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Welfare Improving Coordination of Fiscal and Monetary Policy

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Abstract Should independent monetary and fiscal policies coordinate their actions and/or targets? To examine this question the paper considers a simple reduced-form model in which monetary and fiscal policies are formally independent, but still interdependent—through their mutual spillovers. The analysis shows that the medium-run equilibrium levels of inflation, deficit, and output depend on the two policies' (i) *potency* (elasticity of output with respect to the policy instruments), (ii) *ambition* (the level of their output target), and (iii) *conservatism* (inflation vs. output volatility aversion). What matters is however the *relative* degrees of these characteristics across the two policies rather than the absolute degrees for each policy. This implies that coordination of monetary and fiscal policy is superior to non-cooperative Nash behaviour. In particular, we find that ambition-coordination is more important than conservatism-coordination in terms of avoiding medium-run imbalances due to a tug-of-war between the policies. For this reason, and perhaps surprisingly, ambition-coordination can be welfare improving even if the policymakers' objectives are idiosyncratic, and their coordinated output targets differ from the socially optimal value.

Keywords Coordination, interaction, monetary policy, fiscal policy, central bank, government, inflation, deficit
JEL classification E61, E63

1. Introduction

Early work on the theory of economic policy stressed the importance of accounting for the interactions between fiscal (F) and monetary (M) policy. Tinbergen (1954) and Cooper (1969) showed us that there would be costs in missed targets, instability, and protracted imbalances if policy interaction was ignored. Yet many models used today either ignore the effect of the other policy, or focus on the *direct interaction* related to the independence of the central bank and its incentives.[1]

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[1] The direct interaction refers to the ability of the government (F policymaker) to directly affect M policy outcomes through (i) the appointment of the central banker (Rogoff 1985), (ii) optimal contract with the central banker (Walsh 1995), or (iii) overriding the central bank (Lohmann 1992).

This paper follows in the footsteps of the seminal work of Sargent and Wallace (1981) and Leeper (1991) by focusing on the *indirect interaction.* Specifically, we examine how M and F policies affect each other through spillovers onto the principle target of the other policy.[2] As a matter of experimental control, we will separate the direct and indirect effects by assuming that the M and F policymakers are fully independent in a constitutional and political sense.

Our aim is to consider the desirability (or otherwise) of M and F policy *coordination*. There exists a number of papers in which a monetary-fiscal coordination problem arises, for example Adam and Billi (2008), Branch et al. (2008), Eusepi and Preston (2008), Chadha and Nolan (2007), Weymark (2007), Persson et al. (2006), Benhabib and Eusepi (2005), Gali and Monacelli (2005), Eggertsson and Woodford (2006), Dixit and Lambertini (2003, 2001), van Aarle et al. (2002), Sims (1994), Petit (1989), or Alesina and Tabellini (1987). The fact that these papers use a wide range of modelling approaches and frameworks suggests that an emergence of a coordination problem between M and F policy is a robust finding worthy further investigation.

To offer several novel insights we use a reduced-form model similar to Nordhaus (1994), in which this can be done analytically, and the intuition is easy to discern. In doing so we follow Blanchard (2008) who calls for '*the re-legalization of shortcuts and of simple models*.' In the model both policymakers (i) have the standard quadratic preferences over inflation and output, and (ii) can directly or indirectly affect both of these variables. The difference between the policymakers is their output target; unlike the central bank, the government attempts to achieve output beyond the natural level. Because of that, imbalances can build up over time.

Our interest lies in examining the *medium-run* macroeconomic outcomes of the policy interaction—in contrast to the research of the past decade that has focused on short-run outcomes and the stabilization bias.[3] We believe that the global financial crisis brings medium-run outcomes and imbalances back to the fore. Specifically, we are interested in the horizon of 5–10 years over which imbalances and bubbles can build up.

The model presented in Section 2 incorporates and shows the spillover effects of three standard parameters for each policy. We define the policies' *potency* to be the elasticity of output with respect to the corresponding policy instrument. Next we define policy *ambition* to express the level of the output target relative to the natural rate. Finally, policy *conservatism* describes the degree of aversion to inflation volatility vis-à-vis output volatility.

Most of the papers' novel results are due to the fact that macroeconomic outcomes are affected by the *relative* degrees of these characteristics for M and F policy, not their absolute values for each policy independently. Because of that, some conventional findings may be qualified or reversed by the influence of the other policymaker's decisions, similarly to the intuition of Sargent and Wallace (1981) and Leeper (1991).

Before examining the case for policy coordination in Section 4 under endogenous

[2] For an empirical assessment of such spillover effects in several European countries see Klaas and Jakob (1995).

[3] Nevertheless, the short-run stabilization consequences are examined in a longer working paper version of this article.

preference parameters, Section 3 reports selected auxiliary results of the model under exogenous policy preferences. This is in order to build up the intuition of the *M* and *F* policy interactions in our framework. The section finds, among other things, the following: (i) the equilibrium *M* policy response to a *F* easing (deficit) may be *M* tightening under some circumstances and *M* easing under others; (ii) a more conservative central bank may increase rather than decrease the average level of inflation (unlike in Rogoff 1985); (iii) similarly, an election of a less ambitious government can lead to a higher rather than lower deficit; (iv) an inflation bias may occur even if the central banker and/or the government aim at below-natural output, and conversely, a deflation bias may occur even if they aim at an above-natural output level.

All of these results are due to the interactions between a responsible *M* policy and ambitious *F* policy. The policymakers' actions are not made in a vacuum; they take into account the expected response of the other policy. Because of that, in an effort to correct for the spillovers each policy may end up 'chasing its own tail.'

Some of the results reveal *observational equivalence*—an outcome may obtain under a range of (fundamentally different) parameter values. For instance, anti-inflation and fiscally sustainable policies may be time consistent and credible even if the respective policymaker aims at above-natural output. This implies that achieving a low inflation target and balanced budget may *not* be a result of conservative and responsible policymaking. Conversely, failing to achieve these outcomes may *not* be an indicator of idiosyncratic objectives or incompetent actions as this can happen even if the respective policymaker responsibly aims at the natural output level. In both cases it is the actions of the other policy which are *disciplining* its outcomes in the former case, or *restraining* them in the latter.

While our analysis finds macroeconomic outcomes of the policy interaction to be highly contingent upon the specific (economic and policy) circumstances, such 'ambiguity' does not carry over to the prescription for policymakers. Specifically, all our findings suggest that policy coordination is likely to be desirable. We examine this hypothesis explicitly by letting each policymaker choose his output target (ambition) and its relative weight (conservatism). Intuitively, coordinating on the level of the output target provides a fixed point for the policies, and hence prevents from a feedback loop in which each policy responds to the other in anticipation of its actions.[4] Further, we find that coordination in terms of the policy ambition may be more important than coordination in terms of conservatism in determining medium-run outcomes, and preventing imbalances from accumulating.

These results are in line with Dixit and Lambertini (2001), who call a situation in which the policies coordinate on the socially optimal output target 'monetary-fiscal symbiosis.' Interestingly however, we find that ambition-coordination may still be welfare improving even if (and, in fact, especially when) the policymakers' objectives differ from the social optimum, and when their policy instruments differ in potency. The fact that such coordination avoids the 'tug-of-war' between the policies may more than offset the deviations from the first-best outcomes.

[4] Coordination is advantageous when policies are used according to comparative advantage (Hughes Hallett 1986).

2. Model

2.1 Features

Our aim is to illustrate several new aspects of the M and F policy interaction, and to consider what they reveal about the need to coordinate M and F policies. We are interested in settings that have the following features as in Nordhaus (1994) and much of the subsequent literature:

(i) *Instrument independence:* The instruments of M and F policy are independently set by the central bank and the government respectively in a rational (optimizing) fashion.

(ii) *Overlapping objectives:* The preferences of M and F policy overlap, i.e. the policies have at least one objective in common.

(iii) *Overlapping effects:* The impacts of M and F policy overlap, i.e. the policies can both affect at least one of the objectives that they have in common.

(iv) *Medium-run imbalances:* Our focus is on outcomes that are unaffected by shocks, but that may still be subject to various macroeconomic imbalances.

Note that features (ii) and (iii) imply some *interdependence* of the policies—despite their independence in (i). The majority of policy interaction models in the literature have features (i)–(iii). However, in order to concentrate on the bare essentials of policy coordination, we will use the simplest reduced-form model that has these four features. The advantages of such reduced-form analysis vis-à-vis a fully-fledged micro-founded general equilibrium model, such as the one in our companion work Franta et al. (2009), will become apparent below. In Section 5 we discuss robustness issues and argue that the nature of our main findings would remain unchanged in richer micro-founded models (in which they could not however be shown analytically).

Our interest in the medium-run macroeconomic outcomes will be reflected in the model in three main respects. First, we will examine the values that are obtained on average (over the business cycle), and are hence unaffected by (zero mean) shocks. Second, and because of that, each policymaker will have perfect control over their instrument. Third, we will assume that the long-term budget constraint of the economy may not be satisfied in the medium-run. This is our shortcut to allow for the excessive behaviour of some real world governments, and hence better mimic the resulting macroeconomic imbalances.[5] The current financial crisis highlights the importance of allowing for such imbalances, and analyzing their consequences. See for example Buiter (2009) who is critical of the fact that in most of existing work '*intertemporal budget constraints are always satisfied by assumption* [*making*] *default, bankruptcy and insolvency impossible*…'

[5] Many countries, including a number of industrial ones, have been running an excessive fiscal policy (budget deficits *on average* over the cycle) for decades. While such behaviour is obviously not sustainable forever, it suggests that the long-term budget constraint may be non-binding for significant periods of time. There is a large literature initiated by Leeper (1991) that highlights such issues.

2.2 Setup

It will be assumed that both M and F policymakers are rational and have complete information. These standard assumptions will enable us to focus on the policy interaction separately from any reputational issues that might otherwise arise.[6]

The policymakers' single period utility functions, and the social welfare function (denoted by S) follow the convention in the literature and, as Woodford (2003) has shown, can be derived from microfoundations:[7]

$$u^i = -\beta^i (x - x_T^i)^2 - \pi^2, \tag{1}$$

where $i \in \{M, F, S\}$ is the set of players, π is inflation, and x denotes the output gap (the difference between the actual and correctly measured potential level). $\beta^i > 0$ denotes the degree of *conservatism* (lower β^i values denoting greater conservatism, as in Rogoff 1985). The inflation target of both policies coincides and is normalized to zero, unlike the output gap target, $x_T^i \in \mathbb{R}$. We will refer to the latter as the degree of *ambition*, and specifically to players with $x_T^i = 0$, $x_T^i > 0$, and $x_T^i < 0$ as *responsible*, *over-ambitious*, and *under-ambitious*, respectively.

In order to be able to contrast the influences of both policies we do not formally restrict the values of x_T^M, x_T^F and x_T^S. Nevertheless, in our discussion of Section 3 under exogenous ambition we will focus on the standard case in which the central bank is responsible, the government is over-ambitious, and society may be either of these, i.e. $0 < x_F^T \geq x_S^T \geq x_M^T = 0$.[8] To limit the degree of heterogeneity, we will assume that ambition is the only aspect in which the government's utility function *may* differ from the social welfare function, i.e. impose $\beta^S = \beta^F$. The main reason given in the literature for allowing $x_T^F > x_T^S$ has been the presence of various political economy features such as naïve voters or lobby groups.

Due to the medium-run focus, we will consider π to be directly the instrument of M policy. In terms of F policy, the government will be choosing the budget, denoted G, where $G = 0$, $G > 0$, and $G < 0$ express a balanced budget, a deficit, and a surplus, respectively. In order to incorporate the above feature (iii) we need a supply side relation in which output can be affected by both policies, that is

$$x(\pi, G, .). \tag{2}$$

We follow Nordhaus (1994) in depicting a specific form of such relationship to illustrate the intuition. Specifically, assume:

$$x = \mu(\pi - \pi^e) + \rho(G - \pi), \tag{3}$$

where π^e denotes inflation expected by private agents in a rational (forward looking) fashion. The parameters μ and ρ are positive and denote the *potency* of M and F

[6] For an explicit modelling of reputation in an alternative framework see Hughes Hallett and Libich (2007).
[7] We drop the time subscripts throughout since our interest lies in medium-run outcomes. For the same reason we can disregard the players' discounting without loss of generality.
[8] This is one of the features that distinguishes our framework from the Barro and Gordon (1983) model. There exists no inherent time-inconsistency problem in M policy per se.

policy respectively. The supply function posits that real output can be stimulated by an inflation surprise and a budget deficit in real terms. As for the latter, we can think of inflation reducing the purchasing power of the government's transfer to the public, and thus lower the income effect it generates. Because of that, the stimulatory consequence through consumption and investment will be smaller.

The specification in (3) implicitly assumes that some non-Ricardian features exist—one can think of myopic voters or agents facing borrowing constraints. There exists abundant evidence of both of these features, see e.g. Healy and Malhotra (2009) on the former and Campbell and Mankiw (1990) on the latter.

Hughes Hallett et al. (2009) show that (3) can be derived from a standard New Keynesian model in which fiscal policy is incorporated in a conventional way. The working paper version of this article also examines more general specifications of the supply relationship, and shows that the main findings remain unchanged. Let us note that the demand side of the model is left out as it does not affect the medium-run outcomes. The same is true about the exact details of expectations formation or the presence of shocks.

It is now apparent that the model has the four features listed in Section 2.1. First, the policymakers choose their instruments independently, without any direct interference from the other policymaker. Second, the policies share some objectives in (1), namely preference for inflation control and output stabilization. Third, the specification of (1)–(3) implies that both policies can affect one of the shared objectives, namely the output gap. Fourth, there are no shocks on average in the medium-run and the government faces no (binding) intertemporal budget constraint.

For a long-run analysis one would have to include an intertemporal budget constraint of the government. In our context, it would be assuming that $G \leq 0$ has to hold on average. Nevertheless, we will not impose such a restriction in order to allow for the possibility that the government is running deficits on average over the medium term (say 5–10 years), and for imbalances to build up over time. Based on F outcomes in the real world, in which many countries have run structural deficits for significant periods of time (even in the expansionary part of the business cycle and despite deteriorating demographic factors), we believe such specification should not be ruled out a priori and deserves an investigation.[9]

2.3 Solution

Using (1)–(3) and rational expectations we have the following reaction functions under discretion[10]

$$\pi = \frac{\beta^M(\rho-\mu)(\rho G - x_T^M)}{1+\beta^M\rho(\rho-\mu)} \quad \text{and} \quad G = \frac{x_T^F}{\rho} + \pi. \tag{4}$$

[9] Obviously, this cannot be a description of the long-run since rational agents would refuse to hold government debt.

[10] The paper focuses on the discretionary outcomes for two reasons. First, our attention lies in policy coordination which can be considered as a partial substitute for the (timeless perspective) commitment solution. Second, our focus in on the medium-run outcomes, whereas a timeless perspective targeting rule predominantly affects the short-run stabilization outcomes.

Solving jointly yields the following equilibrium medium-run outcomes (denoted by an asterisk throughout)

$$\pi^* = \beta^M(\rho-\mu)(x_T^F - x_T^M),\ \ G^* = \frac{x_T^F}{\rho} + \beta^M(\rho-\mu)(x_T^F - x_T^M),\ \text{and}\ x^* = x_T^F. \quad (5)$$

Note that M policy is neutral in the medium-run; no M variable affects x^*. Nevertheless, as a consequence of feature (iv) of Section 2.1, output may deviate from the natural level in the medium term, i.e. x^* may be non-zero. This can be interpreted as accumulation of macroeconomic imbalances over the medium term.[11] Naturally, if a long-run budget constraint is imposed this would no longer be possible.

The following section shows how each policy, and importantly their interaction, may contribute to (and in turn be affected by) these imbalances. In doing so it treats the policy parameters as given. Section 4 then endogenizes the degree of ambition and conservatism of both policies in examining the case for policy coordination.

3. Auxiliary results: M and F policy interaction

This section presents selected results of the model with exogenous policy parameters in order to better develop the intuition of the M and F policy interaction.[12]

Remark 1 (Interdependence)**.** *For almost all parameter values, the equilibrium setting of each policy is a function of the other policy's variables.*

Inspection of (5) reveals that, for all $\rho \neq \mu$ and $x_T^F \neq x_T^M$, the level of π^* is a function of x_T^F and ρ, and the value of G^* is a function of β^M, x_T^M and μ. This implies that the other policy's setting generally matters—even if the policies are formally independent. Figure 1 shows how, under selected parameter values, π^* depends on ρ and G^* depends on μ. Figure 2 further shows the dependence of π^* on β^M and x_T^M, and G^* on β^M and x_T^F.

The following proposition examines the way the central bank will respond to the government's actions in more detail.

Proposition 1 (Monetary responses)**.** *Not only the magnitude, but also the direction of the central banker's best response to a budgetary outcome depends on the relative potency of the two policies. There exist circumstances under which the equilibrium response to a fiscal easing (deficit) is:*

(i) M tightening (and this can be true even for an over-ambitious M);

(ii) M easing (and this can be true even for an under-ambitious or responsible M);

(iii) no change in the stance of M policy.

[11] This is consistent with the evidence that the policymakers may have persistent misperceptions about the level of potential output, see e.g. Orphanides (2001), and that, as a result, output can deviate from potential for long periods of time, see e.g. Beck and Wieland (2008).

[12] Many additional results of the model are reported in the working paper version of this article.

Proof. Simple manipulation of the reaction functions in (4) reveals that π^* is (i) decreasing in G iff $\rho \in (\max\{\mu - \frac{1}{\rho\beta^M}, 0\}, \mu)$, (ii) increasing in G iff $\rho \in (0, \mu - \frac{1}{\rho\beta^M}) \cup (\mu, \infty)$, and (iii) independent of G iff $\rho = \mu$. □

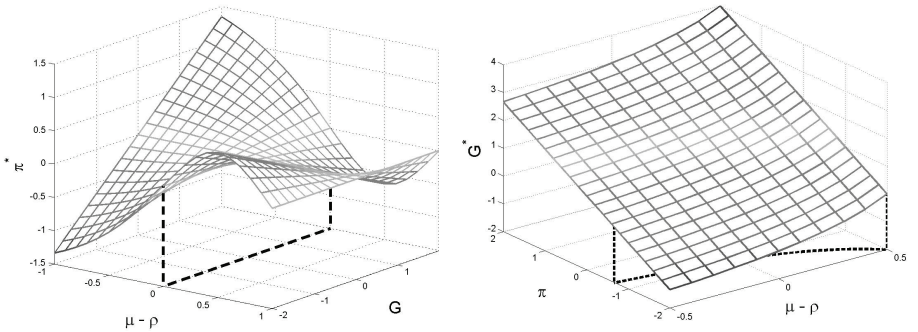

Figure 1. M and F policy reaction functions: Optimal inflation π^* (the left panel) and deficit G^* (the right panel) as functions of the setting of the other policy and their relative potency $\mu - \rho$; under $x_T^M = 0$, $x_T^F = \beta^M = \beta^F = \mu = 1$.

Figure 1 demonstrates these results graphically. Its left panel shows that π^* is non-monotonic in G, with the dashed line indicating the threshold $\mu = \rho$ at which the direction changes.[13] It should be stressed that the difference in optimal M responses is *not* due to business cycle fluctuations—to control for these we have made the model deterministic.

Instead, it is due to the *feedback effect* between M and F policy. Specifically, the level of inflation affects the optimal size of the deficit, which in turn affects the optimal level of inflation. Since the respective magnitudes of these effects may differ, the direction of the monetary responses (i.e. whether M counter-acts or accommodates) may vary too. The intuition is similar to the seminal work of Leeper (1991) under regime switches from active M and passive F policy to passive M and active F policy.

The following proposition relates to the effect of policy ambition on outcomes.

Proposition 2 (Observational equivalence)**.** *The inflation target and balanced budget may be, on average over the medium-run: (i) deviated from even if the respective policymaker is responsible, and (ii) achieved even if the respective policymaker is under or over-ambitious.*

Proof. Rearranging (5) yields

$$\pi^* \begin{cases} = 0 & \text{if } \rho = \mu \text{ and/or } x_T^F = x_T^M, \\ \neq 0 & \text{otherwise,} \end{cases} \quad \text{and} \quad G^* \begin{cases} = 0 & \text{if } \mu = \frac{\beta^M \rho^2 (x_T^F - x_T^M) - x_T^F}{\beta^M \rho (x_T^F - x_T^M)}, \\ \neq 0 & \text{otherwise.} \end{cases}$$

[13] Since the real world potencies may vary over time, it is possible that both $\mu > \rho$ and $\mu < \rho$ occur at some stage. We therefore plot both of these cases in our figures.

It therefore follows that we may observe $\pi^* \neq 0$ and $G^* \neq 0$ even if $x_T^M = 0$ and $x_T^F = 0$ respectively—claim (i), but also $\pi^* = 0$ and $G^* = 0$ even if $x_T^M \neq 0$ and $x_T^F \neq 0$ respectively—claim (ii). □

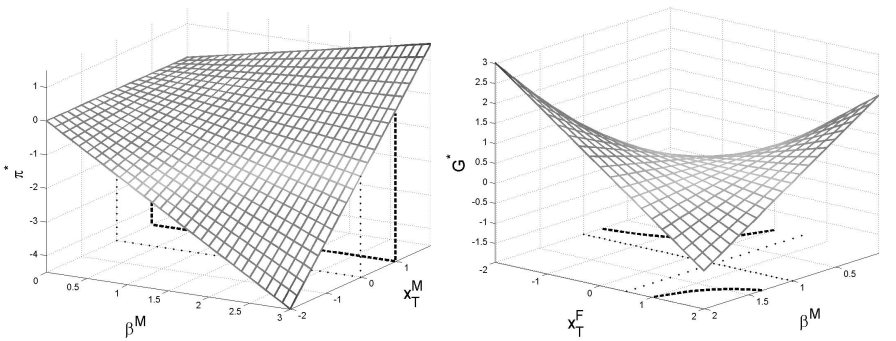

Figure 2. Equilibrium policy setting: inflation π^* (the left panel) and deficit G^* (the right panel) as functions of the output target values (x_T^M and x_T^F respectively) and M policy conservatism β^M; under $x_T^F = \beta^F = \mu = 1$, $\rho = 0.5$ in the left panel, and $x_T^M = 0.5$, $\beta^F = 1$, $\mu = 2$, $\rho = 1$ in the right panel.

For an illustration see Figure 2. In terms of claim (i), the figure shows that all values of π^* and G^*, except those indicated by the dashed lines, differ from zero. This is in line with the intuition of the time-inconsistency result of Kydland and Prescott (1977) and Barro and Gordon (1983), but with two important differences.

First, in addition to an inflation bias, a deflation bias can also occur, and this can happen even if the central banker and/or the government are over-ambitious (see the interval between the two dotted lines in the left panel). Second, the deviation from the inflation target is due to the effect of F policy, not M policy.

In terms of claim (ii), Figure 2 and equation (3) show that the values of π^* and G^* may be zero even if the respective policymaker is not responsible. We can think of this as a 'disciplining' effect coming from the other policy. For example, the central banker may indirectly (by altering the incentives faced by the F policymaker) discipline an otherwise over-ambitious F policymaker and achieve a balanced budget.[14]

These results alert us to the fact that, in predicting macroeconomic outcomes, the policy objectives and settings have to be viewed in light of the other policy's setting. Specifically, achieving the inflation target or balanced budget is not sufficient for us to conclude that the respective policymaker is responsible. Since fundamentally different combinations of parameter values of both policies provide incentives for certain actions, under policy interaction it may be impossible to infer the type of the policymaker from the outcomes of the policy alone.

[14] Note however that the price to pay for this F discipline is a deflationary M policy. In a very different setting of Libich et al. (2007) we allow the policymakers to explicitly commit to their actions (i.e. effectively equip them with an additional instrument). We show that in such cases M policy may, under some circumstances, discipline an over-ambitious F policy without compromising the low inflation target.

The following proposition shows that policy conservatism and ambition may have a non-monotone effect on the level of inflation and the budget when M and F interactions are taken into account. This may reverse the expected outcomes of the delegation process.

Proposition 3 (Appointments and elections)**.**

(i) Appointment of a more conservative and/or less ambitious central banker may increase, decrease, or have no effect on the level of inflation, and the size of the budget deficit.

(ii) Election of a less ambitious government has an equally ambiguous effect.

Proof. All the claims follow directly from (5). For example in terms of claim (i), the value of π^* is: decreasing in β^M under $\mu > \rho \wedge x_T^M < x_T^F$ or $\mu < \rho \wedge x_T^M > x_T^F$; increasing in β^M under $\mu > \rho \wedge x_T^M > x_T^F$ or $\mu < \rho \wedge x_T^M < x_T^F$, and independent of β^M under $\mu = \rho \vee x_T^M = x_T^F$.

In terms of claim (ii), rearranging equation (5) reveals that G^* is independent of x_T^F under $\mu = \overline{\mu}(\rho)$, where this threshold value is

$$\overline{\mu} = \rho + \frac{1}{\rho\beta^M} > \rho.$$

Equation (5) further implies that if $\mu > \overline{\mu}(\rho)$ then G^* is decreasing in x_T^F, and if $\mu < \overline{\mu}(\rho)$ then G^* is increasing in x_T^F. All other claims are proved analogously by inspection of (5). □

The results can be seen in Figure 2. In terms of claim (i) let us focus on the effect of a more conservative central banker—a smaller value of β^M. The left panel shows that for the less likely values $x_T^M > x_T^F$ a lower β^M reduces inflation, and for the more likely values $x_T^M < x_T^F$ it increases inflation, and for the $x_T^M = x_T^F$ values it does not affect inflation.

These results are in contrast to the Barro-Gordon-Rogoff literature whereby a more conservative central banker always reduces the level of inflation (see Hughes Hallett et al. 2009 for further comparative findings in this direction). In our setup a low inflation policy may stimulate the economy better than a high inflation policy—by increasing the real value of the deficit and hence magnifying its income effect and expansionary impact better than any inflation surprise could. This is similar to the intuition of Sargent and Wallace's (1981) unpleasant arithmetic result or the analysis of Leeper (1991).

The right panel of Figure 2 then shows that if $x_T^F = x_T^M$ (indicated by the dotted line), then the value of the deficit is independent of the type of the central banker β^M. However, if $x_T^F < x_T^M$ and $x_T^F > x_T^M$, a more conservative central banker leads to a higher and lower deficit G^* respectively. In words, a more conservative central banker may, depending on the relative potency and ambition in the two policies, accentuate or eliminate the ambition of the F policymaker, and hence worsen or improve the budgetary outcomes. Whichever case obtained depends on what type of F opponent (in terms of ambition and potency) the central banker is facing, which determines how strongly, and in which direction, the opponent is expected to react.

In terms of claim (ii) of the proposition, the right panel of Figure 2 shows that if $\beta^M = 1$ (indicated the dotted line derived from (3)), then G^* is independent of x_T^F. However, under $\beta^M > 1$ and $\beta^M < 1$, a lower value of x_T^F leads to a lower and higher deficit G^* respectively. This implies that caution should be exercised in concluding that a less ambitious government will surely improve the country's fiscal position. Nevertheless, given that the former case obtains over a larger parameter space (including some values of $\mu > \rho$, and all values of $\mu \leq \rho$), it might be argued that a less ambitious government leads to an improvement in the fiscal position more often than not.

4. Main results: optimal M and F policy coordination

The above results imply that the *relative* degrees of M and F policy parameters may play a more important role in macroeconomic outcomes than their levels do individually. In particular, they show that policymakers may often be trying to offset the behaviour of the other policymaker, with spillovers that may lead to undesirable outcomes for both the policies and society. This is exactly the case for coordination made by Tinbergen (1954) and Cooper (1969) years ago. Therefore, two specific questions need to be addressed:

(i) How conservative and ambitious should M and F policy be: what is the socially optimal institutional setting for these policies with respect to x_T^M, x_T^F, β^M, β^F?

(ii) Is this socially optimal scenario incentive compatible and superior to a Nash game in which the respective policymakers choose their policy parameters independently, or is active policy coordination required? If so, is it coordination of the output targets (ambition-coordination), coordination of the stabilization weights (conservatism-coordination), or both, that can improve social welfare?

To examine these questions let us extend our game by endogenizing the four policy preference parameters $\{x_T^M, x_T^F, \beta^M, \beta^F\}$. At the very beginning of the game the corresponding policymakers choose simultaneously the values of their x_T^i and β^i (the timing is not crucial to the results obtained). All chosen $\{x_T^M, x_T^F, \beta^M, \beta^F\}$ can then be observed by the opponent and private agents before the simultaneous moves of π, π^e, and G are made.[15]

Proposition 4 (Nash outcomes)**.** *In the endogenous game there exists* ***multiple*** *pure strategy Nash equilibria, all such that*

$$x_T^{M*} = x_T^{F*}. \tag{6}$$

They all yield the same, highest attainable utility to both policymakers, which is strictly greater than that of any non-Nash outcome (pure or mixed). Therefore, ***ambition-coordination*** *ensuring (6) is desirable for both policymakers.*

[15] Let us note that utility comparisons may be problematic if their parameters are allowed to change. Nevertheless, in our case what matters is the relative magnitudes across policies, not the absolute levels for each policy independently, and therefore such comparison is possible.

Proof. It is shown in Appendix A1 that all Nash equilibria are such that (6) holds, and π^* and G^* satisfy (5)—with any levels of β^M and β^F. In those Nash equilibria we therefore have $\pi^* = 0$ and $x^* = x_T^F$ from (5), and hence $u^i = 0, \forall \beta^i, \mu, \rho, i$ from (1), which is the unique maximum of $u^i, \forall i$.

From the fact that there exist a large (infinite) number of such Nash equilibria it follows that, in the absence of ambition-coordination, the selected values of x_T^M and x_T^F will almost certainly not satisfy (6).[16] Noting that any $x_T^M \neq x_T^F$ is inefficient yielding $u^i < 0, \forall i$ completes the proof. □

Let us note two issues implied by the analysis. First, M and F policy ambition are *strategic complements.* Second, the fact that $x_T^{M*} = x_T^{F*}$ is not essential, what makes ambition-coordination desirable is the fact that x_T^{M*} is a function of x_T^F, and x_T^{F*} is a function of x_T^M. These results are demonstrated graphically in the right panel of Figure 3 showing that the F policymaker's utility is maximized at the coordinated level $x_T^F = x_T^M$.

Proposition 5 (Socially optimal ambition-coordination)**.** *There exists a* ***unique*** *socially optimal combination of M and F policy ambition such that*

$$x_T^{M*} = x_T^{F*} = x_T^S,$$

and it is incentive compatible. Ambition-coordination may however be welfare improving even if the policymakers coordinate on an output target x_T^C other than the socially optimal one, i.e. $x_T^M = x_T^F = x_T^C \neq x_T^S$.

Proof. See Appendix A2. □

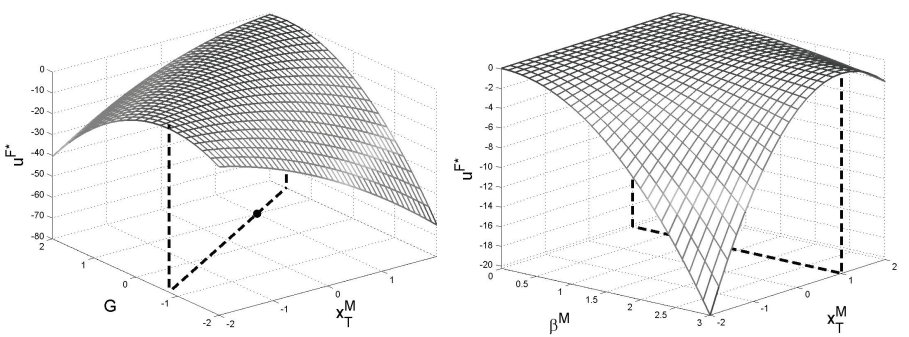

Figure 3. Equilibrium F utility and social welfare (assuming $u^S = u^F$) as a function of M policy ambition x_T^M, and the deficit G or M policy conservatism β^M; under $x_T^S = x_T^F = \beta^M = \rho = 1$, $\mu = 1.5$ in the left panel, and $x_T^S = x_T^F = \beta^F = \mu = 1$, $\rho = 0.5$ in the right panel.

[16] Unlike in our setup, in the real world the policymakers may have some beliefs about the 'likely' x_T choices of the opponent, which may serve as 'focal points' and somewhat reduce the set of possible outcomes. Nevertheless, even then the $x_T^M = x_T^F$ outcome does not obtain with certainty in the absence of coordination.

Figure 3 shows, assuming $x_T^S = x_T^F$ for illustration, that social welfare is maximized at the coordinated ambition level in (6)—the black dot in the left panel and the dashed line in the right panel. It is also apparent from the figure that a greater difference $\left|x_T^F - x_T^M\right|$ implies lower social welfare.

Intuitively, coordination of M and F policy on the level of their output targets is desirable for both players as well as the society because a specific *combination* of x_T^M and x_T^F delivers the optimal inflation target, $\pi^* = 0$. Since M policy cannot affect the equilibrium level of average output, this is the best medium-run M policy setting.

Remark 2. *Conservatism-coordination does not affect medium-run outcomes.*

The redundancy of this type of coordination in our framework is implied by the fact that while β^M has some importance, β^F does not affect any macroeconomic variables in the medium-run. Therefore, the combination of β^M and β^F plays no role either over that horizon.

At face value, the analysis offers two options for the social planner. We examined one of 'delegation-cum-coordination' in which M policy had been delegated to an independent central bank, and showed the need for policy coordination. An alternative solution is one of 'no delegation', in which the central bank would not be made independent in the first place.

In the latter case the government would set both M and F policy, and could achieve both the optimal inflation level and its desired output target without having to coordinate with another independent institution. The problem with this avenue is apparent: if the government is not benevolent, and his ambition is driven by idiosyncratic factors, then it would naturally select a suboptimal output target level, $x_T^F > x_T^S$. Proposition 5 showed that, even in the case in which such outcome is superior to the non-coordinated Nash outcomes, the first-best cannot be achieved.

In such case an independent central bank may act as a vehicle to discipline the government, and achieve the coordinated output targets closer to the socially optimal level. The fact that the majority of countries have opted for an independent central bank suggests that pressure from the government is considered a real possibility.[17]

5. Robustness

We have used a simple reduced-form model for our analysis for two main reasons. First, the intuition of the results can then be shown analytically, unlike in most recent micro-founded general equilibrium models of policy interaction. Second, the existing models typically focus on the stabilization outcomes and fluctuations, and do not consider the medium/long-run levels. As such, they do not allow for persistent imbalances to occur.

Nevertheless, the use of a reduced-form model may raise robustness questions. To address some potential issues the working paper version of this article considers

[17] Nevertheless, the effects of central bank independence have not been unambiguously established in the literature, see e.g. Forder (1998) for a debate. More research is therefore required to shed light on its various aspects, especially with the important distinction of instrument vs. goal independence of Debelle and Fischer (1994) in mind.

extensions in two main directions. First, various modifications to the supply relationship in (3) are investigated, including one in which F policy enters in nominal terms rather than in real terms. Second, stochastic disturbances are incorporated under two scenarios—information symmetry and asymmetry.[18] It is shown that these extensions do not affect our medium-run conclusions.

Are our insights likely to obtain in richer, micro-founded general equilibrium settings? The finding of Remark 1 regarding the interdependence of M and F policy is uncontroversial, and largely independent of the model used. Such interdependence has been the focus of many recent papers cited above using state-of-the-art general equilibrium models. Intuitively, policy interdependence is ensured by features (ii) and (iii) of Section 2.1—the policies share some objectives and both impact these objectives. Thus micro-founded general equilibrium models are not necessary to obtain those results, although they evidently will produce analogously interdependent outcomes too. The problem is that such models cannot be solved analytically, and the intuition is therefore difficult to see.

Similarly, our main finding regarding the importance of ambition-coordination (reported in Propositions 4 and 5) is robust. This follows from two facts. First, the policies are inter-related, i.e. their optimal actions will be affected by some *combination* of the two policies' parameters. Second, the policy parameters that affect the medium-run outcomes are, in most settings including the popular New Keynesian framework, a function of the target *levels* (i.e. x_T's), whereas the stabilization dynamics is more often a function of the relative *weights* (i.e. β's).

In contrast, the results reported in Propositions 1–3 and Remark 2 are arguably less robust. This is because they depend, at least to some extent, on the way M and F policies are assumed to affect the real economy. Our analysis is not sufficient to conclude that they are the (most) likely outcomes, and more research is required to shed light on their real world relevance. For example, Rogoff (1985) examined the importance of policy conservatism for short-run stabilization outcomes. His work therefore implies that the variance of inflation and output in equilibrium will depend on both β^M and β^F, in which case conservatism-coordination may play some role in the short-run. Therefore, caution should be exercised in interpreting those latter results.

Despite these caveats, we believe that the current financial crisis highlights the importance of 'thinking outside the box' and provides a justification for our approach.

6. Summary and conclusions

The interactions between fiscal and monetary policies are both important and complex, even if we abstract from differences in the policies' timing or reputations. One of the reasons behind the complexity is that macroeconomic outcomes depend on the spillovers from each policy onto the targets to which they are not principally assigned.[19] And this is why, even if the policies are politically and constitutionally in-

[18] In the former case both the policymaker and expectation setters can observe the shock in real time, whereas in the latter only the policymakers can.

[19] The received position is that the Central Bank should control inflation and be independent of outside forces (political pressures in particular), and that national fiscal policies should be left free to account for

dependent, they are interdependent—their optimal setting is a function of the other policy's setting. Specifically, we show that the optimal monetary response to a fiscal expansion (in any phase of the business cycle) can be to tighten monetary policy, loosen it, or do nothing at all, depending on the relative potencies and ambition of the policies.

Such interdependence implies a role for policy coordination. The paper examines it in detail and finds that coordination in terms of policy ambition (targets) may be more important for medium-run outcomes than coordination in terms of conservatism (priorities). If the policymakers are benevolent and coordinate on the socially optimal output target then the first-best outcome can be achieved, which is unlikely without coordination. But interestingly, we show that even if the policymakers' objectives are idiosyncratic, and they coordinate on an output target that differs from the socially optimal one, such coordination can still improve social welfare relative to an uncoordinated Nash outcome. This is because coordination prevents from the two policies perpetually trying to offset each others' actions, ie engaging in a tug-of-war.

The fact that there exist multiple policy settings that maximize the policymakers' utility, all equally desirable by both policymakers, implies a different kind of coordination to the one examined in the existing literature. We argue that optimal coordination may be more a matter of information exchanges between the policymakers (about the natural rate of output that should be targeted, x_T) than direct, competitive and discretionary negotiations over the details of each policy choice (the levels of π_t and G_t). Nevertheless, more research is needed to deepen our understanding of the interactions between monetary and fiscal policies, and to formulate specific recommendations regarding a potential policy coordination.

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Appendix

A1. Proof of Proposition 4

Solving by backwards induction, the Nash equilibrium values of inflation and output are those derived in Section 2 under exogenous ambition and conservatism parameters. They were reported in (5).

Moving backwards, substitute these into the players' utility functions and differentiate them with respect to the degree of M and F ambition respectively to obtain

$$\frac{\partial u^{M*}}{\partial x_T^M} = 2\beta^M(x_T^F - x_T^M) + 2\left[\beta^M(\rho-\mu)\right]^2(x_T^F - x_T^M),$$

$$\frac{\partial u^{F*}}{\partial x_T^F} = -2\left[\beta^M(\rho-\mu)\right]^2(x_T^F - x_T^M).$$

Setting equal to zero and rearranging implies that the non-coordinated Nash equilibria obtain for any $x_T^{M*} = x_T^{F*} \in \mathbb{R}$. For the rest of the proof see the main text. □

A2. Proof of Proposition 5

Analogously to the proof of Proposition 4, solving backwards substitute the equilibrium values from (5) into the social welfare function and differentiate with respect to x_T^M and x_T^F respectively to obtain

$$\frac{\partial u^S}{\partial x_T^M} = 2\left[\beta^M(\rho-\mu)\right]^2(x_T^F - x_T^M),$$

$$\frac{\partial u^S}{\partial x_T^F} = -2\beta^M(x_T^F - x_T^S) - 2\left[\beta^M(\rho-\mu)\right]^2(x_T^F - x_T^M).$$

Setting equal to zero and rearranging implies that the unique social welfare maximum obtains under $x_T^{M*} = x_T^{F*} = x_T^S$. As this is one of the pure strategy Nash equilibria reported in Proposition 4 that delivers the highest attainable utility to both players, it is incentive compatible.

Nevertheless, even if the policymakers coordinate on a different output gap target level, $x_T^C = x_T^M = x_T^F \neq x_T^S$, such ambition-coordination may still improve social welfare. Whether or not it is the case depends on the coordinated level x_T^C relative to the uncoordinated x_T^M and x_T^F levels and the social optimum x_T^S. Formally, for ambition-coordination to be welfare improving it must hold that

$$-\beta^F\left(x_T^C - x_T^S\right)^2 > -\beta^F\left(x_T^F - x_T^S\right)^2 - \left[\beta^M(\rho-\mu)(x_T^F - x_T^M)\right]^2,$$

where we have used the above derived equilibrium outcomes. Rearranging, we obtain

$$\left|x_T^C - x_T^S\right| < \sqrt{\left(x_T^F - x_T^S\right)^2 + \frac{\beta^{M^2}}{\beta^F}(\rho-\mu)^2(x_T^F - x_T^M)^2}.$$

This implies that for any uncoordinated $x_T^M \neq x_T^F$ levels there exist a threshold value of $\overline{\left|x_T^C - x_T^S\right|} > 0$, below which ambition-coordination is socially desirable even if $x_T^C \neq x_T^S$. This threshold is a function of the uncoordinated x_T^F and x_T^M levels, the socially optimal level x_T^S, as well as the policy potencies and conservatism. □