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## Policy Coordination under Model Disagreement and Uncertainty

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# Policy Coordination under Model Disagreement and Uncertainty

## Abstract

What are the incentives for governments to coordinate their policies internationally when there is model disagreement and uncertainty? We build a model where countries disagree on policy targets and how policies affect the economies, and show that uncertainty not only determines the type of cooperative policy but also whether countries want to cooperate at all. Countries facing larger model disagreement also need to face larger uncertainty with respect to policy spillovers to agree on cooperation. Thus, uncertainty on spillovers can be a substitute for model agreement.

JEL-Codes: F420, F530, F550, F680.

Keywords: policy coordination, uncertainty, ideological commitment, model disagreement.

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# 1 Introduction

International cooperation among governments is often difficult and fragile. In addition to the standard problems like the incentive to free-ride, conflicts about burden sharing, and the incentive to deviate from cooperative policies for short-term gain, arguably one of the most relevant reasons can be found in the fact that policymakers cannot agree on the nature of the problem. They may not only disagree whether a problem really exists but might view the world through different eyes and thus come to conflicting policy conclusions.

Prominent examples are the discussion about the desirability and reason behind macroeconomic imbalances, the right and adequate use of fiscal and monetary policy, or labor market regulation. The existence of current account imbalances can be either seen as being caused by an imbalance between savings and investment or by mercantilism and “unfair” trade practices. Thus one side would suggest reducing overly expansive consumption, while the other would demand more imports from its trading partners, such as in the conflict between the USA and its trading partners in China or Germany (see Irwin 2017). The discussion in the European Union about the adequate policy mix of monetary and fiscal policy serves as a second example. As Frankel (2016) argues, countries might take the view that expansive fiscal and monetary policy serve as a “locomotive” that pulls also other countries ahead, or take the “moral hazard” view according to which expansive policy has negative effects in terms of inflation or the need to bail-out fiscally insolvent states. While Germany believes in the virtues of a restrictive fiscal and monetary policy, France and others take a different position. France demands a more expansive fiscal policy from Germany because it believes in positive effects for the other European partners. Germany instead is afraid of negative externalities, stemming from interest rate effects or domino effects from solvency risks. With respect to the third example, one view could be that liberalizing labor markets should lead to increased search behavior by workers and thereby reduce the fiscal burden of unemployment (Katz and Meyer 1990), while others may argue that stronger incentives to search for a job could result in worse matches and depress labor productivity (Acemoglu and Shimer 2000). In the first interpretation, labor market deregulation should have positive output effects and a positive demand spillover to other countries, while in the second interpretation declining output in the reforming country would have negative aggregate demand effects on other countries.

Of course, rational policymakers should be able to learn and sooner or later agree on a common model. But very often, policymakers are committed to a particular policy view, as Bordo and Istrefi (2018) argue for monetary policymakers in the US. This may be because of their education, ideology or world view, or they might be simply driven by the influence of some interest groups. These commitments may not only be tied to particular policymakers and change when they leave office, but there might also be a “national” view on the desirability of low rates of inflation or fiscal virtue. Brunnermeier et al. (2016) argue that this is the case with German and French views on monetary and fiscal policy. They describe a stylized version of “German” and “French” perspectives that represent

the northern European countries on the one side and the southern Europeans on the other. Where the Germans prefer austerity, little state intervention, and independent monetary policy, the French believe in state directed economic development, supported by active fiscal and monetary policy. These differences, according to these authors, are at the heart of the policy conflicts and diverging concepts of future European policy and the debate about rules versus discretion. The ideological or even philosophical differences go far beyond simple diverging economic interests of, say, creditors and debtors because they also entail mutual misunderstandings and misinterpretations. These differences are long-standing and rooted in deeply ingrained historical experiences and political philosophies.<sup>1</sup>

Curiously, there is little formal work on this aspect of cooperation and under what circumstances the benefits from cooperation outweigh the costs of cooperation when policymakers disagree on the true model.<sup>2</sup> In what follows, we develop a formal model to look at this question. Our model incorporates different policy targets, policy effects that spill over to other countries, different perceptions of these effects, and uncertainty about the size of the policy effects. We show that countries facing larger model disagreement also need to face spillover uncertainty to agree on cooperation in such a setting. Uncertainty about spillovers can be a substitute for model agreement.

To analyze the effect of uncertainty on cooperation when there is model disagreement among countries, we first replicate the standard result that cooperation is useful in the presence of spillovers and reinforced by the existence of uncertainty (Brainard 1967, Ghosh and Masson 1994). The size of uncertainty with respect to the spillover only determines whether countries pursue more or less active policy under cooperation than under non-cooperation. Even if spillovers are positive, the existence of uncertainty about policy impact leads governments to be more cautious in the use of policy. If spillover uncertainty is too high, cooperative policy is therefore less expansive than if not coordinated. Next, we introduce model disagreement where countries have different policy targets and views on how their policy affects their own country and spill over to other countries. We show that under model disagreement the standard results on the effects of uncertainty on cooperation do no longer hold. Not surprisingly, cooperation becomes much more difficult if governments have different world views about policy consequences. When they have conflicting views about whether policies have positive or negative effects it may in fact follow that non-cooperation is better than cooperation. This inability to agree on cooperative policy is reinforced by the existence of ideological policy commitments. If policy targets, for whatever reason, diverge as well their influence may dominate the incentive to cooperate in order to internalize the effects of policy spillovers and

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<sup>1</sup>A similar argument for the euro-area is made by Guiso et al. (2016) who argue that policymakers must adhere to a country's norms. Part of this national view may be grounded in different historical experiences. The particular German focus on low inflation is often attributed to the traumatic experience of hyperinflation in the 1920s that still shapes today's perspectives (Hayo 1998).

<sup>2</sup>An exception is Frankel and Rockett (1988), who have a different focus than this paper. In their model, policymakers are able to agree on joint policy despite model disagreement but it turns out to be welfare decreasing.

their uncertainty.

More spillover uncertainty, however, reinforces the positive and negative spillovers of the countries' policies and therefore increase the incentive to cooperate. Uncertainty about the policy spillovers can become a substitute for agreeing on a common model. If countries are also uncertain, however, about the impact of their own policies on domestic variables, the incentive to cooperate becomes lower. Higher uncertainty in this case leads to less active policies, generating relatively little spillovers. There is, thus, also little incentive to cooperate.

The paper proceeds as follows: Section 2 relates our paper to the previous literature. Section 3 sets up the basic model, Sections 4 and 5 derive uncoordinated policies and their spillovers. Section 6 derives the cooperative policy and compares utilities under cooperation and non-cooperation. Section 7 concludes.

## 2 Literature Review

Our approach ties in with different literatures. First, our paper connects to the huge literature on the benefits and costs of international policy coordination, in particular macroeconomic policy coordination (Cooper 1969, Hamada 1976, Cooper 1987, Kenen 1990, Canzoneri and Henderson 1991, Eichengreen 2013, Landmann 2018; see also the collection of papers in Buiters and Marston 1986 and Cooper et al. 1989 or Willett 1999). If spillovers are positive, too little policy is undertaken individually, and if spillovers are negative there is too much policy. Coordination is thus concerned with taking these spillovers into account and improve efficiency and welfare. If and how much individual countries gain from coordination depends on their bargaining position when setting policy and thus their political and economic size.

In general, simulation studies have often failed to find large effects from spillovers, undermining the importance of cooperation from a welfare-theoretic perspective (see, for instance, Oudiz and Sachs 1984), which is also theoretically supported by microfounded models of macroeconomic cooperation (Obstfeld and Rogoff 2002, Canzoneri et al. 2005, Benigno and Benigno 2006). One reason might be that those papers only focus on monetary cooperation; cooperation in other policy fields may generate larger welfare gains, as reported by Bodenstein et al. (2018). Likewise, International Monetary Fund (2013) finds empirically that spillover effects can be sizable.

Part of this literature looks at the desirability of cooperation under uncertainty. Uncertainty is related to the effectiveness of the policy instruments and the spillovers that they generate (Brainard, 1967; Ghosh and Masson, 1994; Ostry and Ghosh, 2016), and it is asked by what mechanism welfare improving cooperation can be achieved under these circumstances (Hefeker and Neugart 2018). A result in this literature is that cooperation is always beneficial and that the type of policies under cooperation when compared with the non-cooperative case depends on the uncertainty about the spillover. If spillover uncertainty is small enough relative to its average effect, there will be more active policies under cooperation compared to non-cooperation. Model disagreement, as

we incorporate it in our framework, is not included in these contributions and qualifies some of these findings.

Disagreement about the right model in macroeconomic policy coordination is addressed in Frankel and Rockett (1988). They show that when policymakers are unsure about the true model of the world, and cooperation is based on wrong perceptions, cooperation may actually imply that policymakers move even further away from their true bliss points and lead to a deterioration of economic outcomes compared to the non-cooperative Nash solution (see also Angeloni and Pisani-Ferry 2012 and Frankel 2016 for informal discussions).

This is also related to a broader literature on diverging mental models (Denzau and North 1994). Rodrik (2014) and Mukand and Rodrik (2018) look at the interaction between ideas and interests, arguing that ideas might even sometimes be more important than interests in shaping policy outcomes. They argue that while research is mainly concerned with identifying the “right” model, people often have a tendency to downplay evidence that is inconsistent with their view of the world.<sup>3</sup> And even with rational Bayesian updating of beliefs, divergence in beliefs need not disappear over time when there is disagreement over the interpretation of the signals received (Acemoglu et al. 2016). Similarly, Benabou (2008) describes ideology as “collectively sustained reality distortions” where groups tend to believe that their model is not only right for them but for others as well and show immunity to relevant facts so that inconsistent models can coexist along each other.

Ideological commitment to policy targets, finally, is a staple in political economy and addressed in Alesina and Rosenthal (1995). Policymakers might be either ideologically committed and follow their own, partisan, interests or be under the influence of interests groups. This rules out that they are purely opportunistic and adopt any policy position that is likely to generate a majority of votes (for surveys, see Drazen 2000 or Persson and Tabellini 2000).

Both literatures, the one on ideas and the one on ideological commitment to policy targets, motivate our assumption that countries do not agree on a common economic policymaking model. Our main contribution to the literature is that we formally model the possibilities of cooperation under model disagreement whose existence has often been addressed but so far not been modeled.

## 3 The model

### 3.1 Preferences

We assume two countries, indexed  $i, j$ ;  $i \neq j$ . Let policymakers’ preferences, defined as losses, in each country be given as

$$L_i = y_i^2 + \alpha(x_i - \hat{x}_i)^2 \tag{1}$$

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<sup>3</sup>Saint-Paul (2018) analyzes the incentives and conditions for researchers to develop models that are consistent with their individual political views.



where  $y_i$  is the deviation from a target level of output (normalized to zero).  $x_i$  is the current policy of country  $i$  and  $\hat{x}_i$  is its preferred policy or policy target. While countries are free to set their economic policy  $x_i$  to close their output gap, there is also a cost  $\alpha$  of setting the policy in deviation from policy target  $\hat{x}_i$ . These costs can be pecuniary or political. We assume that the costs of setting a policy that deviates from  $\hat{x}_i$  are equal for all countries.

We will refer to a particular  $\hat{x}_i$  as the ideological position or commitment of the policymaker depending on context. If actual policy is considered monetary policy, there may be some understanding of an optimal rate of inflation, if  $x_i$  is considered as fiscal policy, government has some understanding of an optimal budget deficit or surplus, and if  $x_i$  is considered as labor market policy, government has a preferred level of labor market regulation. Thus, countries can be understood as having different policy targets and we assume  $\hat{x}_i = \bar{x}$ ,  $\hat{x}_j = \underline{x}$  with  $\bar{x} > \underline{x}$ .

### 3.2 The economy

We denote the distortion of the current output  $y_i$  from the desired output with  $\theta > 0$ . The distortion  $\theta$ , which may be an economic shock or a structural distortion, is exogenous, given and equal for both countries. Output is in addition affected by domestic policy  $x_i$  and also affected by foreign policy  $x_j$ , which may contribute to close the output gap or enlarge it further. Thus, we assume the following effect of policies on output

$$y_i = -\theta + a_i x_i + b_i x_j \quad (2)$$

for country  $i$ . The parameters for the policy effects of one's own policy ( $a_i$ ) and the spillover ( $b_i$ ) are stochastic with variances  $Var(a) = \sigma_a^2$  and  $Var(b) = \sigma_b^2$ .<sup>4</sup> For simplicity, we assume variances are equal across countries.

Policymakers do not necessarily agree on the model that applies to their economies. In case of disagreement, we assume  $E_i(a_i) = E_i(a_j) = \bar{a}$ ,  $E_i(b_i) = E_i(b_j) = \bar{b}$ ,  $E_j(a_i) = E_j(a_j) = \underline{a}$ ,  $E_j(b_i) = E_j(b_j) = \underline{b}$  with  $\bar{a} > \underline{a}$  and  $\bar{b} > \underline{b}$ , so countries do not only have a different view about how their own economy works but also how the other economy works.<sup>5</sup> Thus, the perception of the policymakers may differ with respect to whether monetary and fiscal expansions will increase output because of positive demand effects or lower it because of an increase in risk premia and moral hazard effects. Similarly, governments may have different views on the effects of labor market policies on output. One government may be convinced that deregulation boosts output by reducing

<sup>4</sup>The assumption that policy effects are uncertain is empirically supported by a large set of empirical studies. For example, Babecky and Campos (2011) show in a meta analysis of more than 46 studies and 500 estimates that structural reforms undertaken in recent decades had often variable and sometimes even negative outcomes for the reforming countries. In addition, the literature on output spillovers suggests that spillovers are of varying magnitude (Auerbach and Gorodnichenko 2013; Aizenman et al. 2016).

<sup>5</sup>We understand these as subjective expectations where policymakers  $i$  and  $j$  can have different expectations.

distortions in the labor market, others may fear that it reduces match quality or has a negative effect on aggregate demand at home and abroad.

Parameters can be positive or negative, depending on the context that is analyzed. We assume throughout that the expected absolute values for domestic policies are larger than expected spillovers, i.e.  $|E(a_{i,j})| > |E(b_{i,j})|$ .

## 4 Non-cooperative policy

We begin with a non-cooperate policy setting and assume that countries play Nash against each other. Using (2) in (1), expected utility of country  $i$  can be written as the sum of the expected values and the variances of parameters. Therefore,

$$EL_i = (E(y_i))^2 + \sigma_a^2 x_i^2 + \sigma_b^2 x_j^2 + \alpha(x_i - \hat{x}_i)^2. \quad (3)$$

This implies first-order condition  $E(y_i)a_i + \sigma_a^2 x_i + \alpha(x_i - \hat{x}_i) = 0$  which shows the trade-off between increasing expected output and the costs of active policy under uncertainty in terms of the costs of using the policy instrument and its variance.

From this, the reaction function of country  $i$  follows as

$$x_i = \frac{(a_i \theta + \alpha \hat{x}_i) - a_i b_i x_j}{a_i^2 + \alpha + \sigma_a^2}. \quad (4)$$

Policy is increasing in the distortion, and in the policy target  $\hat{x}_i$ , evaluated with the costs  $\alpha$  when not reaching it. Policy is declining in its effectiveness  $a_i$ , the uncertainty about domestic policy  $\sigma_a^2$ , and in the cost of setting policy  $\alpha$ . It is also declining in foreign policy  $x_j$ , evaluated with its perceived positive impact on domestic variables. Thus, if a more expansive policy abroad is expected to lower the output gap at home, the domestic government will lower its own policy efforts. Given Nash behavior, the uncertainty of spillovers  $\sigma_b^2$  is not taken into account when setting policy.

Using the reaction functions for the two countries, the non-cooperative Nash policy setting for  $i \neq j$  is

$$x_i^N = \frac{(a_i \theta + \alpha \hat{x}_i)(a_j^2 + \alpha + \sigma_a^2) - a_i b_i (a_j \theta + \alpha \hat{x}_j)}{(\alpha + \sigma_a^2)(a_j^2 + a_i^2 + \alpha + \sigma_a^2) + a_i a_j (a_i a_j - b_i b_j)}. \quad (5)$$

Given our assumption that  $|a_i| > |b_i|$ , the denominator is always positive. Moreover, optimal policy is increasing in the own policy target and the initial distortion. It is decreasing in the expected influence of the other country's policy that in turn reacts to its distortion and policy target. For negative values of  $a_j$  or  $\hat{x}_j$ , of course, the perceived negative spillover has to be compensated by a more active domestic policy. If the other country pursues a contractive policy because it sees negative effects dominating positive ones, the home country would have to compensate this negative spillover.

## 5 Spillovers

In order to demonstrate the need and effect of cooperation, we next look at the impact of policy spillovers on countries. The impact of  $j$ 's policy on country  $i$ 's expected utility is defined as  $\Lambda_i^N = \frac{\partial E L_i}{\partial x_j}$  and follows from (3) as

$$\Lambda_i^N = 2(-\theta + a_i x_i + b_i x_j) b_i + 2\sigma_b^2 x_j. \quad (6)$$

We evaluate this expression with Nash policies to see whether a change in non-cooperative policies by country  $j$  will yield more utility for country  $i$ . If  $\Lambda_i^N = 0$  a change in country  $j$ 's policy would have no impact on the losses in country  $i$ , if  $\Lambda_i^N > 0$  an increase in  $x_j$  would increase losses in country  $i$  (negative spillover), and  $\Lambda_i^N < 0$  would imply an improvement for country  $i$  from more active policy abroad (positive spillover). Obviously, there would be no necessity to cooperate if  $\Lambda_i^N = 0$  but the larger is  $|\Lambda_i^N|$ , the higher is the incentive to cooperate and internalize policy spillovers.

While the size of  $\Lambda_i^N$  determines the incentive to cooperate, its sign determines whether cooperation implies a more or less active policy. Using (5) in (6), we have

$$\begin{aligned} \Lambda_i^N = 2 \left( -\theta \frac{b_i(\alpha + \sigma_a^2)(a_j^2 + \alpha + \sigma_a^2 - a_j b_i) - \sigma_b^2 a_j(a_i^2 + \alpha + \sigma_a^2 - b_j a_i)}{(\alpha + \sigma_a^2)(a_j^2 + a_i^2 + \alpha + \sigma_a^2) + a_i a_j(a_i a_j - b_i b_j)} \right. \\ \left. + 2\alpha \hat{x}_i \frac{b_i a_i(a_j^2 + \alpha + \sigma_a^2) - a_j b_j(b_i^2 + \sigma_b^2)}{(\alpha + \sigma_a^2)(a_j^2 + a_i^2 + \alpha + \sigma_a^2) + a_i a_j(a_i a_j - b_i b_j)} \right. \\ \left. + 2\alpha \hat{x}_j \frac{b_i^2(\alpha + \sigma_a^2) + \sigma_b^2(a_i^2 + \alpha + \sigma_a^2)}{(\alpha + \sigma_a^2)(a_j^2 + a_i^2 + \alpha + \sigma_a^2) + a_i a_j(a_i a_j - b_i b_j)} \right) \quad (7) \end{aligned}$$

It is evident that the two policy targets for country  $i$  and country  $j$  both have a negative influence on country  $i$ , in particular if  $a_j$  and  $b_j$  are small or even negative. The more ambitious is the foreign country's policy target, the more active policy it will pursue which has a negative spillover on the domestic country because it increases domestic output volatility. A more ambitious domestic policy target has a partial positive influence, however, as it leads the foreign country, according to its reaction function, to pursue a less active policy which reduces the spillback.

### 5.1 Type of spillovers

As condition (7) is not unambiguously signed, we look at two special cases in order to determine whether foreign policy spillovers have a positive or negative effect on domestic output. We start with the most simple case.

**Full symmetry**  $a_i = a_j = a$ ,  $b_i = b_j = b$ , and  $\hat{x}_i = \hat{x}_j = \hat{x}$  :

Assuming that countries are fully symmetric in how they perceive policies to impact domestic and foreign outputs and also with respect to their policy targets,

their identical Nash policies are given as

$$x^N = \frac{a\theta + \alpha\hat{x}}{a(a+b) + \alpha + \sigma_a^2}. \quad (8)$$

From (6), it follows that an expansion of foreign policy has a positive effect on county  $i$ , or  $\Lambda^N < 0$ , if  $b\theta > x^N[b(a+b) + \sigma_b^2]$ . The positive effect from the spillover is that it contributes to close the symmetric output gap. At the same time, the ideological commitment of country  $j$  to its policy target  $\hat{x}$  impacts negatively on country  $i$  because it spills over through  $j$ 's policy and contributes additional volatility to domestic output. Thus, the influence from the common output gap runs counter to the influence from policy targets.

Using (8) in (7), the condition for  $\Lambda^N < 0$  becomes

$$\theta[b(\alpha + \sigma_a^2) - a\sigma_b^2] > \alpha\hat{x}[b(a+b) + \sigma_b^2]. \quad (9)$$

Country  $i$  will prefer more active foreign policy if the costs of using domestic policy to close the output are relatively high. In this case, more active foreign policy is welcome as domestic policy is relatively expensive. More active policy abroad has a negative effect if the spillover variance is high and if there are ambitious policy targets. To benefit from more active policy abroad, the distortion  $\theta$  has to be sufficiently large relative to the policy target  $\hat{x}$ . If  $\theta$  is low, closing the output gap is relatively unimportant and countries would rather reach their policy targets. Clearly, if  $\theta = 0$ , there would be no need for active policies, countries would set  $x = \hat{x}$  and spillovers would become irrelevant. If, in contrast,  $\hat{x} = 0$ , the condition simplifies to  $b/\sigma_b^2 > a/(\alpha + \sigma_a^2)$ , which is the well known mean-variance ratio (Brainard 1967).

**Full asymmetry**  $a_i = -a_j = a$ ,  $b_i = -b_j = b$ , and  $\hat{x}_i = -\hat{x}_j = \hat{x}$  :

Next, we turn to the special case where the two countries are fully asymmetric. They have opposite policy targets and opposite views on the signs of the policy effects for their own country and the spillover. In this case, their asymmetric Nash policies are given by

$$x_i^N = -x_j^N = \frac{a\theta + \alpha\hat{x}}{a(a-b) + \alpha + \sigma_a^2}. \quad (10)$$

From (6), it follows that an expansion of foreign policy has a positive effect on county  $i$ , or  $\Lambda_i^N < 0$ , if  $b\theta > x_j^N[b(a-b) - \sigma_b^2]$ . Since country  $i$  believes that a larger  $x_j$  has a positive effects on its own output, this effect carries over from the symmetric setup. The negative impact of country  $j$ 's ideological commitment, however, is reduced. A less expansive policy abroad to reach the policy target implies a smaller spillover and also less domestic output variability.

More specifically, using (10) in (7), the condition for  $\Lambda_i^N < 0$  becomes

$$\theta[b(\alpha + \sigma_a^2) + a\sigma_b^2] > \alpha\hat{x}[b(a-b) - \sigma_b^2]. \quad (11)$$

Given that country  $j$  perceives spillovers with the opposite sign, a positive spillover for country  $i$  implies a negative spillover for country  $j$ . For country  $j$ ,  $\Lambda_j^N < 0$  requires  $\alpha \hat{x}[b(a-b) - \sigma_b^2] > \theta[b(\alpha + \sigma_a^2) + a\sigma_b^2]$ . Thus,  $\Lambda_i^N = -\Lambda_j^N$  in case of full asymmetry. While one country benefits from an expansion of policy abroad the other suffers. Cooperation and agreement on a joint policy is therefore likely to be more difficult if there is model disagreement.

## 5.2 The role of uncertainty

Next, we explore in more detail how uncertainty about spillovers and domestic policy affect the incentive to cooperate (see also Ghosh and Masson 1994 for the symmetric case). With respect to the effect of uncertainty on the impact of the spillovers we can compare the following two cases:

1. If  $\text{sgn}(\frac{\partial \Lambda_i^N}{\partial \sigma_k^2}) = \text{sgn}(\Lambda_i^N)$  with  $k = a, b$ , uncertainty increases the impact of spillovers on government losses and thus increases the incentive to cooperate.
2. If  $\text{sgn}(\frac{\partial \Lambda_i^N}{\partial \sigma_k^2}) \neq \text{sgn}(\Lambda_i^N)$ , however, the impact of spillovers is lowered by uncertainty and thus cooperation becomes less important to achieve.

Taking the derivative of (6) with respect to spillover uncertainty, we get

$$\frac{\partial \Lambda_i^N}{\partial \sigma_b^2} = 2x_j^N \quad (12)$$

and with respect to the uncertainty about the policy effect on the own economy, it follows that

$$\frac{\partial \Lambda_i^N}{\partial \sigma_a^2} = 2a_i b_i \frac{\partial x_i^N}{\partial \sigma_a^2} + 2(b_i^2 + \sigma_b^2) \frac{\partial x_j^N}{\partial \sigma_a^2}. \quad (13)$$

How uncertainty influences the incentive to cooperate crucially depends on the signs of policy parameters  $a$  and  $b$  and the influence of policy targets  $\hat{x}$ . We, therefore, look again at the two special cases of parameter constellations to see how increases in  $\sigma_b^2$  and  $\sigma_a^2$  affect countries' utilities.

**Full symmetry**  $a_i = a_j = a$ ,  $b_i = b_j = b$ , and  $\hat{x}_i = \hat{x}_j = \hat{x}$  :

Given that  $\Lambda^N$  is equal for all countries in the symmetric case, it is also clear that countries are affected similarly by uncertainty about spillovers and domestic policies. From (12), the influence of spillover variability on the reduction in losses in country  $i$  by more active policies in country  $j$  is  $\frac{\partial \Lambda_i^N}{\partial \sigma_b^2} > 0$ . Spillover uncertainty reinforces the impact of spillovers on countries' utility and therefore increases the incentive to cooperate. As the impact of foreign policy on utility is reinforced, the country's interest in cooperation and an internalization of that effect is increased.

The incentive to cooperate is also affected by an increase in the uncertainty about the effect of domestic policy on own output. From (13) it is given as

$\frac{\partial \Lambda^N}{\partial \sigma_a^2} < 0$  and shows the opposite influence from spillover uncertainty. Under high uncertainty about domestic policy effects, both countries will set only moderate policies. This implies that spillovers are reduced as well and, therefore, the incentive to cooperate is reduced too. While spillover uncertainty increases the incentive to cooperate, the opposite follows from an increasing domestic policy uncertainty.

**Full asymmetry**  $a_i = a = -a_j$ ,  $b_i = b = -b_j$ , and  $\hat{x}_i = \hat{x} = -\hat{x}_j$  :

In the asymmetric case  $\Lambda_i^N = -\Lambda_j^N$  and therefore an increase in uncertainty will have opposing effects on the two countries. From (12), we have  $\frac{\partial \Lambda_i^N}{\partial \sigma_b^2} = -\frac{\partial \Lambda_j^N}{\partial \sigma_b^2} < 0$  and from (13) that  $\frac{\partial \Lambda_i^N}{\partial \sigma_a^2} = -\frac{\partial \Lambda_j^N}{\partial \sigma_a^2} > 0$ . Thus, not only is the influence of uncertainty for country  $i$  reversed, it is also no longer symmetric for both countries and affects country  $j$  differently than country  $i$ .

The intuition for this is straightforward. As country  $j$  perceives the effects of its policy as negative for output, it will run a less expansive policy. This automatically implies that the spillover to country  $i$  is reduced as well and, therefore, this country is less affected by an increase in  $j$ 's policy. The incentive to cooperate is consequently reduced as well. The opposite is the case for the spillover from country  $i$  to country  $j$ . As country  $i$  runs a more expansive policy, the impact on country  $j$  is increased and perceived as being negative. The interest for cooperation increases as a consequence.

As in the symmetric case, the impact of spillover variability and the variability of own policy go in opposite directions for the reason explained above.

We summarize our results as:

**Proposition 1.** *(i) Spillover uncertainty and uncertainty about domestic policy effects have opposing effects on the incentive to cooperate.*

*(ii) Under full symmetry spillover uncertainty increases the incentive to cooperate, domestic policy uncertainty lowers it.*

*(iii) Under full asymmetry the influence of uncertainty on the incentive to cooperate is reversed for country  $i$  but it is preserved for country  $j$ .*

*Proof: see above.*

## 6 Cooperation

The last section derived the marginal influence of uncertainty on how strong countries are affected by spillovers. In this section, we compare countries' individually expected utilities under cooperation and non-cooperation and discuss different modes of cooperation. We compare a bargaining solution, where both countries have equal power, and a form of cooperation in which one country or an international organization dominates the policy choice. We show under which conditions countries that disagree on the model are willing to cooperate. In particular, we are interested whether uncertainty about spillovers can lead to cooperation even if countries disagree.

## 6.1 Policies under cooperation

For the cooperative solution, we assume a process of negotiation that ends in setting a common and coordinated policy  $x^c$ . Joint losses are given as

$$EL^C = \mu EL_i + (1 - \mu)EL_j \quad (14)$$

where we assume first that both countries have equal weight  $\mu = \frac{1}{2}$ . We abstain from deliberate and strategic misrepresentation of “true” beliefs in the negotiation process. Ostry and Ghosh (2016) argue that if countries negotiate about the joint policy position they have the incentive to over-estimate the negative spillovers caused by other countries. This is certainly an issue but we abstract from this additional complication.

From (14), optimal joint policy is

$$x^C = \frac{(a_i + a_j + b_i + b_j)\theta + \alpha(\hat{x}_i + \hat{x}_j)}{2(\alpha + \sigma_a^2 + \sigma_b^2) + (a_i + b_i)^2 + (a_j + b_j)^2}. \quad (15)$$

As before, we explain our results by discussing extreme cases.

**Full symmetry**  $a_i = a_j = a$ ,  $b_i = b_j = b$ , and  $\hat{x}_i = \hat{x}_j = \hat{x}$ :

That cooperation leads to more or less active policy can easiest be seen when looking at a symmetric setup. In case of full symmetry, coordinated policy leads to

$$x^C = \frac{(a + b)\theta + \alpha\hat{x}}{(a + b)^2 + \sigma_a^2 + \sigma_b^2 + \alpha}. \quad (16)$$

For  $x^C > x^N$ , we have the same condition as in (9) which derived under what circumstances countries are positively affected by an increase in foreign policy. As explained above, it requires that spillover uncertainty on output is not too large and that the policy target ( $\hat{x}$ ) is not more important than the output target ( $\theta$ ).

**Full asymmetry**  $a_i = -a_j = a$ ,  $b_i = -b_j = b$ , and  $\hat{x}_i = -\hat{x}_j = \hat{x}$ :

Quite intuitively, when countries have fully asymmetric policy views, (15) becomes  $x^C = 0$ . As countries bargain over a common policy and the two countries have fully opposite views they should agree on both doing nothing.

**Asymmetric bargaining power**  $\mu = 0$ :

Another possibility of cooperation if countries are asymmetric not only in terms of their perceptions of how policies work but also in their bargaining power is that one particular policy view will dominate the other.

One extreme historical example of such domination could be the relation between a colony and a colonizer, such as Great Britain and its colonies. A less extreme example are the smaller member states of the European Union which

joined the union for political reasons and had to adopt common policies despite maybe having a different view of how economies work than larger member states. Similarly, countries might decide for credibility reasons to adopt a currency board with the US-dollar without necessarily sharing the same economic model or believing that their economies function in the same way as the US economy.

Besides having one country dominate the other, it could also be that international organizations, like the International Monetary Fund, the World Bank, or the European Union condition their support on particular policies that small economies would not adopt voluntarily. The so-called Washington Consensus, applied by World Bank and the IMF, has been strongly criticized for forcing one-size-fit-all policies on countries for which these policies were not adequate (see, for instance, Stiglitz 2002). Another example would be the conditionality of IMF, European Central Bank, and European Commission connected with their support for Greece, which has also been criticized not only for being too harsh but applying wrong and not adequate measures (Mody 2018). Lastly, it might also simply be the case these organization are not neutral but adhere to some particular ideological world view and impose these on others.<sup>6</sup>

Then, if country  $j$  has all the bargaining power ( $\mu = 0$ ), joint policy would be

$$x_{\mu=0}^C = \frac{\theta(a_j + b_j) + \alpha \hat{x}_j}{(a_j + b_j)^2 + \sigma_a^2 + \sigma_b^2 + \alpha}. \quad (17)$$

## 6.2 Is cooperation feasible?

In order to establish whether countries can agree on a cooperative solution in which both reduce expected losses, we first evaluate the case of fully asymmetric policy views, and afterwards consider the case where one country, or an international organization, has complete bargaining power and can impose its policy view on the other country.

**Full asymmetry**  $a_i = -a_j = a$ ,  $b_i = -b_j = b$ , and  $\hat{x}_i = -\hat{x}_j = \hat{x}$ :

In this case, the Nash policies of the two countries are given by (10). In case cooperation is pursued, the assumptions imply that  $x^C = 0$  or  $x_i^N > x^C = 0 > x_j^N$ . Cooperation will imply that country  $i$ 's policy is less expansive and that of country  $j$  is less contractive.

Using the respective policies in (3), expected losses for both countries in the Nash case are

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<sup>6</sup>One complaint against the IMF is that its staff is dominated by a US centric view of the world, not least because staffers mostly hold degrees from US universities (Stiglitz 2002, Woods 2006).



$$\begin{aligned}
EL_{i,j}^N &= \theta^2 + \alpha \hat{x}^2 + \left( \frac{a\theta + \alpha \hat{x}}{\alpha + \sigma_a^2 + a^2 - ab} \right)^2 ((a-b)^2 + \sigma_a^2 + \sigma_b^2 + \alpha) \\
&\quad - 2 \frac{(a\theta + \alpha \hat{x})}{\alpha + \sigma_a^2 + a^2 - ab} ((a-b)\theta + \alpha \hat{x}).
\end{aligned} \tag{18}$$

Expected losses under cooperation instead are

$$EL_{i,j}^C = \theta^2 + \alpha \hat{x}^2. \tag{19}$$

Cooperation is utility increasing if  $EL_{i,j}^N > EL_{i,j}^C$  or

$$\sigma_b^2 > \sigma_a^2 + \alpha + (a-b)^2 - \frac{2b}{(a\theta + \alpha \hat{x})} [\theta(\sigma_a^2 + \alpha) - \alpha \hat{x}(a-b)]. \tag{20}$$

Given our assumption about the relative size of policy effects and spillovers, condition (20) depends on the relative size of spillover uncertainty, the need for output stabilization ( $\theta$ ), and the policy target ( $\hat{x}$ ). If spillover uncertainty is high, countries can agree to cooperate because cooperation becomes more interesting in order to internalize the negative effects of spillover uncertainty. Condition (20) defines a critical level of spillover uncertainty,  $\tilde{\sigma}_b^2$ , above which cooperation is utility increasing.

From (20) we find  $\frac{d\tilde{\sigma}_b^2}{d\hat{x}} > 0$  which means spillover uncertainty must be higher in order to compensate for a larger disagreement concerning the policy target  $\hat{x}$ . Moreover,  $\frac{d\tilde{\sigma}_b^2}{d\theta} > 0$  because countries find it more difficult to cooperate if they have different ideas how to best stabilize economic shocks or address structural distortions as these become larger. Also,  $\frac{d\tilde{\sigma}_b^2}{d\sigma_a^2}$  is positive if  $\theta(a-2b) + \alpha \hat{x} > 0$ , which means that a larger domestic uncertainty requires even higher spillover uncertainty to induce more cooperation. The reason is simply that the larger is domestic uncertainty, the less active is domestic policy and the lower consequently policy spillovers will be. Consequently,  $\frac{d\tilde{\sigma}_b^2}{db}$  is almost certainly negative (a sufficient condition is  $2b > a$ ). Lastly, (20) yields that  $\frac{d\tilde{\sigma}_b^2}{d\sigma_a^2}$  has a negative sign if  $\theta(a-2b) + \alpha \hat{x} > 0$ . Thus, domestic uncertainty and disagreement over policy targets have opposing impacts on the incentive to cooperate.

#### Asymmetric cooperation $\mu = 0$ :

The extreme alternative would be that county  $i$  has to adopt the policy of country  $j$  or that of some international organization under cooperation. Expected utility would become

$$EL_i^C = (-\theta + (a+b)x_j)^2 + (\sigma_a^2 + \sigma_b^2)x_j^2 + \alpha(x_j - \hat{x}_i)^2 \tag{21}$$

with a policy of

$$x_{\mu=0}^C = \frac{-\theta(a+b) - \alpha\hat{x}}{(a+b)^2 + \alpha + \sigma_a^2 + \sigma_b^2}$$

and therefore

$$EL_i^C = \theta^2 + \alpha\hat{x}^2 + \frac{(\theta(a+b) + \alpha\hat{x})^2}{(a+b)^2 + \alpha + \sigma_a^2 + \sigma_b^2} + 2\frac{(\theta(a+b) + \alpha\hat{x})^2}{(a+b)^2 + \alpha + \sigma_a^2 + \sigma_b^2}.$$

Thus, asymmetric cooperation is obviously always worse than symmetric cooperation (19). So in case symmetric cooperation will not work, neither will asymmetric cooperation which is not surprising.

Asymmetric cooperation is even worse than non-cooperation,  $EL_i^C > EL_i^N$ , if

$$3\frac{(\theta(a+b) + \alpha\hat{x})^2}{(a+b)^2 + \alpha + \sigma_a^2 + \sigma_b^2} > \left(\frac{a\theta + \alpha\hat{x}}{\alpha + \sigma_a^2 + a^2 - ab}\right)^2(\sigma_b^2 - (\alpha + \sigma_a^2 + (a+b)(a-b))) + 2b\theta\frac{(a\theta + \alpha\hat{x})}{\alpha + \sigma_a^2 + a^2 - ab} \quad (22)$$

which is likely to be fulfilled unless  $\sigma_b^2$  dominates all other influences. That is, it is indeed very likely that asymmetric cooperation is worse than playing Nash. As before, however, we see that a larger uncertainty about spillovers makes cooperation more likely as the expression on the left hand side becomes smaller while that on the right hand side increases.

Again, we summarize our main findings as:

**Proposition 2.** (i) *Under full symmetry, cooperation is possible and Pareto-improving.*

(ii) *Under full asymmetry, spillover uncertainty can overcome model disagreement. Cooperation is feasible if spillover uncertainty is high enough.*

(iii) *Cooperation under asymmetric bargaining power is only possible if spillover uncertainty dominates all other parameters.*

*Proof: see above.*

### 6.3 Discussion

Our results show that the incentive to cooperate shrinks as soon as countries have different views about how their economies function and whether particular policies have a positive or negative on their own output and that of the other country. As Eichengreen (2013), Frankel (2016) and Ostry and Ghosh (2016) explain, it is therefore not surprising that macroeconomic cooperation has not really worked well. Despite attempts to coordinate monetary and fiscal policies as well as exchange rate policies in the G7, there are very few cases where this

has functioned well. While leading countries managed to agree on fiscal stimulus at the Bonn Summit in 1978 and on exchange rate levels at the following Plaza Accord (1985) and Louvre Agreement (1987), cooperation proved more difficult afterwards as Germany and Japan came to regret what they agreed to. As Frankel (2016) explains, this was not only driven by material interests that were different, but also by different world views where some countries believed they played the locomotive game with positive spillovers, and Germany believed to be playing the moral hazard game with negative spillovers. The same difference in perceptions might have been the reason why countries could agree on fiscal stimulus in the G-20 at the London summit in 2009 but European countries failed to reach such in agreement in the Euro crisis little time later. While some European countries criticized Germany for being restrictive and thereby aggravating the crisis, Germany and its allies believed that lax fiscal policy were the root of the problem (Brunnermeier et al. 2016).

Turning to the activities of the G-20 in the wake of the great financial crisis, Angeloni and Pisani-Ferry (2012) show that cooperation has been quite successful initially but became more difficult as the scope of policies widened and as the initial crisis impulse dampened down. One explanation for the initial possibility of cooperation in the light of our model would be that countries took measures in areas in which they agreed, mostly the need for financial market regulation and supervision of banking systems, because there is often less disagreement in technical matters compared to monetary and fiscal policy. As Eichengreen (2013) argues, cooperation is more easy in technical matters since these are usually negotiated by experts who tend to have a similar world view. When the scope of policies widens and policymakers take over, however, the room for disagreements widens.

But as our model suggests, it could also be that the initial uncertainty helped to overcome different perceptions about the general effects of macroeconomic policies. That countries in the G-20 were initially able to agree on fiscal stimulus, something they were less able to in other situations, might also have had to do with an increased awareness that there are strong spillovers in a crisis situation, and that countries were confronted with particularly high levels of uncertainty at the beginning of the global financial crisis. Our model would suggest that in such situations of increased uncertainty model disagreements and ideological commitments can be overcome.

Similarly, in the European context cooperation was possible with the creation of the Financial Stability Mechanisms EFSF and FSM at the height of the crisis, but as the immediate crisis receded different perceptions about the nature of the problem gained upper hand again. Further measures to deepen cooperation in the euro-zone, such as a common budget, a full banking union and other matters have no chance of being implemented any time soon as recent discussions have made clear. Again, one explanation for this, we would argue, is that uncertainty has gone down and that model disagreements can no longer be overcome. Hence, cooperation may be possible in times of crises and heightened uncertainty but difficult to sustain as uncertainty decreases.

## 7 Conclusion

Spillovers in policies between countries are generally a strong reason to cooperate. When cooperating, countries can internalize the positive or negative externalities on other countries that arise from monetary, fiscal, or labor market policies. Yet we observe very often that countries do not cooperate even when spillovers exist. One reason for this could be that countries are not able to agree on a common view of the underlying problem because they apply different economic models.

It has been shown previously that without model disagreement, uncertainty of the spillover effects is only determining whether cooperative policies are more or less active when compared to non-cooperative policies (Brainard 1967, Ghosh and Masson 1994, Hefeker and Neugart 2018). Under model disagreement, however, more uncertainty of spillovers increases the effect of a policy change on the other countries' expected payoffs for both countries, thereby raising the incentives to cooperate. This paves the way for a new role of spillover uncertainty. We show that a large enough uncertainty about the influence of spillovers may compensate for the unwillingness of countries that do not agree on a common economic model to coordinate their policies. An increase in uncertainty may thus, at least to some extent, alleviate the stark and negative predictions that have been made about the negative effects of model disagreement on the possibility for international cooperation.

Therefore, more uncertainty should increase the incentive to cooperate internationally, in particular if the size of spillovers increase due to, for instance, intensified trade and financial relations (Biljanovska et al. 2017). Despite strong increases in economic interconnections and globalization, however, we do not see a strong increase in policy coordination. Even in the highly integrated European Union we do not see that countries could agree, for instance, on a common fiscal policy, and one reason could be that model disagreement has also increased.

One suggestion put forward to solve this problem is that independent agents, such as the International Monetary Fund solve the disagreement by convincing countries of the "right" model (Ostry and Ghosh 2016). If these agents are indeed perceived as being non-partisan to one particular model, they may enjoy higher credibility, convince governments of the true model and thus enable coordinated policies. The problem, however, is that often agencies such as the IMF or the European Central Bank are not perceived as being non-partisan. As we have also shown, if these agencies are committed to their own policy view and impose this on individual countries, coordination can become even more unlikely, simply because this view is imposed and not the outcome of a bargaining process in which different views are compromised upon.

Another possibility to solve this problem and to find the true model could be a process of experimentation with different policy models, as it has been suggested in the literature about uncertain economic reforms (Binswanger and Oechslin 2015; Hefeker and Neugart 2018). If countries pursue different models in order to find out about the true model, compensation and risk-pooling can be one way to discover the true model. Countries are induced to pursue

more reforms if they are supported by other countries, if such reforms are costly, and/or if they are compensated when particular policies turn out not to be successful. This approach, however, depends crucially on the existence of a “true” model that applies to all the economies involved. If we not only have different perceptions about the true model but also de facto asymmetries, cooperation would be additionally difficult.

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