjoy a supportive fiscal adjustment.

Note, however, that over time the real exchange rate under the “go it alone” scenario gradually depreciates. Why? As discussed above, in these scenarios, external debt is increasing. Hence, and as discussed below (in [Figure 10](#)), the risk premium rises – a factor that brings about a depreciation of the real exchange rate. This effect tends to be dominant after 20 periods; thus, by the end of the time window, for cases where values of  $\psi$  are lower (lower central bank credibility), the real exchange rate is less valuable under the “go it alone” scenario than under the cooperative scenario. Note finally that, for higher values of  $\psi$  (higher central bank credibility) there is less variability in the real exchange rate.

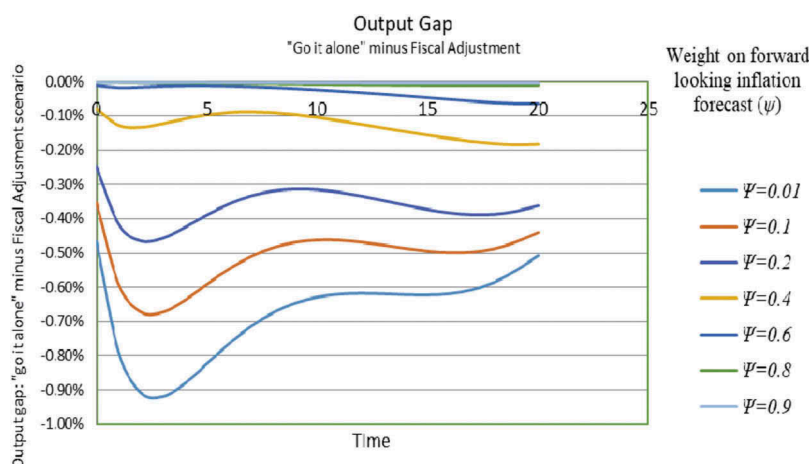
[Figure 11](#) compares trajectories for the external risk premium between a “go it alone” scenario and a fiscal adjustment scenario. Under a “go it alone scenario” the risk premium on external debt rises, mirroring the ratio of external debt to GDP which is also rising. The risk premium – which reflects external sustainability concerns – is more severe for cases where inflation forecasts are less forward looking – low values of  $\psi$ .

[Figure 12](#) compares trajectories for the output gap between a “go it alone” scenario and a fiscal adjustment scenario. Note that for higher values of  $\psi$ , there is little variability of the output gap under either “go it alone” or cooperative scenario. This reflects that fact that when credibility is high, the central bank has an easy job in bringing down inflation – without imposing a sacrifice on the economy.

However, for lower values of  $\psi$  the story is different: bringing down the inflation rate does entail a sacrifice – a negative output gap. The question is: where will the sacrifice be greater – if the only monetary policy is tightened (“go it alone”) or if some combination of fiscal and monetary policy occurs? The answer depends on the relative strengths of the channels of transmission. In the calibration shown here, the sacrifice is more severe under the “go it alone” policy than under if both monetary and fiscal adjustments take place. Why?



**Figure 11.** Risk Premium (in Percent).



**Figure 12.** Output gap – in percent of potential output.

First, a monetary tightening will bring down both the domestic and the external components of output. By contrast, a fiscal tightening will reduce domestic demand but increase net exports.

Second, raising the interest rate to reduce inflation becomes a less effective policy if there is exchange rate passthrough and a rising risk premium. In the calibration chosen, such effects were strong enough to warrant an even bigger output-gap sacrifice. By contrast, if the authority implements a fiscal adjustment, such pass-through and risk premium effects are dampened – and hence the output-gap sacrifice is reduced.

Finally, note that even though this paper has emphasized implications for external balance – i.e., foreign debt – there are also important fiscal and monetary implications that are largely domestic in nature. *These implications are shown in Appendix D.*

## 5. Summary and conclusions

This paper has focused on the policy challenges a country faces when it wants to both reduce inflation and maintain a sustainable external position. According to Robert Mundell's (1962) policy assignment framework, we know that these two goals can conflict with one another unless monetary and fiscal policies are properly coordinated. Unfortunately, if the fiscal authority is unwilling or unable to cooperate – a case of *fiscal intransigence* – reconciling these two goals can be difficult. Central banks that pursue a disinflation on a “go it alone” basis – without a supporting fiscal adjustment – will likely help widen the country's external deficits and worsen its net external liability position.

In this case, the country becomes more vulnerable to a sudden reversal of flows in the external financial account, potentially causing an abrupt depreciation of the exchange rate that may also be transmitted to increased domestic inflation. In this sense, the analysis echoes Sargent and Wallace (1981) observation that, without cooperation from the fiscal authority, “although fighting current inflation with tight monetary policy works temporarily, it eventually leads to higher inflation.” However, the analysis extends its analysis to an open economy, tracing the impacts of fiscal and monetary policy on net external debt.

The paper first presents a static “back of the envelope” calculation that yields a joint assessment of the adjustments to the real exchange rate (i.e., exchange rate misalignment) and domestic absorption (i.e., fiscal adjustment) required to reach both inflation and external goals simultaneously. It is shown that a familiar approach to estimate misalignment of the real exchange rate – an approach that is part of the Fund’s External Balance Assessment (EBA) – is a special case that implicitly treats inflation goals and fiscal policy as exogenously determined. As another case, if the central bank tightens monetary policy in order to reduce inflation on a “go it alone” (fiscal dominant) basis, the degree of real exchange rate overvaluation will be more severe than otherwise.

The paper then examines the same issues in a dynamic setting. We introduce alternative assumptions regarding how forward looking are inflation forecasts. When the central bank is more credible, economic agents will form their expectations of inflation in a forward-looking manner. When the central bank lacks credibility, agents will instead take a sceptical “wait and see” approach, basing their expectations on what they have already observed.

Central banks that enjoy more credibility will have an easier time reducing inflation than those with less credibility. For higher credibility central banks, the monetary tightening required to reach the inflation target will be lower; the degree of appreciation of the real exchange rate and hence external debt accumulation will be smaller. However, if the fiscal authority chooses to cooperate, the fiscal adjustment required to stabilize the debt will also be less severe when central bank credibility is higher.

On the other hand, lower central bank credibility means that the monetary tightening required to reach the inflation target will be more severe, the degree of real exchange rate appreciation and hence external debt accumulation will be higher, and the fiscal adjustment required to stabilize foreign debt will be more severe.

The analysis in this paper also provides a cautionary note regarding the model that is used to help country authorities reduce inflation. In recent years, central banks have increasingly relied on models that focus on key internal gaps (output, inflation, interest rate) and the real exchange rate – as contained in the *core* of the model herein. Unlike this paper, issues related to fiscal or external balances are largely absent<sup>14</sup> Such models have two key purposes. First, they are intended to indicate the appropriate *monetary* policy that would be required to achieve a given inflation target over a given time frame. Second, they are intended to guide *expectations* regarding both the output gap – i.e., how bad the output sacrifice will be – and the evolution of inflationary expectations themselves.

This paper proposes to extend such a model in a way that also projects the likely evolution of the trade balance, external debt, and other key external sector variables. Unless a “gap model” a model is so extended – as is done in this paper – it may not be adequate for the task at hand: substantially reducing inflation. Why not?

First, without such an extension, the model may unintentionally mask what is an *implicit* goal of a “go-it-alone” disinflation strategy: expenditure switching. That is, in its attempt to keep the real exchange rate, the output gap is restrained because – *by design* – the central bank has shifted some demand abroad; lower net exports.

Second, without such an extension, the model is *inherently* unable to account for changes in the risk premium that occur endogenously. That is, financial markets are likely

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<sup>14</sup>That is, such models would incorporate Equations (14) through (18) but would not include Equation (19) or the expenditure breakdown in Appendix A. An example of such a model is International Monetary Fund (2016).

to tighten as a direct and offsetting response to domestic monetary tightening. The dynamic analysis shows that foreign financial tightening (i.e., “capital outflows”) will likely jeopardize the efforts to reduce inflation – including by worsening the sacrifice ratio.

Third, such a model is unable to provide a full comparison of a non-cooperative “go-it-alone” monetary tightening against a cooperative strategy where both fiscal and monetary authorities contribute to the task at hand. By contrast, the analysis in this paper, by reviving “two-instrument, two-target” approach, shows a way to make such a comparison.

Importantly, increases in the risk premium may not take place in a way that is as orderly or predictable as is assumed in this model. Rather, a severe financial tightening can occur abruptly and unpredictably – “sudden stops” in external financing as discussed by Calvo and Reinhart (2000), among others. Such unpredictability in external financial conditions means that it is even more important to pursue a cooperative strategy – both fiscal and monetary adjustments – to reduce inflation.

### Disclosure statement

No potential conflict of interest was reported by the author.

### Notes on contributor

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## Appendix A: Translating Percent of Potential Output into Currency Units

A key feature of this paper is that model results are available in both percent of potential output (i.e., the output gap) and real currency units (real Dollars, Peso, Bhat, and so on). The bridge between these two seemingly disparate units requires a simple assumption: in the steady state – when output equals potential, and both the interest rate and the real exchange rate are at their natural values – expenditure components are also pinned down to steady-state values. Such an idea, while straightforward, may not be generally recognized; see Tanner (2018) for further elaboration on this point.

To see how such an idea is applied in this paper, we reconsider the static IS curve developed herein (all results discussed in this appendix extend to the dynamic model as well). Note that output (gross domestic product) identically equals domestic expenditures ( $DE$ ) and net exports ( $NX$ ) – expressed in currency units:

$$Y = DE + NX . \quad (\text{A.1})$$

We may write the demand-side expression for each as:

$$DE = Y^P [\overline{de} + (1 - \alpha_1) * y + \alpha_2 * (r - \bar{r})] \quad (\text{A.2})$$

and

$$NX = Y^P [\overline{nx} - \alpha_3 y + \eta(q - \bar{q}) + \delta_{NX}] . \quad (\text{A.3})$$

where  $\overline{de}$  and  $\overline{nx}$  denote steady-state ratios to potential output for domestic expenditures (consumption plus investment plus government expenditures) and net exports, respectively. Substituting (A.2) and (A.3) into (A.1) and solving, we obtain:

$$Y = DE + NX = Y^P \{ \overline{de} + (1 - \alpha_1) * y + \alpha_2 * (r - \bar{r}) + \overline{nx} - \alpha_3 y + \eta(q - \bar{q}) + \delta_{NX} \} . \quad (\text{A.4})$$

Utilize the fact that  $\overline{de} + \overline{nx} = 1$ . Note also that we may think of steady-state currency values for domestic expenditures and net exports, namely:  $\overline{DE} = \overline{de} * Y^P$  and  $\overline{NX} = \overline{nx} * Y^P$ , respectively. This implies:

$$\frac{\overline{DE} + \overline{NX}}{Y^P} = 1. \quad (\text{A.5})$$

By using identity (A.5), divide equation (A.4) by potential output  $Y^P$  and then subtract one from both sides. Then, fully solving for the output gap  $y$  we obtain the output-gap expression for the IS curve – Equation (1) in the paper repeated below for convenience:

$$y = \frac{1}{(\alpha_1 + \alpha_3)} * [\alpha_2 * (r - \bar{r}) + \eta * (q - \bar{q}) + \delta_D + \delta_{NX}]. \quad (1)$$

Then, we substitute values for the equilibrium output gap, real interest rate, and real exchange rate into equation (A.3) to obtain equilibrium values for net exports – consistent with Equation (4) in the body of the paper, again repeated for convenience:

$$nx = -\alpha_3 y + \eta(q - \bar{q}) + \delta_{NX}. \quad (4)$$

And, as mentioned before, the logic above extends to the dynamic model. This feature is critical, insofar as it permits us to obtain the dynamics of external debt – Equation (19) repeated for convenience:

$$d_t^F = d_{t-1}^F \frac{(1 + r^{EXT} + rp_t)}{(1 + \hat{y})(1 + \hat{q})} - nx_t. \quad (19)$$

Thus, to know how external debt evolves, it is required that we make assumptions regarding the steady-state composition of output, namely  $\overline{de}$  and  $\overline{nx}$ . However, a key question remains: from where do we get those steady-state values? What is the equilibrium composition of expenditures – domestic versus foreign? In the existing literature, we see several approaches to this question. One would be to take the observed long-run values for such variables – an empirical approach based on the so-called “great ratios,” a concept first proposed by Klein and Kosobud (1961) and later expanded upon by King, Plosser, Stock, and Watson (1991), Ahmed and Rogers (2000), and Mills (2001). More recently such an approach has been applied to a dynamic stochastic general equilibrium (DSGE) setting; see Vitek (2015).

The empirically driven “great ratio” approach may be supported with theoretical foundations. For example, Tanner (2018) appeals to some basic elements of theoretical economic growth models. For example, the steady-state investment ratio should correspond to the volume of depreciation on the steady-state capital stock. Also, as suggested in that paper, the steady-state net export ratio should be one that ensures a sustainable trajectory for net foreign assets.

## Appendix B: The IS Curve: Combining Ricardian and Rule-of-Thumb Households

IS Equation (14) represents a model with two kinds of households – forward looking or “Ricardian” households (R) and “rule of thumb” (or hand-to-mouth) (H) households that represent proportions  $\theta$  and  $(1 - \theta)$  respectively of total output, where  $0 < \theta < 1$ . That is:

$$y_t^R = \theta y_t \quad (\text{A.6})$$

$$y_t^H = (1 - \theta)y_t. \quad (\text{A.7})$$

where  $y_t^R$  and  $y_t^H$  denote output from R and H households, respectively. The distinction between these two kinds of households is discussed in several papers, including Mankiw (2000) and Gali, Lopez-Salido, and Valles (2004).



For a representative Ricardian (R) household, the output gap  $y_t^R$  is described by the following equation:

$$y_t^R = \underbrace{Ey_{t+1}^R}_{\text{Expenditure Smoothing}} + \theta \underbrace{[\alpha_2(i_t - E\pi_{t+1} - \bar{r})]}_{\text{Current real interest rate}} + \underbrace{\eta(q_t - \bar{q})}_{\text{Real exchange rate "expenditure switching"}} + \underbrace{\rho y_{t-1}}_{\text{Lagged income}} + \underbrace{\alpha_{2L}(i_{t-1} - E\pi_t - \bar{r})}_{\text{Lagged real interest rate}} + \underbrace{\delta_t^R}_{\text{Demand shock}} - \underbrace{\alpha_3 y_t^R}_{\text{Imports}}. \quad (\text{A.8})$$

The first term on the right-hand side  $Ey_{t+1}^R$  corresponds to the idea that R households smooth their expenditures over time, in the sense that the level of current expenditures corresponds to their expected future value, reflecting an underlying intertemporal optimization – an Euler equation relationship. Note that deviations from this full-smoothing result will correspond to movements in the real interest rate and the real exchange rate, past output, and a demand shock. Note also that in any period, a fraction of expenditures  $\alpha_3$  corresponds to imports.

For a representative “rule of thumb” or “hand-to-mouth” (H) household, the output gap  $y_t^H$  is described by an equation that resembles a more traditional Keynesian IS curve:

$$y_t^H = (1 - \theta) \underbrace{[\alpha_2(i_t - E\pi_{t+1} - \bar{r})]}_{\text{Current real interest rate}} + \underbrace{\eta(q_t - \bar{q})}_{\text{Real exchange rate "expenditure switching"}} + \underbrace{\rho y_{t-1}}_{\text{Lagged income}} + \underbrace{\alpha_{2L}(i_{t-1} - E\pi_t - \bar{r})}_{\text{Lagged real interest rate}} - \underbrace{\delta_t^H}_{\text{Demand shock}} + \underbrace{\alpha_1 y_t^H}_{\text{Induced domestic expenditures}} - \underbrace{\alpha_3 y_t^H}_{\text{Imports}} \quad (\text{A.9})$$

The first term on the right-hand side  $\alpha_1 y_t^H$  corresponds to the induced domestic component of domestic expenditures: H household devotes a fraction  $\alpha_1$  of each unit of output to domestic expenditures. (That is,  $\alpha_1$  is a marginal propensity to spend.) The remainder of the equation is identical to that for R households.

To obtain total output (the sum of  $y_t^R$  and  $y_t^H$ ) we first substitute (A.6) into (A.8) and (A.7) into (A.9). We then isolate all terms in  $y_t$  on the left-hand side. We are now able to add the rewritten versions of (A.8) and (A.9) to obtain Equation (14) in the main body of the text, rewritten for convenience below:

$$y_t = \frac{\theta Ey_{t+1} + \alpha_2(i_t - E\pi_{t+1} - \bar{r}) + \eta(q_t - \bar{q}) + \rho y_{t-1} + \alpha_{2L}(i_{t-1} - E\pi_t - \bar{r}) + \delta_t}{(1 + \alpha_D)} \quad (14)$$

where  $(1 + \alpha_D) \equiv \theta(1 + \alpha_3) + (1 - \theta)(1 - \alpha_1 + \alpha_3)$  and  $\delta_t = \theta\delta_t^R + (1 - \theta)\delta_t^H$ . We have thus fully derived equation (14) in the text as a weighted average of R and H households. Households of type R, which comprise a fraction  $\theta$  of total output, link their current expenditures to their expected future expenditures – reflecting intertemporal optimization. Households of type H, which comprise a fraction  $(1 - \theta)$  of total output, link their current expenditures to their current output – in a “hand-to-mouth” or “rule-of-thumb” fashion.

## Appendix C: Model Parameters

**Table A1.** Parameters for the static model (Part 3 of paper; EML holds).

Propensity to save	$a_1$	0.3
Interest rate impact	$a_2$	−0.1
Propensity to import	$a_3$	0.05
Exchange rate impact	$\eta$	−0.25
Phillips Curve parameter	$k$	0.3

**Table A2.** Parameters: Dynamic model (Part 4 of paper).

IS Curve		
	$y_t = \frac{\theta E y_{t+1} + a_2(i_t - E\pi_{t+1} - \bar{r}) + \eta(a_t - \bar{q}) + \rho y_{t-1} + a_{2L}(i_{t-1} - E\pi_t - \bar{r}) + \delta_t}{(1 + a_D)}$	
$\theta$	Forward looking consumption ("Euler" parameter)	0.21
$a_2$	Real interest rate	−0.07
$\eta$	Real exchange rate	−0.06
$\rho$	Lagged output	0.58
$a_{2L}$	Lagged real interest rate	−0.08
$a_D$	Domestic demand parameter	−0.10
$a_3$	Net export response to gap (marginal propensity to import)	0.30
Monetary Reaction Function (Taylor-type rule)		
	$i_t = \bar{r} + E\pi_{t+1} + \beta_\pi(\pi_t - \pi^*) + \beta_y y_t + i_t^{DISC}$	
$\beta_\pi$	Inflation response	1.50
$\beta_y$	Output gap response	0.50
Phillips Curve		
	$\pi_t = \psi E\pi_{t+1} + (1 - \psi)\pi_{t-1} + k * (y_t - z_t) + \theta_{rp} r_t$	
$k$	Output gap response	0.12
$\theta_{rp}$	Passthrough	0.32

## Appendix D. Extension to Domestic Fiscal and Monetary Interactions

Even though this paper has emphasized implications for external balance – i.e., foreign debt – there are also important fiscal and monetary implications that are largely domestic in nature. Under the “go it alone” scenario, public debt will rise – both because there is no adjustment to the primary balance and because the primary balance will shrink during a recession. However, additional pressures will be placed on the public debt burden owing to the shrinkage of non-interest-bearing monetary liabilities – the base for seignorage revenues.

To see this, first note that public debt evolves according to:

$$D_t = D_{t-1}(1 + i_t) - PS_t - M_t - M_{t-1}, \quad (\text{A.10})$$

where  $D_t$  is public debt,  $PS_t$  is the primary (non-interest) surplus, and  $M_t$  represents the monetary liabilities available to the government. Scaling by output reveals the familiar debt dynamic equation in percent of output:

$$d_t = d_{t-1} \frac{(1 + r_t)}{(1 + \hat{y}_t)} - ps_t - \Delta \tilde{m}_t, \quad (\text{A.11})$$

where  $d$  and  $ps$  are government debt and the primary surplus a ratio to output,  $\hat{y}$  is output growth, and  $\Delta \tilde{m}_t$  reflects the change in money holding (i.e., seignorage) scaled by output, namely:

$$\Delta \tilde{m}_t = \frac{M_t - M_{t-1}}{Y_t P_t}, \quad (\text{A.12})$$

where  $P_t$  is the overall price level.

Thus, equations (A.10) through (A.12) help illustrate how a disinflation strategy can impact the country's fiscal position. First, and consistent with the previous discussion, tighter monetary policy will *directly* raise public debt by boosting the real interest payments on inherited debt:  $d_{t-1} r_t$ . Second, to the extent that revenues and expenditures are sensitive to the business cycle, a monetary tightening will reduce the cyclical element of the primary surplus, to the extent that revenues and expenditures are sensitive to the business cycle.

Finally, regarding a key fiscal-monetary interaction, tighter monetary policy will reduce the base for seignorage  $\Delta \tilde{m}_t$ : by raising interest rates and squeezing the demand for money, the central bank reduces the resources available to the government for interest-free financing.

More precisely, a monetary contraction money reduces this base – through changes in both output (scale) and interest rates (opportunity cost) effects. To gauge such impacts, assume a Cambridge equation for base money demand, namely:

$$\frac{M_t^d}{P_t} = Y_t^p [\bar{k} + \varepsilon_{m,y} * y_t + \phi_{m,i} * (i_t - \bar{i})], \quad (\text{A.13})$$

where  $\bar{k}$  is the normal (natural) value for the inverse of velocity (i.e., “fluidity”),  $\varepsilon_{m,y} > 0$  is the response of money demand to the output gap, and  $\phi_{m,i} < 0$  reflects the opportunity cost effect of nominal interest rates on money demand, where  $\bar{i} = \bar{r} + \pi^*$  is the steady-state *nominal* interest rate. Thus, note that if both  $y_t$  and  $i_t - \bar{i}$  are zero – output is at potential and there is no interest rate gap – velocity is at its baseline value,  $1/\bar{k}$ . A monetary tightening will increase velocity and reduce money demand through both the output gap and interest rate channels. Therefore, money demand as a fraction of potential output is:

$$m_t = [\bar{k} + \varepsilon_{m,y} * y_t + \phi_{m,i} * (i_t - \bar{i})]. \quad (\text{A.14})$$

Accordingly, to compare the impacts on the base for seignorage across policies – “go it alone” versus cooperative – we can calculate the following monetary gap (*mongap*) between policies A and C:<sup>15</sup>

$$mongap_t = \left[ \underbrace{\varepsilon_{m,y} * (y_t^A - y_t^C)}_{\text{Response of money demand to cyclical output}} + \underbrace{\phi_{m,i} * (i_t^A - i_t^C)}_{\text{Response of money demand to interest rates}} \right]. \quad (\text{A.15})$$

The first term on the right-hand side is of an ambiguous sign. It tells us that if output goes down under A more than C (as was the case in the previous simulations), then the capacity to finance deficits through money creation will fall accordingly; the reverse holds true if output is less under C than under A. However, sign of the second term on the right-hand side is unambiguous. The interest rate under A must be higher than under C. Accordingly, since  $\phi_{m,i} < 0$ , through the interest rate channel, the capacity to finance deficits through money creation will fall by more under A than under C.

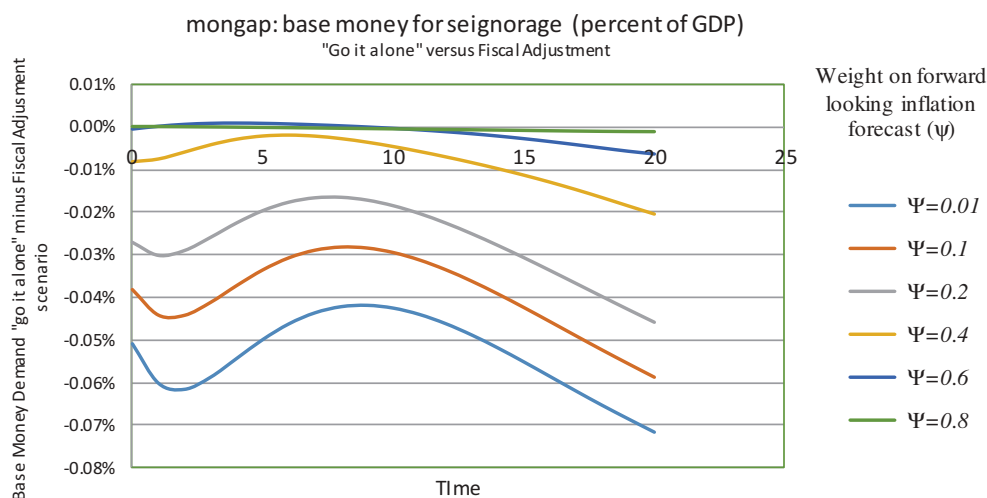
Figure A1 presents the simulation results. Like the previous results, these also depend critically on the value of  $\psi$ . For lower values of  $\psi$  – high inertia, low credibility – the endogenous impact on base money demand is substantially more severe under the “go it alone” strategy than under the fiscal-cum-monetary adjustment. This result reflects both the severity of the output-gap effect (directly shown in Figure 11 in the paper's main body) and the interest rate effect (reflecting both the policy rate as shown in Figure 7 (in the main body) and the risk premium as shown in Figure 10). However, for higher values of  $\psi$  the endogenous shrinkage of base money demand becomes less severe –

<sup>15</sup>We have thus scaled seignorage financing as fractions of potential output. Such a scaling, standard in applied work on fiscal policy, puts the endogenous shrinkage of the base for seignorage on a comparable basis across scenarios.

reflecting the fact that a less severe contraction of demand is required to bring the inflation down when there is less inertia and the central bank enjoys more credibility.

This analysis recalls the “unpleasant monetary arithmetic” introduced by Sargent and Wallace (1981). In their analysis, if the government attempts to reduce inflation solely through a monetary tightening, with no fiscal adjustment, an endogenous rise in velocity will thwart the central bank in its goal to reduce inflation. Our analysis has similar elements but highlights different channels. As public debt rises, the central bank may face constraints on its ability to fight inflation through its independent monetary policy. That is, the central bank may be forced into a situation where fiscal goals (limiting the rise of government debt) dominate monetary ones – *fiscal dominance*. Also, unlike the original analysis by Sargent and Wallace (1981), this one includes a key role for central bank credibility.

Under a “go it alone scenario” – no fiscal adjustment – the endogenous shrinkage of the monetary base is more severe for cases where inflation forecasts are less forward looking – low values of  $\psi$ . This places additional pressures on the fiscal position of the government which must either issue more debt or further adjust the primary surplus. Such endogenous impacts on the monetary base subside as the value of  $\psi$  increases.



**Figure A1.** Endogenous Impacts on Seignorage Base (mongap).

Source: Author's calculations.