Who's Afraid of Commitment?

Fiscal transfers and commitment in monetary unions

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Abstract

In this paper, we consider the challenges facing monetary policy commitment in a monetary union, when adverse shocks may occur heterogeneously. We model a two country monetary union, with a fiscal transfer scheme, designed to compensate for shocks that are more negative than the union average. We suggest that the presence of such a scheme may result in a common central bank coming under less pressure to abandon a credible commitment, given that countries can be better off under the presence of a risk sharing scheme, depending upon the specification.

1 Introduction

The time inconsistency problem in economic policy-making has been a challenge for institutional design since the issue was highlighted in the late 1970s in the work of Kydland and Prescott (1977). Much has been written about the topic, in contexts ranging from optimal capital taxation (see Sargent, 1987, Chapter XV; and Persson and Tabellini, 2002, Chapter 12) to sovereign debt accumulation (see Calvo, 1988 for a consideration of this topic)[1]. It is the area of monetary policy that we focus on in this paper, however, where time inconsistency *can* lead to serious failure of monetary policy transmission mechanisms, and welfare loss through higher inflation than would be desirable with no output boost (referred to in the literature as the *inflation bias*). The specific context in which we consider the problem is monetary unions: collections of states, fiscally decentralized, with a common currency set by a single monetary policy-maker. The benchmark example is the Euro Area, though less obvious examples include the United States (if we stretch the definition a little) and the CFA franc systems of West and Central Africa. However, for the purposes of this analysis (because of the ubiquity of literature on the Euro Area) we focus on the Euro Area, with some nods to the United States - that is particularly for the purpose of comparing the more and less integrated systems of the US and Euro Area, respectively.

We motivate this research for several reasons. First, the theory on optimal currency areas suggests that - under certain assumptions - currency areas can be welfare improving for some regions (this literature can be traced back to Mundell (1961), on optimal currency areas). For states prone to high inflation, currency areas can reduce inflationary pressures - the CFA franc zones have typically had lower inflation rates than their neighbours in Sub-Saharan Africa (The Economist (2002) & Elbadawi and Majd (1996) both suggest inflation stability, though at the expense of economic growth). Second, the recent experiences of country-specific crises in the Euro Area suggests that research on monetary unions with diverse member states can be of use in understanding policy responses to economic crises (Blinder (2013, pp. 409 - 428) has a nice discussion of some of the challenges facing Europe in the period from 2008 to 2011, though focused mainly on the sovereign debt crisis. In this, he includes comment on the diverse economic stability of the Euro Area constituent countries, and compares this with the United States). Such topics are of interest from both an academic and popular perspective - for example, the Euro Area and its structure has received comment in *Buttonwood's Notebook* in The Economist for its structural differences with the United States (Economist, 2010). Even now, we see reference in the popular literature to the need for further integration in the Euro Area, and the challenges that process faces - see The Economist, (2017) for a brief article on the history and future challenges of economic integration in Europe.

Our concern in this paper is with member countries that are subject to heterogeneous and asymmetric shocks. Consider, for example, a monetary union in which nations participate because of political motivations, linguistic and historic ties, or because of very close trading links. In all of these cases, the motivation for monetary union does not preclude member states from being subject to heterogeneous shocks. Further, we can create conditions under which policy shocks in a monetary union, in the name of integration, may induce country-specific shocks (Consider policies that foster in specialisation in a union. In an effort to integrate markets and improve trade, a union can end up with

[1]See also Nahallel, 2000, pp. 274 - 75, for historical examples of commitment devices in England versus France on the topic of sovereign debt.

some countries facing industry specific shocks on their area of specialisation). Thus, it is of interest to consider how monetary policy commitment can be sustained in those cases. The following will contribute to the literature by arguing that monetary policy under heterogeneous shocks can include fiscal transfers between member states designed to induce members subject to negative shocks to accept a less expansionary monetary policy. One of the working assumptions we make throughout this paper is that capital markets are not capable of perfectly insuring against idiosyncratic risk. That assumption is founded in the idea that capital markets are imperfect across monetary unions, something that we see evidence of in the Euro Area, where asset portfolios are still not as integrated as one would hope for in an optimal currency union[2]. We note that Kehoe and Pastorino (2017) argue that in the presence of sophisticated financial markets, fiscal transfers in a monetary union do not assist in providing insurance, and are only of use in the case of redistributing wealth across the union. However, we do not expect that financial markets in all monetary unions are as integrated as necessary for their argument to carry full force. Thus, we expect that our work is helpful in describing less integrated monetary unions, where financial frictions are significant.

The paper is structured as follows. We begin by referring back to the original work of Kydland and Prescott (1977), in order to clarify the concept of time inconsistency from its origins. We then proceed to expand upon the idea within the area of monetary unions specifically, introducing the challenges of particular prominence in a monetary union, where fiscal and monetary forces may be particularly likely to wander adrift in objectives. This leads us to consider the literature on a method of inducing commitment in monetary unions: a fiscal transfer scheme of some kind. Having done so, we then lay out the model that we use to analyse the problem at hand. This model adopts elements from several sources, cited as we proceed, in order to allow us to analyse the effects of fiscal transfer schemes in a commitment context. That allows us to consider the implications of the model for monetary unions under which there are heterogeneous shocks, and whether fiscal transfer schemes may be suitable policy mechanisms to overcome the resulting commitment issues. Specifically, we seek to answer the following question: can fiscal transfer schemes between members assist in inducing credibility of monetary policy, by removing an incentive to water down monetary policy rules?

[2]See Berger, et al. (2018), pp. 9 - 11 for a brief overview of Euro Area financial integration. The data they cite from the ECB suggests that measures of integration had been improving prior to the global financial crisis, but abruptly fell around 2007 - the result of integration being biased toward pro-cyclical financing methods.

2 Literature Review

2.1 *Foundations of Dynamic Inconsistency*

As we note above, the literature on time inconsistency in dynamic economic policy was started with Kydland and Prescott's (1977) contribution. They cite the work of Friedman (1948), as an example of a view to rules over discretion in economic policy-making, specifically monetary policy. However, unlike Friedman (who argues that discretionary control of policy should be removed from government, in an attempt to promote long-run stability), Kydland and Prescott base their conclusion on an argument derived from rational expectation in a dynamic game - as opposed to the more ideologically driven claim made by Friedman in his motivation for monetary rules.

The fundamental issue in time inconsistency problems is this: a policy for the *leading* agent that is optimal today, is not optimal tomorrow, when a decision has been made by a *following* agent who has played their part in the game. The *follower* anticipates this inconsistency, and thus expects the leader to choose an action that is, *ex ante*, not optimal. Immediately below, we outline the general idea behind time inconsistency in the context of taxation in order to build a conceptual foundation for what follows later in the paper. In the interest of brevity, we omit details, for a much more comprehensive and illustrative example can be found across the literature (see, for example, Persson and Tabellini, 2012, Chapter 6 for a simple yet illuminating model and discussion).

Consider a two period economy[3], with a government and an agent who live in each period. In period one, the agent supplies quantity of labour, l, in return for a wage, w. The agent has disutility from labour supply and increasing, concave utility from consumption of a good with unit price. In period two, the agent does not work and consumes the good from their wage. The government can forcibly tax the agent in period two, taking from their wage earned in period one, and does so at the rate μ. Thus, given a unit price of consumption goods, the agent can consume $(1-\mu) \times w$ units in the second period. We assume that agents gain no utility from the spending of the government: for example, we might consider the agent to be a self-sustaining commune, that does not participate in education programmes or any other form of public service (as unrealistic as this might be, we use it as a motivating tool only). If the agent maximises utility rationally, they will consider what the government will do in the second period, and factor this into their allocation of labour in the first period. If the government chooses the tax rate in period two, their incentive (if they are aiming to maximise tax receipts to maximise spending on public goods) is to tax at the highest rate possible. However, taxing the agent at the $\mu = 1$ means that they consume nothing in the second period, despite having exerted costly effort on labour in the first period. Therefore, a rational agent will not exert effort in the first period, because they know any earnings will be taken by the government. Thus, there is no income for the government to tax. This is the case no matter what tax rate the government proposes in period one: when period two comes around, and private agents have incurred the cost of working, the government will optimally choose to revise the tax rate upward.

Therefore, the government wants to find a way to make *credible* the initial announcement of what the tax rate will be. This is often easier said than done. In most countries today, tax rates are set by a legislative process, and changing them thus incurs a cost,

[3]This brief model is altered from the lecture notes of Sevi Rodriguez Mora, and with a view to Ljungqvist and Sargent, 2004, pp.779-81.

because there are many steps that have to be undertaken. So, changing an already set tax rate is very difficult, though not impossible. Long term capital investment may have a long enough durable life that even tax changes several years after the original investment can present problems for time consistent policy. Thus, the presence of commitment devices that are considered credible by private agents is not straightforward, and much work has been undertaken trying to find optimal mechanisms.

2.2 *Monetary Unions and Fiscal Transfers*

Monetary unions are one commitment device used by states that may have problems generating credibility of monetary policy via other means (such as reputation). As such, it is particularly valuable for nations with a history of commitment problems to participate in a monetary union with other states that have a stronger history of commitment to a low-inflation monetary policy[4]. One of the problems, however, that arises in a monetary union is the fact that one monetary policy is set for all parts of the union: that is, expansionary and contractionary monetary policy is set across all states, regardless of the specific supply shocks that they may be subject to. Conventional monetary tools used to combat fluctuations are not available at the national level, and there are no foreign exchange depreciation tools for inducing demand in an open economy model (an issue most prominently associated with Greece in the recent European crisis). Furthermore, a crisis is typically not the place to undertake the structural reforms that might speed up a country's emergence from a crisis: Eggertsson, et al. (2014) argue that the structural reforms enacted in the Euro Area in 2009 - 2013 did not improve the output potential of reforming nations; rather, the timing of the reforms meant that the effects were contractionary. That fact can allow the problem of time inconsistency to rear its ugly head once again: member states have incentives to either press the central bank to pursue union-wide surprise expansionary policy, or they may choose to leave the union altogether.

The challenge for the institutional designer is thus one of creating institutions such that enable credibility to be sustained, while also ensuring that incentives to leave the monetary union are kept at bay and the inability to stabilise output and reduce output differentials are not so severe that society faces a significant social welfare cost. Asymmetric shocks make this even more difficult: some members may look for demand stabilising monetary policy (expansion), while others seek price stability and look to avoid costly inflation.

Often in a monetary authority, there exist rules on fiscal spending that inhibit the ability of member states to smooth shocks (the Stability and Growth Pact of the Euro Area, for example, is intended to keep member states' deficits below a pre-set threshold). Although some authors (for example, Chari and Kehoe (2007) and (2008) argue that, if there is no time inconsistency problem in monetary policy, then fiscal constraints are more do more harm than good) argue against the imposition of non-monetary constraints if there is a credible monetary policy, we recognise the fact that in many monetary unions, political considerations often lead to policies that are grounded in negotiation between parties with different national preferences, and thus non-monetary constraints are likely to remain in many monetary unions.

[4]Although Aguiar, et. al (2015) demonstrate that, in monetary unions, credibility of nations with high sovereign debt stocks may be improved by medium average debt stocks in the union, rather than all other members having low debt stocks.

One of the proposed methods to overcome the lack of monetary stabilisation tools, is a method of fiscal transfers (below we use the shorthand FTS to denote a fiscal transfer scheme), from the rest of the union members to those subject to negative shocks (such that they would ordinarily attempt to use monetary policy to stabilise). Indeed, some argue that in an optimal currency area, the monetary union ought to coincide with a fiscal union (Kenen, 1969). This is the method that we explore later in the paper, to understand its effects on inducing commitment from the central monetary authority. However, before doing so, we briefly review some of the literature on fiscal transfers and the interaction of fiscal and monetary policy. There is relatively little on the interaction of fiscal transfer schemes and the credibility of monetary policy - the main thrust of our work - and so we look at a slightly broader literature on closely related topics as well.

Beetsma and Bovenberg (2001) discuss the optimality of monetary union when there is no fiscal union alongside the central monetary policy. They argue that, in spite of conventional wisdom suggesting that stabilization is best achieved by fiscal transfers and national monetary policy, the lack of monetary commitment and fiscal discipline means that it can be optimal to have precisely the opposite - a monetary union without a fiscal union. The monetary union induces credibility in monetary policy, and the lack of fiscal transfers overcomes the problem of moral hazard that results when fiscal authorities have a transfer mechanism to fall back on. Further, they show that the presence of moral hazard implies that risk sharing will be incomplete: that is, the stabilising effect of the transfers will not be full and full insurance of fiscal shocks is not optimal. In order to induce fiscal discipline on the part of national governments, the shock stabilisation effects of transfers are reduced, and if shocks are small the gain from fiscal discipline outweighs the loss from lower transfers.

In an earlier article on fiscal federalism in monetary unions and federations, Persson and Tabellini (1996a) discuss the effects of constitutional design on the tradeoff between risk sharing of shocks, and the moral hazard problem that national governments are incentivised to follow under fiscal transfers. That is, they consider what institutional design is most effective, given that there is a fiscal transfer system in place: in doing so they compare the different structures of the Euro Area and the USA. They suggest that, since national policies are typically not verifiable in a system of intergovernmental transfers, national policies will not be coordinated and risk sharing will be incomplete. The presence of a risk sharing mechanism incentivises less public investment by the national government than in the first best case (under the assumption that public investment increases the probability of the country being in a high productivity state), and thus gives lower social welfare than in the first best outcome. However, by altering the timing, and assuming that the transfer scheme is decided prior to national policy, they find that risk sharing is incomplete in a non-cooperative equilibrium, however national public investment is higher than in the case of simultaneous decision making. The intuition is thus: when the national decision is made, with the union's decision to undertake incomplete insurance set, they find it optimal to increase public investment in order to increase the probability of being in a good state. They find there is more commitment capacity in *vertical* systems such as the US, than in *horizontal* systems like the Euro Area. In their words, "centralizing tasks and power" leads to welfare improvements (Persson and Tabellini, 1996a, pg. 644).

Similarly, in a companion piece also by Persson and Tabellini (1996b), the authors investigate the shock insurance effects under two different systems: one a social insurance system voted on and adminstered at the *federal* level, and the other a system of intergovernmental transfers that are decided upon by a bargaining process. They find that, in the former system there is overinsurance relative to the efficient scheme with no restrictions, and in the latter there is underinsurance relative to the efficient outcome. Importantly for the purpose of this paper, the conclusion on under-provision of risk sharing in a fiscal transfer system rests on the method of Nash bargaining, rather than simply by voting. The nature of the FTS is that the redistribution of income is between the rich and poor countries, and they have opposing interests. In that way, bargaining affects the extent of risk sharing because the rich country has more bargaining power (under the assumption that autarky is the threat mechanism) than the poor country. That is why there is under-provision of risk sharing transfers.

The literature we have discussed above suggests that there is a tendency toward under-provision of risk sharing, primarily as a result of moral hazard concerns. The result for the question that we pursue below is that risk sharing is not full, and countries that are subject to negative shocks may have less incentive to remain committed to a low inflationary environment - they are receiving less in transfers, and thus are more inclined to pressure the central bank for expansionary monetary policy. That can lead to a breakdown in commitment for the monetary policy maker, and a loss of reputation.

Finally, we consider the question of credibility in the presence of *parallel agreements*, as in Stasavage and Guillaume (2002). The authors argue that the presence of institutional arrangements in conjunction with a monetary union makes the cost of exit higher, and thus makes monetary commitments more durable. In their article, they investigate an estimation of the likelihood of exit from a monetary union among African nations in the presence of various levels of parallel agreement (in areas like trade and security): their finding is that the existence of these agreements leads to a lower probability of exit for a country. While they do not explicitly consider an FTS, we see such an arrangement to be beneficial while being a member of the monetary union. To our knowledge, the literature is sparse on this point, and thus we have little more to review. However, it is of note that there are findings which suggest other institutional mechanisms can induce remaining in a monetary union.

3 A Model of Monetary and Fiscal Policy

We adapt the models of Hefeker and Neugart (2015) & Dixit and Lambertini (2001) in order to provide a basis for analysis, in a monetary union with an FTS. We assume several of the requirements for the model to go through. For example, we simply assume that something presents us with a natural rate of output that is lower than desired and possible: a system of monopolistic competition might be one reason for the inefficiently low output; another might be tax distortions.

We use a two country monetary union, of equal population size, and with identical forms of production function - with the exception of a shock term. That is, with the exception of the supply shocks, they are symmetric[5], and we make the assumption that the joint distribution of the shocks are identical across both countries. However, the member countries can differ in their inflation aversion - the weight attached to off-target inflation may be different, although it is time-invariant[6]. This presents itself in the model as different levels of π_i^F, the ideal inflation rate for the fiscal policymaker of country i and thus affects the loss function, $\mathcal{L}_{F,i}$ that the national government is trying to minimise.

3.1 *Private Sector and National Economy*

Households maximise utility, which is an increasing function of consumption and a decreasing function of labour supply. The utility function is the same across all households and preferences are captured by a concave utility function $U(\cdot)$, which we assume is continuous and differentiable, as is standard (see de la Fuente (2000), pp. 332 – 339, for a foundation for these assumptions). We assume that factors are not mobile across countries: if they were fully mobile, then idiosyncratic shocks would be completely abated by factor mobility. However, in many unions - even with freedom of movement (as in the Euro Area) - labour mobility is not sufficiently high to provide stabilisation.

Since inflation expectations are formed by the private sector, we impose the condition of rational expectations[7] here, and thus it is required in equilibrium that $E[\pi_i] = \pi_i^e$.

Output, y_i, of country i (where $i = 1, 2$) broadly follows an expectations augmented Phillips curve with additional stochastic elements[8] is:

$$y_i = \overline{y}_i + \pi_i - \pi_i^e - t_i \tag{1}$$

We assume that there are no spillover effects from the tax distortions of other governments in the union: t_{-i} does not affect y_i. That may be a simplification, but it simplifies the already challenging exposition, and may be reasonable in some monetary unions with less integrated markets.

[5]In the language of the literature, the countries are *ex ante* symmetric. They could be *ex post* symmetric if the supply shocks were identical, but that outcome is of less interest to us here, and we ignore any detailed analysis of that case.

[6]This assumption is based on the idea that inflation aversion is grounded in a history and perhaps institutional features. Thus, it is very *sticky*, and for our purposes we will treat it as time invariant.

[7]We acknowledge that rational expectations are the subject of some dispute. However, we take it here to mean that the private sector is not systematically wrong in its expectations of the action profile of the central bank. That seems plausible, if there exist sufficiently liquid markets such that systematically wrong expectations could be routinely exploited.

[8]Persson and Tabellini, 2012, pg. 8.

3.2 *Fiscal Policy and Transfers*

We model fiscal policy in the following way: each country has a government, that taxes households and provides public goods. In addition to this, there is a central *authority* that the facilitates the FTS across member states - this is a semantic feature and does not need to be modelled, as it merely moves the transfers between countries without any choice variables. These transfers are not complete, however: we do not think it feasible that countries will fully equalize across shocks, primarily for political reasons[9]. Even in federal systems, where member states are part of a single country, full equalisation does not take place (Poghosyan, et al.(2016) have a useful discussion of different empirical estimation methods in this literature, as well as the merits and pitfalls of each. Their review suggests that insurance against region-specific shocks is incomplete in the US, and smaller than in Canada and the UK). We argue that this will also not be the case in a monetary union, and think it even less likely. In the Euro Area, most transfer payments are non-cyclical and structural in nature: examples of payments include redevelopment projects in relatively poorer areas and payments to specific industries, as is the case under the auspices of the Common Agricultural Policy (CAP).

The government of country i faces the following constraint:

$$\overline{g}_i = t_i - \epsilon_i + \gamma(\epsilon_i - \overline{\epsilon}) \tag{2}$$

where $\overline{\epsilon} = \frac{1}{2}\epsilon_i + \frac{1}{2}\epsilon_{-i}$ is the average shock term for our particular example, with two countries of equal size. By definition, in a two country union with equally sized members, the average shock is the midpoint between the two shock terms. Positive values of ϵ are associated with *negative* shocks.

The stochastic shocks are not correlated across countries, nor are they serially correlated. They are independently and identically distributed, and we specify the following

$$E(\epsilon_i) = 0, \quad E(\epsilon_i^2) = \sigma^2, \quad E(\epsilon_i \epsilon_{-i}) = 0$$

The key here is that government spending is fixed, and thus a negative shock in (2) means that taxes must increase in order to maintain the budget constraint. That has a negative effect on output, by more negatively affecting (1). This assumption (based on Hefeker and Neugart, 2015) is grounded in the idea that government wage costs are fixed in the short term, and most spending is pre-committed. We find this reasonable, since the bulk of government spending is often decided via a negotiated process in the legislature, rather than in the form of an immediate command - see Alesina and Perotti (1996), pg. 402. Those obligations allow us to model negative shocks without resorting to government choice of spending and taxation rates. The tax rate, t_i adjusts endogenously to ensure that the budget remains balanced. The FTS allows at least some of the shock to be abated. The extent to which it does this depends both on the average shock ($\overline{\epsilon}$) and the parameter γ.

The transfers are designed in the following way: if a country has a negative shock that is higher than the union average it receives a transfer, and those with lower than average

[9] Shocks and their effects are often not fully verifiable, and thus we might expect paying nations to be unconvinced by the claimed extent of the negative shocks. We have in mind the failure to accurately identify Greek fiscal positioning prior to the Euro Area sovereign debt crisis - that example is illustrative of the kind of issues that monetary unions can face in verifying compliance. That is the basis on which we claim that shocks and fiscal positioning is not fully verifiable.

shocks pay toward a transfer. The following condition must hold, given that there is no union debt: $\gamma(\epsilon_i - \overline{\epsilon}) + \gamma(\epsilon_{-i} - \overline{\epsilon}) = 0$, i.e. net transfers sum to zero. The parameter γ will become important for us, because it dictates the extent to which being away from the average is received or paid by the country. We technically restrict $\gamma \in [0, 1]$, although as the literature suggests, it is likely to be quite far from 1, which would imply full insurance of idiosyncratic risk. So we expect γ closer to 0 than to 1.

Finally, the government of country i aims to minimise the following loss function:

$$\mathcal{L}_{F,i} = \frac{1}{2}\theta^F(y_i - y_i^F)^2 + \frac{1}{2}(\pi_i - \pi_i^F)^2 \tag{3}$$

They do this in a different way to the central bank, however. While the central bank chooses a rate of inflation for the union (with the exception of velocity shock effects), the fiscal authority does not explicitly choose any policy variables. However, we introduce later the idea that a fiscal authority may be incentivised to try and force the central bank to expand monetary policy, if output is below the fiscal authority's target level.

The national government of country i has an ideal level of output and inflation, y_i^F and π_i^F. We assume that the ideal level of output is greater than the natural rate, so the national authority wants to boost output above the level that would obtain without any surprise inflation or shock, ϵ_i.

3.3 *Monetary Policy*

The central bank chooses the policy π_0, which denotes the monetary policy action of the central bank. We do not explore the issue of how this is chosen[10] here - suffice to say that higher values of π_0 imply more expansionary monetary policy, and lower values imply less expansionary policy. The union faces a common inflation level, π, which is influenced by monetary policies of the central bank in the following way:

$$\pi_i = \pi_0 - \nu_i \tag{4}$$

$$\pi = \frac{1}{2}\sum_i \pi_i = \pi_0 - \overline{\nu} \tag{5}$$

where ν_i are velocity shocks in the transmission of monetary policy. They occur with $E(\nu_i) = 0$ and $E(\nu_i^2) = \tau^2$, with no correlation across countries - in this way, we can think of ν_i as a shock to monetary policy in a country in the same way as ϵ_i is a shock to the fiscal policy in a member country. We also here define the following: $\overline{\nu} = \frac{1}{2}\nu_i + \frac{1}{2}\nu_{-i}$, for our two country case.

So, the common inflation level is composed of the chosen variable of the central bank, and the cumulative effect of the velocity shocks in the transmission mechanism. In the above case, because we are using two countries, the denominator of the fraction is 2 rather than n, as would be the case for a more general model. As has been the case above, we use sigma notation for brevity when summing over both countries.

The objective of the central bank is to minimise the following loss function:

[10] Even the word *chosen* is perhaps presumptive here. In our very simple model, however, we make the assumption that the monetary policy transmission mechanism is such that central bank is able to quite straightforwardly select the inflation rate that pertains in the economy.

$$\mathcal{L}_M = \frac{1}{2}\sum_i \theta^M (y_i - y_i^M)^2 + \frac{1}{2}(\pi - \pi^M)^2 \tag{6}$$

As in much of the literature, we follow Barro and Gordon (1983) in our assumption of the form of the loss function, though in our formulation the loss function is quadratic in output as well as inflation. Both output and inflation deviations enter the loss function quadratically, however the value of θ^M weights the importance of output deviations relative to inflation deviations, as the value of θ_i^F does for the fiscal authority of country i - the difference is that the monetary authority places the same weight on the output deviations of every member state, fiscal authorities can have different weights on the output differential in their country. The more focused on inflation the central bank is, the lower this value will be, for it is more willing to sacrifice output differentials for inflation stability. The assumptions on the values in the loss functions are as follows:

$$\pi^F > \pi^M = 0, \quad y_i^F > y_i^M, \quad \frac{1}{2}\theta_i^F > \theta^M \qquad \forall i$$

We also restrict $\theta^M \in (0, 1)$, because the monetary authority places more weight on the variation of inflation than they do on output. We do not necessarily place the same restriction on the fiscal authorities' weighting, because the fiscal policy-maker *may* be far more interested in output deviations than inflation stability.

3.4 *Timing*

The timing is as follows (and comes roughly from Dixit and Lambertini (2001)). (1) If monetary policy is committed, the central bank chooses the policy rule prior to the shocks, ϵ_i and ν_i being realised. However, if monetary policy is discretionary, nothing happens at this first stage. (2) Then, the private sector sets inflation expectations and price/wage contracts are set. (3) The stochastic shocks are then realised. (4) Under discretionary monetary policy, the central bank chooses their choice variable, π_0; if monetary policy is committed, then the rule that was chosen in the first stage is implemented.

Were we to introduce a choice of fiscal policy on the part of each national government, then we begin to face the question of timing for the fiscal and monetary policies. Often the default is to consider a Nash game, in which fiscal and monetary authorities act simultaneously - one can also consider a Stackelberg case where one authority moves first. Often, since fiscal policy is typically more committed, the fiscal authorities are the first movers, and the common central bank follows. The two arrangements we highlight here can lead to quite different consequences, because the leader can force the following player into a stricter subset of their action set.

We note here that the timing of when and how γ is chosen is left to the side. We acknowledge that this is an important choice in dictating the equilibrium and various outcomes of the economy, and discuss that in some detail below. However, we can assume that the value of the parameter is set in advance, at the outset of the creation of the monetary union. Some discussion related to optimal choice of the extent of risk sharing is contained in the appendix of Berger, et al. (2018, Annex 1), where the authors conclude that full risk sharing is not optimal, which agrees with out claim above, regarding γ being some distance from 1.

4 A Repeated Game of Monetary Union with Fiscal Transfers

Following the style of Dixit (2000), we analyse the model introduced above by considering how fiscal transfers affect incentives to water down monetary policy commitment. First, however, we discuss briefly the analysis of Dixit in a world without fiscal transfers. We then move on to use some of that intuition to investigate our fiscal transfer scheme and the ability to sustain incentive compatibility constraints.

Dixit considers a case of stochastic shocks on both the perceived benefits of extra output at a given time (via surprise inflation) and a stochastic shock on country specific deviations from purchasing power parity in the monetary union. Each national welfare level is an increasing function of surprise inflation (which produces output above the natural rate), and a decreasing function of the inflation deviation from the target level. The central bank in the union maximises a weighted average of the component countries' welfare - Dixit allows for unequal weights on the welfare of each country, perhaps according to the level of political influence in the union (Dixit, 2000, pg. 762). Having considered optimality under discretionary behaviour and under a credible rule, he then proceeds to consider the circumstances under which a member country would be incentivised to lobby the central bank to provide more expansionary monetary policy. Such lobbying, if successful, is cheating under the model: it involves an abandonment of the commitment rule, and a return to the discretionary Nash equilibrium for all subsequent periods. In order to avoid this, Dixit introduces the idea of a flexible rule, a policy that adjusts away from the ideal level of inflation under commitment, toward a level (typically higher) that allows for sufficient inflation surprises to ensure that countries undergoing a negative shock are incentivised not to force the *cheating* outcome. That policy depends on a number of factors, including: the size of the average supply shock, which increases the cost of reverting to discretionary policy; and the rate of discounting that a country applies to its welfare across periods.

We conduct our analysis for country i, although we can derive very similar expressions for country $-i$ and the intuition is identical - although the final outcomes may be different, depending on the shocks. We follow Dixit in assuming that the membership of the monetary union is fixed: no potential entrants are weighing up the benefits of joining, and the present members do not have an option to leave. This is one of the key departures of our model from Hefeker and Neugart (2015), who are interested in how expansionary policy has to be maintained to induce current members not to leave. This assumption is debatable, although the political determinants of such a decision are too complex to include in such a model, and so we forgo the inclusion of that option[11].

4.1 *Discretion*

We begin by defining the action of the central bank under discretion, and the payoff to the fiscal policymaker in the form of their loss function. Taking the first order conditions of (6), with respect to the choice variable π_0, and using the definitions in (5), (2), and (1), we get:

[11]For example, an interesting extension may be the inclusion of a voting mechanism in each country - if agents were heterogeneous, over an income distribution as in Persson and Tabellini (1996a) - to decide on whether or not to remain in the union. Some agents may be better off if the country remains in the union, some may be better off in a country which exits, if we allow for different inflation preferences.

$$\pi_0 = \overline{\nu_i} - \sum_i \theta^M (\overline{y}_i + \pi_0 - \nu_i - \pi_i^e - t_i - y_i^M) \tag{7}$$

where $t_i = \overline{g}_i + \epsilon_i - \gamma(\epsilon_i - \overline{\epsilon})$.

Note here that, because we are discussing the discretionary action of the central bank, the shocks have already occurred and thus the central bank does not take expectations of the shock terms in it's reaction function taken in terms of expected inflation. However, we still have the expectation of the inflation level in each country to contend with. Under the rational expectations hypothesis, the private agents who set their inflation expectations prior to any shocks being realised, equation (7) is known by the private agents when they set their expectations. Setting π_i^e equal to the expectation of (4), we get $\pi_i^e = \pi_0$. Substituting this in (7), and we get:

$$\pi(\epsilon_i, \nu_i) = -\sum_i \theta^M h_i \tag{8}$$

$$\pi_i(\epsilon_i, \nu_i) = -\sum_i \theta^M h_i + \overline{\nu_i} - \nu_i \tag{9}$$

where we use the definition, $h_i = \overline{y}_i - \nu_i - t_i - y_i^M$.

The fiscal loss function (that the fiscal authority seeks to minimise) of country i under discretion is thus:

$$\mathcal{L}_{F,i}^D = \frac{1}{2}\{\theta_i^F (\overline{y}_i - \nu_i - t_i - y_i^F)^2 + (-\sum_i \theta^M h_i + \frac{1}{2}\sum_i \nu_i - \nu_i - \pi_i^F)^2\} \tag{10}$$

This leads us[12] to the expected loss of country i of:

$$E[\mathcal{L}_{F,i}^D] = \frac{1}{2}\theta^F \left\{ q^F + \tau^2 + \sigma^2(1 - \gamma + \frac{1}{2}\gamma^2) \right\} \\ + \frac{1}{2}\left\{ \theta^M[\mathcal{J}] + (\pi_i^F)^2 + 2(\theta^M)^2\tau^2 + \frac{1}{2}\tau^2 + (\theta^M)^2\gamma\sigma^2 + 2(\theta^M)^2\sigma^2 \right\} \tag{11}$$

where we define $q^X = \overline{y}_i^2 - 2\overline{y}_i\overline{g}_i + \overline{g}_i^2 - 2y_i^X\overline{y}_i + 2y_i^X\overline{g}_i + (y_i^X)^2$, and where $\mathcal{J}$ is an expression of parameters from both countries in the union, and interaction terms that follow from the quadratic nature of the loss function. Because of its prohibitive size, we place it in Appendix 2.

Note here the presence of the γ parameters on fiscal risk sharing. The above loss function is optimally *minimised*, because it is not a utility maximisation problem.

4.2 *Commitment*

As in Dixit (2000), we assume credible commitment to a policy rule for the moment, and consider an abandonment of this later when we look at whether the fiscal authority has an incentive to try and force the monetary authority to abandon its rule. So, we look for a policy rule, $\Pi(\epsilon_i, \nu_i)$, for the central bank such that $\Pi(\cdot) = \pi_0^C$, and the rule provides

[12] We forgo a full derivation in the paper, because it is simply a lot of algebra. However, Appendix 1 contains a number of assumptions that have been used in that algebra, specifically on the expectations of various terms.

the inflation rate that obtains in the economy. While the optimal commitment rule may not be linear, since the model is linear-quadratic, we make the assumption that the commitment rule is linear - though we do not prove the optimality of this assumption. We make it for the sake of simplicity, and assume that if it is not optimal, it is not significantly different. We posit that the rule takes the form:

$$\Pi(\cdot) = \psi + \psi_\epsilon \bar{\epsilon} + \psi_\nu \bar{\nu} \tag{12}$$

Note that, because the private sector sets its inflation expectations prior to the realisation of the shocks, their expectation of how the policy rule is applied becomes: $\pi_i^e = \psi$, because the expectations of the average shock terms are 0. When the private sector sets its inflation expectations, it has no more information than the value of the parameters in the policy rule, and the distribution of the shocks: therefore - when we have mean 0 shock terms - they cannot reasonably have expectations other than the target that the central bank seeks to pursue. Of course, we know that this might be quite wrong, but the private agent has no more information than this. This leads to the following:

$$\pi_i - \pi_i^e = \psi_\epsilon \bar{\epsilon} + \psi_\nu \bar{\nu} - \nu_i \tag{13}$$

which we can substitute into (1).

Now, the central bank has to set out its policy rule prior to the realisation of the shocks, just as the private agents have to form their expectations without being aware of which value the shock terms will take. Thus, when the central bank minimises the value of $\mathcal{L}_M$, it does so with respect to the *expected* loss, knowing only the first and second central moments of the distribution of the shocks. We take expectations over the loss function, and substitute in the definitional terms from our model to get the following:

$$E[\mathcal{L}_M] = \frac{1}{2} E \left\{ \sum_i \theta^M (\overline{y}_i + \psi_\epsilon \bar{\epsilon} + \psi_\nu \bar{\nu} - \nu_i - \overline{g}_i - \epsilon_i + \gamma(\epsilon_i - \bar{\epsilon})^2 + (\psi + \psi_\epsilon \bar{\epsilon} + \psi_\nu \bar{\nu} - \bar{\nu})^2 \right\} \tag{14}$$

since in our model, $\pi^M = 0$.

Through a significant amount of algebra (again see the appendix for important assumptions), we obtain the following expected loss function - in terms of parameters (γ, σ^2, τ^2) which we can then work with to choose the optimal values in the policy rule.

$$\begin{aligned} E[\mathcal{L}_M] = \frac{1}{2} \sum_i \theta^M \left\{ q^M - \sigma^2(\psi_\epsilon + \gamma\psi_\epsilon) - \sigma^2(\frac{3}{2}\gamma^2 + \gamma - 1) + \frac{1}{2}\tau^2(\psi_\nu^2 - \psi_\nu) + \tau^2 \right\} \\ + \frac{1}{2} \left\{ \psi^2 + \frac{1}{2}\psi_\epsilon^2 \sigma^2 + \frac{1}{2}\psi_\nu^2 \tau^2 - \psi_\nu \tau^2 + \frac{1}{2}\tau^2 \right\} \end{aligned} \tag{15}$$

where q^M is defined as above in our discretionary section.

We then take first order conditions with respect to the three parameters of the policy rule, and (after some rearranging) get the following:

$$\frac{\partial E[\mathcal{L}_M]}{\partial \psi} = 0 \Rightarrow \psi = 0$$

$$\frac{\partial E[\mathcal{L}_M]}{\partial \psi_\epsilon} = 0 \Rightarrow \psi_\epsilon = \theta^M (1 + \gamma)$$

$$\frac{\partial E[\mathcal{L}_M]}{\partial \psi_\nu} = 0 \Rightarrow \psi_\nu = \frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1}$$

Note that the value of ψ in this case is 0, as a result of the central bank having an ideal inflation rate set at 0. Most models, with other values of ideal inflation, will have that value in this place. Because in the absence of any shocks, that is the inflation rate that occurs, and the central bank can perfectly target its ideal inflation rate. Thus, the policy rule that the central bank follows for π_0^C is the following:

$$\pi_0^C = \left\{\theta^M(1+\gamma)\right\}\bar{\epsilon} + \left\{\frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1}\right\}\bar{\nu} \tag{16}$$

Thus, we define the following two differentials:

$$\pi_i - \pi_i^e = \left\{\theta^M(1+\gamma)\right\}\bar{\epsilon} + \left\{\frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1}\right\}\bar{\nu} - \nu_i$$

$$\pi_i - \pi_i^F = \left\{\theta^M(1+\gamma)\right\}\bar{\epsilon} + \left\{\frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1}\right\}\bar{\nu} - \nu_i - \pi_i^F$$

Now, we have everything required to substitute these definitions into the fiscal authorities' loss function, and obtain a loss function under commitment (which we have assumed to be credible), for a given realisation of the shocks.

$$\mathcal{L}_{F,i}^C = \frac{1}{2}\theta_i^F\left\{\overline{y}_i + \theta^M(1+\gamma)\bar{\epsilon} + \left\{\frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1}\right\}\bar{\nu} - \nu_i - t_i - y_i^F\right\}^2 + \frac{1}{2}\left\{\overline{y}_i + \theta^M(1+\gamma)\bar{\epsilon} + \left\{\frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1}\right\}\bar{\nu} - \nu_i - \pi_i^F\right\}^2 \tag{17}$$

And we then take expectations, as in the discretionary case, to obtain the expected loss function, as a function of parameters and the second moment of the distribution. For the purpose of brevity, we have derived this while keeping ψ_ϵ and ψ_ν in their simplest form, because these expressions contain only parameters that are specified in advance of the game, and we are undertaking only algebra with them, not calculus operations. The expected loss function is as therefore:

$$E[\mathcal{L}_{F,i}^C] = \frac{1}{2}\theta_i^F\left\{q^F + \frac{1}{2}\psi_\nu^2\tau^2 + \tau^2(1-\psi_\nu) + \frac{1}{2}\psi_\epsilon^2\sigma^2 - \psi_\epsilon\sigma^2 + \frac{1}{2}\gamma^2\sigma^2 - \gamma\sigma^2\right\} + \frac{1}{2}\left\{\frac{1}{2}\psi_\epsilon^2\sigma^2 + \frac{1}{2}\psi_\nu^2\tau^2 - \psi_\nu\tau^2 + \tau^2 + (\pi_i^F)^2\right\} \tag{18}$$

4.3 ***Why Deviate?***

Having set out the expected loss functions, under both discretion and a credible commitment rule. we now pursue the question of the conditions under which a fiscal authority may be incentivised to try and induce the central bank to abandon their credible commitment rule - this occurs as in Dixit (2000). The fiscal authority has no choice over fiscal tools - unlike in some models, they do not choose expansionary or contractionary fiscal policy. However, we allow for the fiscal authority to choose whether or not to pressure the central bank into abandoning its policy rule. We consider a case where the fiscal authority of country i can pressure the central bank at the union level, though we do not model the specifics of how this occurs. Suffice to say, we posit that the national authority makes a decision to attempt to pressure the central bank into abandoning their rule, in the stage between the shocks being realised and the central bank setting policy.

If the fiscal authority is successful, the central bank chooses the discretionary optimal policy after shocks have been realised. However, private agents have already set their expectations of inflation, in accordance with the expectation that the policy rule is followed. Therefore, there is an opportunity to create genuine surprise inflation that, for a single period, does not adhere to the rational expectations equilibria. However, we make the assumption that, once the rule is broken credibility is lost permanently, and the discretionary equilibrium obtains in all future periods. Now, as Dixit notes, there are a multitude of different ways in which we could model punishment by private agents. One could model in such a way that credibility is regained after a certain number of periods, and the rule returns - there remains the possibility that deviation will occur afterwards, and we do not model any change in bargaining power as a result of successful pressure on the central bank (we can consider a scenario in which a country that successfully pressures the central bank loses the ability to place pressure for longer than the loss of central bank credibility). We do not model any cost to making an *attempt* to pressure the central bank: there is scope to argue that making an unsuccessful attempt might incur a cost to the national policymaker (a loss of transfers or some other punitive penalty), that would change the benefits and costs to making an attempt. In that case, the probability of success when placing pressure on the central bank might mean that a large immediate benefit of success might not be chosen by the policymaker, because they would be guaranteed a reasonable payoff, and not incur the cost of a failed attempt. However, we do not model that here, though it is a plausible extension. Furthermore, because we do not allow for exit from the union, the

In the event that the member state is successful in pressuring the central bank to deviate from the rule - while private agents continue to expect that the policy rule will be followed - they gain the following payoff, where we use the superscript P to denote the outcome under successful *pressure*:

$$
\begin{aligned}
B_i^P &= \mathcal{L}_{F,i}^C - \mathcal{L}_{F,i}^P \\
&\qquad = \frac{1}{2}\theta_i^F \left\{ \overline{y}_i + \theta^M(1+\gamma)\overline{\epsilon} + \left\{ \frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1} \right\} \overline{\nu} - \nu_i - t_i - y_i^F \right\}^2 \\
&\qquad\quad + \frac{1}{2} \left\{ \overline{y}_i + \theta^M(1+\gamma)\overline{\epsilon} + \left\{ \frac{\frac{1}{2}\theta^M + 1}{\theta^M + 1} \right\} \overline{\nu} - \nu_i - \pi_i^F \right\}^2 \\
&- \frac{1}{2}\theta^F \left\{ \overline{y}_i - \sum_i \theta^M h_i + \overline{\nu} - \nu_i - t_i - y_i^F \right\}^2 - \frac{1}{2} \left\{ - \sum_i \theta^M h_i + \overline{\nu} - \nu_i - \pi_i^F \right\}^2 \qquad (19)
\end{aligned}
$$

where the benefit is the difference between the loss function under the rule and the loss function under the deviation: the larger is the difference, the greater the reduction in the loss function from a deviation. In this equation, we use the following definitions: $\pi_i^D - \pi_i^{e,R} = -\sum_i \theta^M h_i + \overline{\nu} - \nu_i - 0$, and $\pi_i^D - \pi_i^F = -\sum_i \theta^M h_i + \overline{\nu} - \nu_i - \pi_i^F$, where h_i is defined as above and $\pi_i^{e,R}$ is the expected inflation rate when the private sector believes that the central bank will adhere to its rule.

We further follow the example of Dixit in our method of discounting the future[13] by simply discounting the future by $\frac{1}{r_i}$, where r_i denotes the discount factor of country i. This is applied in the case where pressure is successful, and there is no longer a credible rule. Therefore, the discretionary equilibrium obtains in all future time periods. As in most repeated games of monetary policy, time is assumed to go to infinity. The cost of having successfully pressured the central bank becomes the difference between the loss function of discretionary policy, and the loss function of abiding by a rule. We can calculate the cost by:

$$
\begin{aligned}
C_i^P &= E[\mathcal{L}_{F,i}^D] - E[\mathcal{L}_{F,i}^C] \\
&\qquad\qquad = \frac{1}{2}\theta^F \left\{ q^F + \tau^2 + \sigma^2(1 - \gamma + \frac{1}{2}\gamma^2) \right\} \\
&\qquad + \frac{1}{2} \left\{ \theta^M[\mathcal{J}] + (\pi_i^F)^2 + 2(\theta^M)^2\tau^2 + \frac{1}{2}\tau^2 + (\theta^M)^2\gamma\sigma^2 + 2(\theta^M)^2\sigma^2 \right\} \\
&\qquad - \frac{1}{2}\theta_i^F \left\{ q^F + \frac{1}{2}\psi_\nu^2\tau^2 + \tau^2(1-\psi_\nu) + \frac{1}{2}\psi_\epsilon^2\sigma^2 - \psi_\epsilon\sigma^2 + \frac{1}{2}\gamma^2\sigma^2 - \gamma\sigma^2 \right\} \\
&\qquad\qquad - \frac{1}{2} \left\{ \frac{1}{2}\psi_\epsilon^2\sigma^2 + \frac{1}{2}\psi_\nu^2\tau^2 - \psi_\nu\tau^2 + \tau^2 + (\pi_i^F)^2 \right\} \qquad (20)
\end{aligned}
$$

Since the cost is incurred in every period except the deviation, we discount the sum of the future costs, to obtain a total expected present cost of successful deviation of $\frac{1}{r_i}C_i^P$.

[13] We refrain from using a scaling factor on the payoffs, or any other such game theoretic method (see Fudenberg and Tirole (1991), Chapter 5 for general repeated game theory at the micro level. Primarily because the decision is made once, and from that point on, we have no need to compare payoffs between any two periods.

Country i is incentivised to pressure the central bank to abandon its rule if the following condition holds:

$$\frac{1}{r_i} C_i^P \leq B_i^P \tag{21}$$

where the weak inequality is a matter of choice. We assume that if the cost and benefit of deviation is the same, the fiscal policymaker is indifferent, and they will attempt to abandon the rule, because there is no cost to failing in an attempt to pressure the central bank.

We do not completely solve the model here, as solving for the optimal rule as a function of the shocks and the parameter γ is beyond the scope of this paper. However, we end this section by commenting on the question that was originally set out in the first place, about whether fiscal transfers can help make monetary commitment more credible. To answer this question, we mostly abstract from the preferences of each policymaker, and focus simply on the parameter γ. It is contained in the following terms: h_i, t_i and ψ_ϵ. There is no clear answer here, but we hope that some comment sheds light on the effect of γ on our model.

We are interested primarily in the member state for whom $(\epsilon_i - \bar{\epsilon}) > 0$, as that is the more negatively affected country, and if we assume all of the fiscal preferences are the same, then they are the country that is more interested in surprise inflation, in order to boost output and offset the negative fiscal shock. This means that, in the terms h_i and t_i, $\gamma(\epsilon_i - \bar{\epsilon}) > 0$. The first two terms in (19) are positively impacted by an increasing γ and thus increase the benefits of the deviation. However, the terms in the third and fourth expressions of (19) are more ambiguous. γ has a negative effect on tax distortions and thus a negative effect on the term h_i. The presence of a summation means that the effect of increasing γ is to likely increase these terms, though this depends on the value of θ^M. In the case of (20), analysis is even more subtle, but we see that γ has a downward effect on the first term, and an upward effect on the second term. Again, however, the value of θ^M is important for understanding the magnitude of these effects. Only a full numerical solution could accurately discern the optimal levels. In the third and fourth terms of (20), γ has an effect on the expression that depends on the value of θ^M.

Intuitively, the reasoning is that when members are subject to negative supply shocks, they are better off with the presence of fiscal transfers, because this offsets some of the tax burden that has to be levied to achieve budget balance. However, the effect of shocks on monetary policy are dependent on θ^M, the weight that the central bank places on output deviations relative to inflation. This is an important parameter in out model, because it tells us how the central bank will respond to output differentials relative to inflation. The more activist the central bank is, the more it will respond to shocks anyway, and so the fiscal transfers become less important, because the central bank is more willing to forgo the low inflation that it seeks in the discretionary equilibrium. Higher values of θ^M lead to a greater loss from output that below the natural level.

We anticipate, however, that for most cases, the presence of an FTS leads to more willingness to accept low inflation, because of the compensation by transfers, to offset the fiscal shock. The extent to which that is the case, or to which it is optimal, however, is something that is beyond the scope of this paper, and would require more space for numerical simulations.

5 Conclusions and Remarks

The above model is not intended as a normative example of a mechanism of fiscal transfers that ought to be used in a monetary union. We utilise such a simple model in order to motivate some of the intuition behind commitment of monetary policy in a union. The normative implications of our model, if any, are that the presence of fiscal transfers can help provide credible commitment to a greater degree than without fiscal transfers. Again, this is under the fairly limited specifications of our model, without the presence of debt or microfoundations. We do not think that the lack of these components is a major issue for the model, however. While some have attempted to microfound fiscal transfer schemes in a monetary union (see Evers, 2006 or Hjortsoe, 2016 for such examples), for the scope of this paper it is sufficient to make assumptions over the transmission mechanisms and the model of the economy.

We note that the recent implementation of the European Stability Mechanism (ESM) might be considered a method by which stabilisation of shocks is achieved. However, for a number of reasons, we do not consider that scheme to fully encompass the true intention behind a fiscal transfer scheme that we have laid out above. The scheme is primarily designed to be implemented once the damage is done, and loans from the ESM require a strict fiscal 'adjustment programme' to be adhered to (Tomann, 2017): such requirements are not employed in the model above, though they could be added and we make no judgement on the costs or benefits of those programmes, for that topic could fill several volumes in itself. Ultimately, as Berger, et al. note (2018 pg. 4), the loans under the ESM have to be repaid. Thus, the impact of this form of transfer is perhaps less significant than the lump sum transfer that we explore above, because future liabilities have to be accounted for in the model of the government budget. The inclusion of sovereign debt would likely change the analysis, and is not something we explore here. We also consider that in the model above, the countries in a monetary union are *ex ante* symmetric. In reality, the large creditor countries in a transfer scheme such as the ESM may be unable to fulfil their obligations as a result of poor growth outlook - countries such as Italy provide examples of this (Tomann, 2017, pg. 164). Policies borne out of political necessity are not always grounded in sound economic theory, and as such we expect that the efficacy of the Euro Area's current stabilisation mechanism is an avenue for further research.

Stabilisation effects are important for ensuring that participating countries in a monetary union are incentivised to either remain in the union or to accept the policy rule without making attempts to persuade the central bank to water down their commitment. Dreyer and Schmid (2015) argue that current Euro Area fiscal transfers are much lower than would be the case under a structure similar to the US, and that significantly increasing the net fiscal transfer level in the Euro Area would move the zone much closer to the extent of redistribution and risk sharing that exists in the US, where stabilisation is much more significant. There are several reasons for why one could argue that the US has proven much more durable as a monetary union than has the Euro Area, including language, culture and net migration. However, the extent of stabilisation policy - though far from perfect - is one reason for why commitment and stability could be maintained in a monetary union, according to the model above.

This work has attempted to show that the presence of a fiscal transfer scheme can induce improved commitment in the context of a monetary union, when member states are subject to adverse shocks. We find that it certainly helps, although There is an intuitive aspect to this, as we have noted above. However, the challenge for policymakers is overcoming the political obstacles to such integration in a number of monetary unions of today. While the Euro Area, for example, is often moving toward more and more *collaboration*, this is frequently in areas where national governments can agree and achieve consensus on joint actions. Implementing a system of transfers, however, is a much more involved process - and perhaps one that the Euro Area is not quite ready for. In our model, we assume identical distributions of shocks across both countries. In reality, one may need to consider some members as having a very different distribution of shocks compared with others: this is a further extension that could be pursued.

A Appendix 1

In this appendix, we explain some of the definitions and assumptions used in deriving the expected values. We do not undertake the algebra here, because it is uninteresting and tedious. However, we note some of the assumptions that we used in our derivations, in order that any repetition of the algebra goes through as above.

We begin by reiterating some of the assumptions made on the distribution of the shock terms, which are repeated below:

$$E(\epsilon_i) = 0, \quad E(\epsilon_i^2) = \sigma^2, \quad E(\epsilon_i \epsilon_{-i}) = 0 \qquad \forall i$$
$$E(\nu_i) = 0, \quad E(\nu_i^2) = \tau^2, \quad E(\nu_i \nu_{-i}) = 0 \qquad \forall i$$

Additionally, we assume that there is no covariance between the i.i.d shocks terms, $E(\epsilon_i \nu_i) = 0, \forall i$.

From the definitions in section 3, we have that $\bar{\epsilon} = \frac{1}{2}\epsilon_i + \frac{1}{2}\epsilon_{-i}$ and thus $\epsilon_i \bar{\epsilon}_i = \frac{1}{2}\epsilon_i^2 = \frac{1}{2}\sigma^2$. The same holds for ν_i, except where τ^2 replaces σ^2.

Finally, we use the definitions, $E(\bar{\epsilon}) = 0$ and $E(\bar{\nu}) = 0$, which both follow from the linearity of the expectations operator, and the assumptions and definitions above. The one further definition that we use is:

$$Var(\bar{\epsilon}) = \frac{1}{2}\sigma^2, \qquad Var(\bar{\nu}) = \frac{1}{2}\tau^2$$

These definitions allow us to derive the expected loss functions used in the body of the work. The algebra, as we have explained, is too tedious and extensive to include here. However, with these assumptions, we expect that the above results can be replicated. These assumptions make use of Grimmett and Welsh, 2014, Chapters 7 & 8.

B Appendix 2

$$\begin{aligned}\mathcal{J} = {} & \theta^M \overline{y}_i^2 - 2\theta^M \overline{g}_i \overline{y}_i - 2\theta^M \overline{y}_i y_i^F + 2\theta^M \overline{y}_{-i} \overline{y}_i - 2\theta^M \overline{g}_{-i} \overline{y}_i - 2\theta^M \overline{y}_i y_{-i}^F + 2\overline{y}_i \pi_i^F \theta^M \overline{g}_i^2 + 2\theta^M y_i^F \overline{g}_i \\ & - 2\theta^M \overline{y}_{-i} \overline{g}_i + 2\theta^M \overline{g}_i \overline{g}_{-i} + 2\theta^M \overline{g}_i y_{-i}^F - 2\overline{g}_i \pi_i^F + \theta^M (y_i^F)^2 - 2\theta^M y_i^F \overline{y}_{-i} + 2\theta^M y_i^F \overline{g}_{-i} \\ & + 2\theta^M y_i^F y_{-i}^F - 2y_i^F \pi_i^F + \theta^M (\overline{y}_{-i})^2 - 2\theta^M \overline{y}_{-i} \overline{g}_{-i} - 2\theta^M y_{-i}^F \overline{y}_{-i} + 2\overline{y}_{-i} \pi_i^F + \theta^M (\overline{g}_{-i})^2 + 2\theta^M \overline{g}_{-i} y_{-i}^F - 2\overline{g}_{-i} \pi_i^F - 2y_{-i}^F \pi\end{aligned}$$

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