National Public Debt and Fiscal Insurance in a Monetary Union with Ramsey Taxes

Kenneth Kletzer

Department of Economics
University of California
Santa Cruz, CA 95064

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Abstract

Optimal fiscal policy is studied in an interdependent non-monetary global economy without lump-sum taxation and with internationally integrated financial markets. Public debt is issued by national governments responsible for servicing their own debt and financing public expenditures by taxing domestic labor income. The global economy can represent a monetary union that is a prospective fiscal union. The extension of Ramsey taxation to interdependent economies illustrates how the potential gains from fiscal unification in a monetary union depend on restrictions on governments’ abilities to issue contingent public debt. One of the consequences of monetary unification is the loss of unanticipated inflation as a tool of fiscal policy. This is captured in the model by reducing government access to contingent markets. The paper begins with the benchmark case in which governments can issue state contingent debt and then considers the restriction to short maturity non-contingent debt contracts followed by endogenous debt markets under asymmetric information. One result is that optimal tax rates depend on current account balances when public debt markets are not complete. Under endogenously incomplete contracts for public debt, national government debt tends to rise over time toward a debt limit. The introduction of a fiscal insurance scheme with imperfect information is analyzed using this case to show how such schemes affect debt dynamics and welfare when governments can only issue conventional debt. The constrained optimal fiscal insurance is characterized.
1. Introduction

The Eurozone’s current difficulties with public indebtedness and debt sustainability have created significant worries about maintaining the euro. The crisis has given rise to reconsideration of the restrictions on public debt and the role of fiscal federalism for the union. The dynamics of public debt with a common currency are the subject of this paper. The role of public debt is analyzed in a nonmonetary model with distortionary taxation. The absence of lump-sum taxes creates a meaningful role for government debt in an economy subject to uncertainty. Although only real aspects of fiscal policy are studied, the absence of money in the model does not mean that comparisons of public finance with independent national currencies and with a common currency cannot be formed. These comparisons are only valid when all nominal prices are perfectly flexible and inflation just affects the value of nominal public debt. The source of uncertainty is modeled as shocks to government expenditures. The analysis studies optimal taxation of labor income under restrictions on how governments can share risk with creditors. The economy is an interdependent global economy with free trade and financially integrated private sectors. Comparison of the allocative effects of constraints on the ability of governments to issue contingent debt portrays possible consequences of currency unification for fiscal policies and public debt dynamics. It also allows the consideration of the role for fiscal insurance in a currency union. The primary focus of the analysis is on the importance and consequences of the requirement that national governments bear responsibility for meeting the cost of domestic public spending and public debt servicing by raising domestic tax revenues.

A substantial literature studies the role of fiscal policies and public debt in monetary union. Directly related papers include Beetsma and Jensen (2005) who study fiscal interdependence and stabilization when public goods enter household utility and taxes are lump sum and Ferrero (2009) who analyzes optimal fiscal and monetary rules for stabilization in a monetary union without lump-sum taxes. One focus has been the importance of idiosyncratic country-specific shocks on resource allocation when governments lose the capacity to use monetary policy for stabilization purposes. The role of fiscal federalism or fiscal insurance schemes has been considered in this context. Because this paper studies the economy with separate national fiscal policies in competitive equilibrium, tax distortions give rise to gains from fiscal insurance in the presence of uncertainty. The prospects that one country’s government might force inflationary increases for the entire union to maintain national solvency or to seek bailouts through threats to private solvency is another important topic motivated by the euro. The possibility of bailouts is not included in the analysis of optimal fiscal policies with commitment here. The analysis of how debt behaves with separate national budgets using conventional public debt instruments in a risky economy is an input to thinking about debt
management to avoid strategic fiscal policies that seek to take advantage of time inconsistent no-bailout clauses or legislated limits on debt to output ratios.

The main purpose of this paper is to see how the literature on dynamic Ramsey taxation can be used to discuss the evolution of debt and gains from fiscal integration. To this purpose, policy coordination is not a topic. Instead, the paper studies the characterization of optimal fiscal policies in interdependent open economies without fiscal unification and with constraints that highlight the consequences of adopting a common currency. For simplicity, labor is the only factor of production in the model economy. It produces tradable goods using a linear technology, and leisure represents a nontradable good. The only tax is a proportional tax on labor income imposed at the national level. Capital is left out because its inclusion would only complicate expressions without adding anything to the derivation of optimal capital income taxation in closed economies.

The starting point for analyzing the role of public debt with optimal taxation for a monetary union without fiscal union is the case in which governments can issue state-contingent debt. This is a straightforward extension of the approach taken by Lucas and Stokey (1983). Benigno and De Paoli (2010) derive optimal linear taxes with state-contingent debt for a small open economy. In this multiple country global economy version, households and firms can trade freely across borders on complete markets in an uncertain environment. Governments can also trade in state contingent securities. Equivalently, they can finance primary deficits and surpluses by issuing state contingent one-period debt. The situation analyzed requires that each government maintain responsibility for financing the cost of its public expenditures through domestic taxation. A national government bears sole financial responsibility for servicing its public debt. Thus, household wealth will differ across countries because public expenditure needs vary across countries. In the optimal tax equilibrium, the marginal excess burden of taxation is not equated across countries. The potential gains from fiscal unification are present value efficiency gains. A common fiscal authority would impose a equal rate tax on labor in each country in the model economy and would need to redistribute financial wealth lump sum in an initial period to realize Pareto gains. The benefits of fiscal unification do not arise from risk sharing. In equilibrium, the idiosyncratic risk of random national expenditures is shared across countries through household and government access to complete markets. Instead, the only gains for from fiscal unification in this version come from convergence of tax rates that are already fully smoothed with respect to idiosyncratic national shocks to reduce the aggregate excess burden of taxation in present value.

The ability of each government to issue contingent debt is then restricted, but households still trade internationally on complete markets. Thus, current account transactions are carried out in state contingent
claims. The economy differs from the closed representative household economy with uncertain government expenditures and the limitation that the government only issues risk-free real bonds studied by Aiyagari, et al (2001) by allowing households in each country trade with one another and hold debt issued by other governments. Taxes and the excess burden of distortionary taxation are not smoothed across states of nature when governments can only issue non-contingent public debt. Smoothing takes place over time roughly as under Barro’s (1979) tax smoothing hypothesis. The dynamics for national public debt replicate the results of Aiyagari, et al. When public sector debt or credit is limited only by solvency constraints for the government and households, then the restriction of public debt to non-contingent debt imparts an downward drift to national public debt which converges to sufficient public credit to eliminate the excess burden of taxation in the limit. Aiyagari, et al show that imposing tighter limits on public debt or credit removes the convergence result, and public debt need not converge at all. In the interdependent global economy, households cannot share the risk of tax distortions on leisure consumption which is not tradable, although risk sharing in traded goods is complete. The constraint that governments can only issue non-contingent debt reduces sharing of this in tradable goods as well.

An exercise for considering the effects of monetary unification might be the comparison of allocations and welfare with and without state contingent public debt. This comparison is in the spirit of Bohn’s (1988, 1990) demonstration that unanticipated inflation with perfectly flexible prices and single period debt can implement the state contingent optimum. With separate currencies, independent monetary policies and floating exchange rates, the state contingent debt economy models the use of unanticipated inflation for the sole purpose of rendering non-contingent nominal public debt into contingent real public debt. In this story, the cost of adopting monetary union without changing anything on the fiscal side other than denominating public debt in units of the common currency is a reduction in the smoothing of the marginal excess tax burden over expenditure fluctuations. The cost of requiring member countries to finance their own public expenditures with domestic tax revenues then increases with a currency union.

The interpretation of inflation taxation as implementing state contingent public debt with non-contingent nominal debt issues leads to volatile inflation as demonstrated by Chari, Christiano and Kehoe (1991). With rigid nominal prices, inflationary surprises are costly. Siu (2004) and Schmitt-Grohe and Uribe (2004) show that price stickiness significantly reduces the optimal volatility of inflation and amplitude of fluctuations in real debt payments. A intermediate approach to the fully state contingent debt model and the non-contingent debt model without money and nominal rigidities endogenizes market incompleteness by adding information asymmetries. The modeling strategy assumes each government has private information about why it chooses the level of public expenditures it does each period. Bond holders do not
observe the marginal benefits for the government of public expenditures. In the constrained optimum, each
government issues state contingent but the requirement of incentive compatibility constrains the amount
they can issue across states of nature restricting risk sharing between the government and its creditors. The
sharing of risk in the marginal excess tax burden is incomplete with private government information. This
can significantly reduce the degree of variation in debt payments in the optimum which translates to less
volatile inflation in the flexible price monetary economy interpretation.

Sleet (2004) and Sleet and Yeltekin (2006) analyze the private government information economy with a
representative household in the closed economy under particular household and government preferences.
Their approach is adapted to the interdependent global economy model. In particular, households continue
to trade on complete asset markets internationally sharing tradable goods consumption risk. Although
national governments have more information about the expenditure shocks that affect households in
equilibrium, incentive compatibility constrains the ability of governments to trade on complete markets.
Private information of the government reduces its ability to share the risk of tax increases and decreases.
This generates the asymmetry that households can use markets to an extent governments cannot. An
important consequence of private information is that public debt and the excess burden of taxation grow
stochastically over time.4

The assumption that a government has private information that determines public expenditures can
be motivated by considering a country with a large number of heterogenous households. Individuals
observe their marginal benefit from public goods but not the benefits of others, or the government can have
distributional objectives in the provision of public goods that vary. Other interpretations can made in terms
of political economy or fiscal institutions. Bond holders may be less informed about government spending
preferences for a country with less transparent budget making (for example, with more off-balance sheet
budgeting), more influence of private lobbies, or facing a more contentious political environment. Bond
holders can face less certainty that they know how a government will behave if a country has high turnover
of elected leaders.

Fiscal insurance schemes can address idiosyncratic country risk across national governments of
interdependent economies. A mutual fiscal insurance scheme with a zero balance at every date can improve
welfare in the presence of idiosyncratic national fiscal shocks when governments only issue non-contingent
public debt. While idiosyncratic expenditure shocks can be pooled, aggregate risk arising from fiscal
policies can only be addressed using state contingent debt instruments. Any aggregate risk would require
deeper fiscal integration in the sense that a central fiscal authority would need to issue debt or the use
of unanticipated inflation for purely fiscal purposes. A welfare-improving fiscal insurance scheme must
condition intergovernmental transfers on both current public expenditures and outstanding public debt. The conditionality on outstanding public debt arises from incentive compatibility in the presence of private information under commitment of the countries to pooling arrangement.

The analysis of optimal taxation and public debt requires debt limits to be imposed on the government. With restrictions on contingent public debt, limits are imposed and these are reached with positive probability in finite time. The last substantive section of the paper discusses debt limits when governments can default as sovereign debtors. Debt limits need to be self-enforcing, and both debtors and creditors can gain from allowing debt repayment to vary with government expenditures when these boundaries are reached. In this section, the implications of endogenous debt limits for fiscal insurance schemes is discussed.

The paper proceeds by describing the economy in Section 2 and extending the state contingent public debt model in Section 3. The fourth section discusses the consequences of restricting public debt to be issued in non-contingent bonds. Section 5 considers the model with private government information. Sections 6 and 7 discuss fiscal insurance schemes and endogenous debt limits, respectively. The last section concludes.

2. Fiscal Policy Environment

The model economy is composed of \( N \) countries that engage in free trade and do not impose taxes strategically to influence the terms of trade. This environment envisions an economic union with a common currency and separate national fiscal policies. It is a non-monetary model, and the \( N \) countries compose a closed economy. Each country is represented by a single household and a fiscal authority. There are two goods, a tradable good produced using labor and intrinsically valued leisure. These can be interpreted as aggregate tradable and nontradable goods. Each government must finance a flow of public expenditure on traded goods using linear taxes on labor income. Labor is the only factor of production because the emphasis here is on the role of national public debts with cooperative taxation. Introducing capital would only layer standard results on capital income taxation onto the model. The economy has an infinite horizon and is stochastic. The random variables are government expenditures.

In each country \( i = 1, ..., N \), the preferences of the representative household are represented by the utility function,

\[
U_i^0 = E_0 \sum_{t=0}^{\infty} \beta^t u \left( c_i^t, 1 - n_i^t \right),
\]

and output is produced using the linear technology with unit productivity, \( y^t = n_i^t \). \( u(c, \ell) \) is assumed to
strictly concave and twice continuously differentiable for \( c > 0 \) and \( 0 < \ell \leq 1 \). The marginal utilities satisfy \( \lim_{c \to 0} u_c(c, \ell) \) and \( \lim_{\ell \to 0} u_\ell(c, \ell) \). The expectation is taken with respect to date 0 information.

The household faces a budget identity given by

\[
\sum_{\theta^{t+1} | \theta^t} p_t(\theta^{t+1} | \theta^t) a^i_{t+1}(\theta^{t+1}) = a^i_t(\theta^t) + \left(1 - \tau^i_t(\theta^t)\right) n^i_t(\theta^t) - c^i_t(\theta^t)
\]

where \( \theta_t \) is the state of nature at date \( t \) with finite support \( \Theta_t \). Each \( \theta \) is a \( N \)-dimensional vector. \( \theta^t \) is the history of states, \((\theta_0, ..., \theta_t)\). Financial assets are given by \( a^i_t(\theta^t) \) at the beginning period \( t \) in history \( \theta^t \) and are denominated in units of consumption. The labor income tax, given by the tax rate \( \tau^i_t(\theta^t) \), is linear and can be state contingent. \( p_t(\theta^{t+1} | \theta^t) \) is the relative price of a unit of the consumption good delivered in state \( \theta_{t+1} \) conditional on the history \( \theta^t \) in terms of the good available in \( \theta^t \). Factor markets are competitive so that the post-tax return to labor equals \( 1 - \tau^i_t(\theta^t) \). The household also faces a conventional solvency constraint to close its budget over the infinite planning horizon and has initial financial assets of \( a^i_0 \).

This framework allows for general stochastic processes for the \( N \) levels of government expenditures, \( g^i_t \). The extensions of the benchmark model will restrict these to be Markovian and use independent and identical distributions for exposition. For simplicity of exposition, I assume that the support, \( \Theta_t \), is independent of time.

The first step is to define a competitive equilibrium for the economy. The allocation is given by the \( N \)-dimensional consumption and leisure choices of the \( N \) households at each date \( t \) in each \( \theta^t \). The Arrow-Debreu prices of the consumption good in terms of the numeraire good, consumption at date 0 in the predetermined state \( \theta_0 \), are denoted by \( q_t(\theta^t) \). The relative prices of leisure in terms of the numeraire are \( q_t(\theta^t)(1 - \tau^i_t(\theta^t)) \). Thus,

\[
p_t(\theta^{t+1} | \theta^t) = \frac{q_{t+1}(\theta^{t+1})}{q_t(\theta^t)}.
\]

In a competitive equilibrium, the resource constraint,

\[
\sum_{i=1}^{N} n^i_t(\theta^t) - c^i_t(\theta^t) - g^i_t(\theta^t) \geq 0,
\]

is satisfied for every \( \theta^t \) for each date \( t \). Financial market equilibrium requires the sum of net foreign assets across all countries be zero. This equilibrium condition is

\[
\sum_{i=1}^{N} a^i_t(\theta^t) - b^i_t(\theta^t) = 0
\]

for every \( \theta^t \) for each date \( t \), where \( b^i_t(\theta^t) \) is the outstanding stock of public debt for government \( i \) due at
time $t$ in $\theta^t$. The household budget constraint is given by

$$a_i^t \geq \sum_{t=0}^{\infty} \sum_{\theta^t} q_{\theta^t} \left( c_i^t \left( \theta^t \right) - \tau_i^t (\theta^t) n_i^t (\theta^t) \right)$$

(2)

The fiscal policies must also be specified. A fiscal policy is a contingent sequence of government expenditures, taxes and government debt for each of the $N$ countries for each date and history. The fiscal policy for government $i$ is defined by the sequence \{ $g_i^t (\theta^t), \tau_i^t (\theta^t), b_i^t (\theta^t)$ \} over all $\theta^t$ for each $t \geq 0$. A feasible fiscal policy for government $i$ must satisfy a budget constraint given by

$$b_i^0 \leq \sum_{t=0}^{\infty} \sum_{\theta^t} q_{\theta^t} \left( \tau_i^t (\theta^t) n_i^t (\theta^t) - g_i^t (\theta^t) \right)$$

(3)

for equilibrium prices \{ $q_{\theta^t}$ \}. This is derived by solving the budget identity,

$$\sum_{\theta^t+1 | \theta^t} p_{\theta^t+1} \frac{b_{\theta^t+1}}{b_{\theta^t}} = b_i^t (\theta^t) - \tau_i^t (\theta^t) n_i^t (\theta^t) + g_i^t (\theta^t),$$

forward and imposing the solvency constraint given by,

$$\lim_{t \to \infty} \sum_{\theta^t} q_{\theta^t} \left( \tau_i^t (\theta^t) n_i^t (\theta^t) \right).$$

The labor income rate is restricted to be no greater than one, $\tau_i^t (\theta^t) \leq 1$, and government expenditures are non-negative. In the benchmark case, each government can issue state-contingent debt in either positive or negative amounts.

In a competitive equilibrium, the public sector budget constraint given by (3) holds for each government’s fiscal policy at the equilibrium prices. In equilibrium, the allocation is resource feasible (it satisfies condition (1)), households maximize their utility over their respective budget constraints given prices and labor income tax rates and firms maximize profits at each date and state.

The second step is to determine optimal fiscal policy. A social planner solves the optimal tax problem given restrictions on reallocating national budgetary responsibility. The main assumption for this paper is that each government must finance the entirety of its public expenditures and initial public debt obligations through taxes imposed on domestic labor income as indicated by (3). A fiscal policy for the planner is defined to be a $N$-tuple of policies \{ $g_i^t (\theta^t), \tau_i^t (\theta^t), b_i^t (\theta^t)$ \} for each $i = 1, \ldots, N$.

The planner’s objective is the sum of the utilities of the representative households for the $N$ countries given by

$$W(\bar{c}, \bar{n}) = E_0 \sum_{i=1}^{N} \lambda_i \sum_{t=0}^{\infty} \beta^t u (c_i^t, 1 - n_i^t)$$

where $\bar{c}$ and $\bar{n}$ represent the $N$-tuples of the state-contingent sequences of national consumption and labor supplies, $\{c_i^t (\theta^t)\}$ and $\{n_i^t (\theta^t)\}$. The parameters, $\lambda_i$, are multipliers that are endogenously determined.
in the optimum. Their values depend upon the distribution of household wealth at time 0 and are related to equilibrium marginal utilities. With lump-sum taxes, the $\lambda_i$ are inversely proportional to equilibrium marginal utilities at time 0. In the optimal tax problem, the distribution of utilities across countries also depends on the social cost of tax distortions and the variation in the present value of government obligations across countries. The Ramsey problem for the planner is to choose a competitive equilibrium that maximizes its objective with respect to a fiscal policy given initial financial assets, $a^i_0$ and $b^i_0$ for each $i = 1, ..., N$. The planner assigns a fiscal policy $\{g^i_t(\theta^t), \tau^i_t(\theta^t), b^i_t(\theta^t)\}$ to each national government $i = 1, ..., N$ taking account of the endogeneity of equilibrium household consumptions, labor supplies, saving plans and prices and of the requirement that each government’s budget constraint (3) is satisfied at equilibrium prices.

3. Independent Fiscal Policies with State-Contingent Debt

The benchmark case is an extension of the Lucas and Stokey (1983) economy with state-contingent public debt to an economy with multiple governments with separate intertemporal public sector budget constraints. In this model there are heterogeneous households of number $N$ each consuming a different nontradable good (leisure) and paying taxes to a fiscal authority that must finance national public expenditures. The purpose of this section is find out how the separate fiscal responsibilities of governments affect equilibrium and welfare with state-contingent debt. In subsequent sections, the ability of the governments to issue state-contingent public debt will be constrained but households will still be able to trade with each other on complete markets.

I adapt the primal approach to solving the optimal Ramsey tax problem which uses the first-order conditions for the household optimum to eliminate the tax rate, $\tau^i_t(\theta^t)$, and relative prices, $q_t(\theta^t)$, from the intertemporal budget constraint to form an implementability constraint. In this economy, however, the planner faces a separate budget constraint for each national government. The household first-order condition for the leisure-consumption choice can be substituted within each national budget constraint, but the relative prices of state contingent consumption, $q_t(\theta^t)$, depend on the demands for tradable goods by all consumers. The marginal rates of substitution in state contingent commodities are equal across borders under free trade. The imposition of these first-order conditions will appear as an additional constraint in the planner’s problem.

The implementability constraints are formed from the national budget constraints as

$$E_0 \sum_{t=0}^{\infty} q_t(\theta^t) \left( 1 - \frac{u^i_t(\theta^t)}{u^i_c(\theta^t)} \right) \pi^i_t(\theta^t) - g^i_t(\theta^t) = b^i_0 \quad \text{for each } i = 1, ..., N. \quad (4)$$
The additional implementation constraint is

$$\beta^t u_i^c (\theta^t) = q_t (\theta^t)$$

for each \( i = 1, ..., N \). \( (5) \)

For this case, in which governments access complete asset markets for debt issues, substituting the stochastic discount factor for each country’s household using (5) into that country’s public sector budget constraint (4) does not matter for finding the Ramsey solution. Doing so allows the planner to impose differential taxes on traded commodities, that is, tariffs, across countries. For governments that have access to complete markets for debt, differential national commodity taxes are redundant to national labor income taxes in the Ramsey optimum. The constraints are expressed separately in the benchmark case to be used as public finance constraints are added.

In addition to the budget constraints for each government, the planner needs to satisfy the lifetime budget constraints for all \( N \) households and the global resource constraint (1) for each date. The lifetime budget constraint for household \( i \) can be rewritten as

$$E_0 \sum_{t=0}^{\infty} q_t (\theta^t) \left( c_i^t (\theta^t) - \frac{u_i^c (\theta^t)}{u_i^c (\theta_0)} n_i^t (\theta^t) \right) = a_0^i. \tag{6}$$

These constraints determine the allocation of goods consumption across households given the initial distribution of net foreign assets, \( f_{i0} = a_0^i - b_{i0} \). For each possible choice of fiscal policies, private consumptions, labor supplies and outputs are determined by households and firms in competitive equilibrium taking taxes and debt issuance as given.

To find an optimum for the planner, I need to include the budget constraints for each government and each household plus the first-order conditions goods market equilibrium and the resource constraints. However, the necessary conditions for the Ramsey fiscal policies can be derived by maximizing the planner’s objective over the constraint set without the household budget constraint if the first-order conditions for competitive equilibrium in goods and labor markets are included. When households trade on complete markets, the lifetime budget constraints are needed to determine the allocation of goods consumption at date 0, that is, the endogenous welfare weights, \( \{ \lambda_i \} \). To keep things thrifty, much of the analysis drops the household budget constraint and takes the \( \lambda_i \) as given. I then use the complete markets for private trade to interpret \( \lambda_i \) in terms of \( u_i^c (\theta_0) \).

The complete markets case requires finding a solution to

$$\begin{array}{c}
\max_{\{ c_i^t (\theta^t), n_i^t (\theta^t), q_t (\theta^t) \}} E_0 \sum_{i=1}^N \sum_{t=0}^{\infty} \beta^t u_i^c (\theta^t) \left( c_i^t (\theta^t) - n_i^t (\theta^t) \right) \\
\text{subject to conditions (4), (5) and (1) given the allocation of initial public debt outstanding, \{ b_{i0} \}.
\end{array}$$

The necessary conditions for an optimum include the first-order conditions with respect to consumption of
goods and of leisure in history $\theta^t$,

$$\lambda_i u_i^c(\theta^t) + \frac{u_i^c(\theta^t)}{u_i^c(\theta_0)} \left( \varphi^i \left( \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} - \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} n_i^c(\theta^t) + \zeta_i \right) \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} \right) = \eta_i(\theta^t) \quad (7)$$

and

$$\lambda_i u_i^c(\theta^t) + \frac{u_i^c(\theta^t)}{u_i^c(\theta_0)} \left( \varphi^i \left( \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} n_i^c(\theta^t) + 1 \right) - \varphi^i \left( \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} n_i^c(\theta^t) + 1 \right) + \zeta_i \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} \right) = \eta_i(\theta^t), \quad (8)$$

where $\varphi$ is the multiplier for the government budget constraint (4), $\zeta_i$ is the multiplier for the first-order condition constraint (5) and $\beta^t \eta_i(\theta^t)$ is the multiplier for the resource constraint (1). The first-order condition for the planner with respect to the relative prices, $q_t(\theta^t)$, is

$$\sum_{i=1}^{N} \zeta_i = \sum_{i=1}^{N} \varphi^i s_i^t(\theta^t), \quad (9)$$

where $s_i^t(\theta^t) = \left( 1 - \frac{u_i^c(\theta^t)}{u_i^c(\theta_0)} \right) n_i^c(\theta^t) - g_i^t(\theta^t)$ is the primary surplus for government $i$ at time $t$.

The right-hand side of the conditions (7) and (8) is the same for all $N$ countries. Consider first how the ratio of the left-hand side of equation (7) for date $t$ for $(\theta^{t-1}, \theta_t)$ multiplied by $\beta$ to the similar expression for date $t - 1$ for $\theta^{t-1}$. This is the ratio of the social marginal utilities of consumption and equals the ratio, $\frac{\partial \eta_i(\theta^t)}{\partial \eta_i(\theta^{t-1})}$, of social marginal costs of consumption in these dates and states. With complete markets, this is the competitive equilibrium price, $\frac{q_t(\theta^t)}{q_t(\theta^{t-1})}$. To see this, note that $\frac{u_i^c(\theta^t)}{u_i^c(\theta^{t-1})} = \frac{u_i^c(\theta^t)}{u_i^c(\theta^{t-1})}$ for each pair of households, $i, j$. Using the derived ratio of the marginal social utilities for households $i$ and $j$, the quantity

$$\chi^i = - \left( \varphi^i \left( \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} - \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} n_i^c(\theta^t) + \zeta_i \right) \frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} \right) \frac{1}{\frac{u_i^c(\theta^t)}{u_i^c(\theta_0)}}$$

must be constant over time.

Using the households’ first-order conditions for commodity market equilibrium (5) and the first-order condition in consumption for the fiscal optimum (7)) leads to the equality,

$$\chi^i + \lambda_j u_j^c(\theta_0) = \left( \chi^k + \lambda_k \right) u_k^c(\theta_0),$$

for each pair of countries, $j, k \in \{1, \ldots, N\}$. The ratio of the marginal utilities of commodity consumption across countries depends on each country’s stochastic process for government expenditures and its initial outstanding public debt through the $\chi^i$ term as

$$\frac{u_i^c(\theta^t)}{u_i^c(\theta^t)} = \frac{\lambda_k - \chi^k}{\lambda_j + \chi^j}.$$ 

This condition yields the distribution of consumption across countries given the distribution of initial household financial wealth under the optimal fiscal policy.
Consider the case that the utilities are additively separable between consumption of commodities and of leisure so that the cross partial derivative terms vanish and
\[ \chi^i = - \left( \varphi^i (1 - \tau^i_t) n^i_t (\theta^l) + \zeta^i_t \right) \frac{u^i_{cc} (\theta^l)}{u^i_{cl} (\theta^l)} \frac{1}{u^i_c (\theta^l)}. \]
The multiplier, \( \zeta^i_t \), measures the sharing of risk across households in the optimum. Notice that the sum of the terms, \( \varphi^i (1 - \tau^i_t) n^i_t (\theta^l) + \zeta^i_t \), and the first-order condition (7) together imply
\[ \sum_{i=1}^{N} \varphi^i (1 - \tau^i_t) n^i_t (\theta^l) + \sum_{i=1}^{N} \varphi^i s^i_t (\theta^l) = \sum_{i=1}^{N} \varphi^i (n^i_t (\theta^l) - g^i_t (\theta^l)) \]
is a constant if consumption is completely smoothed across dates and states for all households in competitive equilibrium. This measures the welfare cost of the restriction to linear taxes on the surplus the planner seeks to allocate across households for commodity consumption. The variation expressed by the curvature of the utility function in \( \chi^i \) adjusts this social cost for incomplete smoothing of aggregate output net of government expenditures.

If the utilities are additively separable in commodity and leisure consumption, then the competitive equilibrium allocation for the consumption of goods cannot be improved upon given the distribution of initial household wealth. In this case, the idiosyncratic effects of national expenditure shocks on output will be fully shared across countries through complete markets in contingent commodities. The effects of distortionary taxes on leisure consumptions do not affect the marginal conditions for the allocation of commodities. The excess burden of taxation on output is shared by all households along with the systemic components of expenditure shocks. Separable utility ensures that efficient smoothing of consumption in commodities is achieved in a competitive equilibrium with complete markets in securities for commodities only.

These welfare statements are not true in general if utilities are not separable. Leisure is a non-traded good. It is well understood in the absence of tax distortions that international trade in contingent securities for tradable commodities only is insufficient to implement efficient risk sharing in tradable goods if utilities are not separable. With the restriction of tax instruments to linear labor income taxes, the same result follows for this economy. This deviation ought to also be reflected in the multipliers \( \zeta^i_t \) in the Ramsey equilibrium so that their interpretation is not straightforward.

Combining the two first-order conditions for goods and leisure consumption leads a relationship that implicitly defines the labor income tax rate,
\[ (\lambda_i u^i (\theta_0) + \varphi^i) (\dot{u}^i_c (\theta^l) - u^i_c (\theta^l)) - \varphi^i u^i (\theta^l) \left( \frac{u^i_{cc} (\theta^l)}{u^i_{cl} (\theta^l)} - \frac{u^i_{c} (\theta^l)}{u^i_c (\theta^l)} \right) n^i_t (\theta^l) \]
\[ = \varphi^i (\dot{u}^i_{cl} (\theta^l) - u^i_{cc} (\theta^l)) n^i_t (\theta^l) + \zeta^i_t (u^i_{cc} (\theta^l) - u^i_{cl} (\theta^l)). \]
With separable utilities, the last term vanishes and the first-order condition (7) shows that the weighted sum of primary government surpluses equals zero with the weights being the multipliers on the government budget constraints. The social cost of paying for surpluses in some countries through distortionary labor income taxes is offset by the social cost of deficit financing of public expenditures in other countries. The multipliers, $\varphi^i$, measure the excess burden of taxation in terms of social marginal utility (the planner’s objective). If the sharing of commodity consumption risk is complete (the separable utilities case), then the social cost of raising revenue using distortionary taxes is minimized in the Ramsey equilibrium with free trade. The government budget constraints and initial net foreign assets determine the distribution of utility across countries and the relative values of the $\varphi^i$. The individual national tax rates can be backed out of the necessary conditions using the household consumption-leisure choices given the value of these multipliers.

A standard example helps to simplify and illustrate equilibrium. Let the utility function be separable and display constant elasticity of substitution:

$$u(c, \ell) = \frac{c^{1-\sigma}}{1-\sigma} + \alpha \frac{\ell^{1-\gamma}}{1-\gamma},$$

for $\sigma, \gamma > 0$. For these utilities, equation (??) can be used to derive a simple expression for the tax rate for country $j$,

$$\tau^j_t(\theta^t) = \frac{\varphi^j \left( \phi \left( n^j_t(\theta^t) \right) - 1 \right) + \chi^j u^i_c(\theta_0)}{\lambda^j u^i_c(\theta_0) + \varphi^j \phi \left( n^j_t(\theta^t) \right)},$$

(11)

where $\phi \left( n^j_t(\theta^t) \right) = 1 + \frac{\gamma n^j_t(\theta^t)}{1 - \frac{n^j_t(\theta^t)}{n^j_t(\theta^t)}}$ is one plus the Frisch elasticity of labor supply. The tax rate only varies over dates and states with the elasticity of labor supply. If the Frisch elasticity is constant, then so is the tax rate for the country. Optimal risk sharing with separable utilities yields a constant $\varphi^i$ which measures the excess burden of taxation due to the restriction to linear labor income taxes.

This formula is similar to solution for the tax rate for a single country version of the economy given by

$$\tau_t(\theta^t) = \frac{\varphi \phi \left( n^i_t(\theta^t) - 1 \right) + \varphi \sigma}{1 + \phi \phi \left( n^i_t(\theta^t) \right)},$$

where $\sigma \varphi^i$ replaces $\chi^i u^i_c(\theta_0)$. The essential difference is the closed economy problem constrains the national trade balance, $n^i_t - g^i_t - c^i_t$, to equal zero. Private risk sharing in the interdependent global economy, smooths consumption across states through the trade balance using contingent contracts. Neglecting to add the constraint that the stochastic discount factor must equal the competitive equilibrium relative price of future consumption in terms of initial consumption will lead to an equivalent formula to equation (11) under the assumption of separable utilities. Doing so, however, allows the planner to use commodity taxes which it will in the nonseparable utility case. If lump-taxes were available to each government, the multipliers $\varphi^i$
and $\zeta_i$ would all equal zero and the multipliers, $\lambda_i$, would equal the inverse of the initial marginal utilities for both commodities and leisure.

To illustrate the role of international risk sharing, consider the example in which government expenditures for each country follow a common invariant Markov chain and always sum to a constant. With no aggregate uncertainty, the tax rates are all constant with complete markets when utilities are separable and display constant elasticity of substitution in commodities. The constant tax rates, labor supplies and consumptions for each country are determined by its initial public expenditures, $g^j(\theta_0)$. If, instead, there is aggregate uncertainty (the sum of the $g^j$ is Markov), the tax rate for each country, $\tau^j(\theta_t)$, is an invariant function of the current state. Although all taxes depend on the initial state (that is, distribution of the initial realization of public expenditures), innovations in tax rates depend only on the current state through the elasticity of labor supply. Thus, the approach replicates the results of Lucas and Stokey (1983) for a global economy.

Differences in tax rates and the excess burdens of distortionary taxation across the countries arise because individual budget constraints are imposed on national governments. The assumption of contingent public debt is convenient for seeing the role of national fiscal responsibility. The overall welfare cost is measured by unequal shadow prices for initial public debt, $\varphi_i$. Consider how a single fiscal authority that must satisfy a single aggregate public sector budget constraint for a fiscal union chooses optimal labor income taxes for each country. Under identical household preferences and a utilitarian objective, it should impose the same tax on all households. Non-tradable commodities (leisure) should be uniformly taxed in the Ramsey equilibrium in a utilitarian fiscal union. Because countries are symmetric in the model economy, each country in the optimum will pay taxes in the amount $T^j_0$ in present value to finance an equal share of total government obligations,

$$\sum_{i=1}^{N} \left[ \hat{b}_i(\theta_0) + E_t \sum_{t=0}^{\infty} \beta^t \left( \frac{c^j(\theta^t)}{c^j(\theta_t)} \right)^{-\sigma} \hat{g}_i^j(\theta^t) \right] = 1,$$

where the present value is computed using the equilibrium prices for the fiscal union. This implies a redistribution of government debt at date zero from country $j$ to the rest of the fiscal union equal to

$$\Delta \hat{b}_j = \hat{b}_j^0 + E_t \sum_{t=0}^{\infty} \beta^t \left( \frac{c^j(\theta^t)}{c^j(\theta_t)} \right)^{-\sigma} \hat{g}_j^j(\theta^t) - T^j_0.$$

For a Pareto improvement, the redistribution of public debt must be offset by a reallocation of foreign assets across households. A country with high public debt or future expenditures needs to receive a net wealth transfer which could be made by the payment of an equal amount of net foreign assets to the rest of the union. For country $j$, making a net payment, $\Delta f_j^0 = \Delta \hat{b}_j^0$, would keep household financial wealth, $a_j^0$,
unchanged, maintaining the initial distribution of wealth across countries. These transfers are capital levies
on financial assets. If these time 0 levies are feasible, then the utility for each country is higher in the union
as efficiency in the allocation of labor is improved and each country receives the given exogenous stream
of public expenditure, \( \{g^t_i\} \). The formation of a fiscal union that maintains the status quo distribution of
national welfare under individual government budget responsibility leads to a potential Pareto improvement
if the shadow prices \( \varphi_i \) are not all equal in the pre-union equilibrium. Fiscal unification decreases the total
excess burden of taxation from \( \sum_i \varphi_i b^i_0 \) to \( \hat{\varphi} \sum_i b^i_0 \) where \( \hat{\varphi} \) is the shadow price for union-wide public debt
in the optimum for a consolidated fiscal authority.

The ability of governments to issue contingent debt illustrates the risk sharing benefits of creating a
single tax authority when only linear factor income taxes can be used to raise public revenues. While
assuming contingent debt is convenient, it does not generate the observed history dependence of public
debt and taxes emphasized by Barro (1979). Restricting fiscal authorities to issue single-period maturity
debt without state-contingent payments in a stochastic economy addresses this issue. Bohn (1988
and 1990) proposes that one way governments achieve state contingencies in public debt is to issue
nominal non-contingent debt. Unanticipated variations in inflation impact state contingent real returns to
non-contingent nominal public debt.\(^5\) In the interdependent global economy, flexible nominal exchange
rates allow differential inflation that could possibly create the changes in the real value of national public
debts required to implement the state contingent optimum if public debt is issued in national currency units.
This possibility is lost in the adoption of a monetary union.

Discussions of the fiscal consequences of monetary unification are typically based on Mundell’s
theory of optimum currency areas which highlights the role of monetary and fiscal policies for output
stabilization in the presence of nominal rigidities. With restricted state contingency in the issuance of public
debt, another consequence is the loss of the capacity to use unanticipated inflation as a fiscal tool with
independent stochastic public spending. This motivates my comparison of the monetary union economy
with and without contingent public debt in the nonmonetary model. Crudely, an economy with perfectly
flexible nominal prices in domestic currencies and non-contingent public debts corresponds to the state
contingent public debt version of the model in this section. In the same economy, restricting governments
to issue only non-contingent public debt portrays the optimal tax problem for a monetary union in the
next sections. The argument for using this approach is that the tax distortion and limits on contracting
by governments creates a need for fiscal policy to address shocks originating in government demand.
Therefore, it models a role for a common fiscal policy beyond fiscal coordination based on idiosyncratic
shocks to national economies.
A note the literature is in order here. Several papers consider the consequences of public debt issued in non-contingent bonds. Angeletos (2002) and Buera and Nicolini (2004) show how the term structure of non-contingent debt of different maturities can be used to implement the complete markets equilibrium under some restrictions. However, Buera and Nicolini demonstrate that the government may only replicate the state contingencies using the term structure of debt by taking and reversing very large short and long positions. Chari, Christiano and Kehoe (1991) study optimal monetary and fiscal policy with nominal non-contingent debt. Unanticipated inflation acts as a lump-sum levy on household holdings of public debt. They show that optimal inflation can be volatile and is serially uncorrelated in a monetary economy with flexible nominal prices.

Chari, Christiano and Kehoe provide the rationale for comparing optimal taxation with floating exchange rates and with a single currency using the model with and without state-contingent public debt. There are some caveats. The optimal monetary policy yields the Friedman rule and fluctuations in inflation can be substantial. If nominal prices and wages are sticky, then unanticipated inflation reduces welfare and there is a trade off between reducing the excess burden of taxation and increasing fluctuations in marginal costs. This trade off with non-contingent nominal public debt has been analyzed in the closed economy by Siu (2004), Schmitt-Grohe and Uribe (2004), Benigno and Woodford (2005) and Lustig, Sleet and Yeltekin (2008). Benigno and De Paoli (2010) analyze optimal taxation with sticky prices in a small open economy. The general result is that the optimal response of nominal non-contingent debt is quite muted in the presence of sticky nominal prices for single-period debt maturities. In numerical simulations, the stochastic process for real payments with single-period non-contingent nominal debt displays small variance and provides little risk sharing. The constrained optimum seems to approximate the constrained optimum for real-indexed non-contingent debt. Lustig, Sleet and Yeltekin show that with longer maturity debt, inflation responds to a rise in government expenditure with a lag so that nominal prices are reset in anticipation of the price level rise and real returns on long maturity nominal debt fall.

4. Fiscal Policies with non-contingent Debt

Against this background, I consider the optimal behavior of non-contingent public debt in the interdependent global economy. The purpose is to understand how the requirement that each government bears responsibility for financing its current and future expenditures and paying off its debt works in a monetary union with idiosyncratic national uncertainty. The optimal fiscal policy problem needs to be modified when the individual national governments cannot use state contingent securities to manage public debt. In contrast with the analysis of optimal fiscal policy with real non-contingent debt in closed
economies, households can trade private state contingent securities. Aiyagari, et al (2001) analyze optimal taxation with risk-free government bonds in a representative household closed economy. There are no parties other than the representative household and the government to share risks so government debt is the only security that can serve a risk sharing purpose. In the global economy model, households are heterogeneous across countries so that sharing risk between households and sharing risk between governments and households are not redundant motives for trade. The motive for households to trade securities with each other is to share the risk of tax increases to pay for idiosyncratic fluctuations in national government spending. With lump-sum taxation, restricting participation in complete markets in tradable goods to households would not affect resource allocation. When only distortionary tax instruments are available to the governments, the constraint that governments can only issue risk-free bonds but households can continue to trade state-contingent securities reduces welfare and introduces debt dynamics.

Introducing this constraint on public finance extends the model of Aiyagari, et al to the multi-country environment with open capital accounts. The optimal tax problem needs to account for the difference between tradable private assets, \( f_t \), and government debt, \( b_t \). Because they can trade on complete markets, the optimization problem for each household is unchanged from the previous section. The first-order conditions are the same, but the standard implementability condition written from the household lifetime budget constraints (6) cannot be used because the two assets must be distinguished when the government can only impose distortionary taxes. Household portfolios contain both private, internationally traded, contingent claims and non-contingent bonds issued by the national governments. If taxes were lump-sum, then the non-contingency of government debt would make no difference. Either the household budget constraint or the government budget constraint could have been used to formulate the implementability condition in the previous section. With non-contingent public debt, a sequence of implementability conditions is needed for each government. As before, the first-order condition derived from household optimization under free commodity trade will appear with a separate multiplier in the optimization problem to avoid the use of tariffs.

The constraints for government \( i \) are given by the single-period budget identity,

\[
p_t (\theta_t | \theta_t^{t-1}) \hat{b}_{i,t+1} (\theta_t) + \left( \tau_t^i (\theta_t) n_t^i (\theta_t) - g_t^i (\theta_t) \right) \geq \hat{b}_{i,t} (\theta_t^{t-1}),
\]

where \( \hat{b}_{i,t} (\theta_t^{t-1}) \) equals outstanding single-period public debt at the beginning of period \( t \). The dependence on the history of shocks through date \( t - 1, \theta_t^{t-1} \), rather than on \( \theta_t^t \), indicates the non-contingency of debt issued in period \( t - 1 \) for repayment in period \( t \). The market discount factor for \( \hat{b}_{i,t+1} \) is \( p_t (\theta_t^t) \) which is not contingent on date \( t + 1 \) shocks. In competitive equilibrium, this price equals the expectation of the
stochastic discount factor, \( E_t \beta u_{c,t+1}/u_{c,t} \). Solving the single-period government budget identity forward imposes a budget constraint for each date \( t \) given history \( \theta^{t-1} \) given by

\[
 b_i^t (\theta^{t-1}) \leq E_t \left( \sum_{s=t}^{\infty} \frac{q_s}{q_t} \left( \tau_i^s(\theta^s) n_i^s(\theta^s) - g_i^s(\theta^s) \right) \right).
\]

A debt limit needs to be imposed to ensure existence of an equilibrium. For the closed economy, Aiyagari, et al impose ad hoc upper and lower limits on public indebtedness. They demonstrate that in the absence of a lower bound on public debt, public credit can grow until the government has sufficient assets to fully finance future public expenditures. In examples, this occurs when the public expenditures converge to a non-trivial stationary distribution. Using the insight from Aiyagari, et al, debt limits are imposed as a no lending upper bound and an ad hoc lower limit on public debt,

\[ 0 \leq b_{i,t+1}(\theta^t) \leq b_i^t, \tag{12} \]

for all \( t \geq 0 \).

The series of implementability conditions for each government \( i \) are given by

\[
 E_t \left( \sum_{s=t}^{\infty} \frac{q_s}{q_t} \left( 1 - \frac{u_{c,s}^i(\theta^s)}{u_{c,t}^i(\theta^t)} \right) n_i^s(\theta^s) - g_i^s(\theta^s) \right) = b_i^t (\theta^{t-1}) \quad \text{for each } i = 1, \ldots, N \text{ and for all } t \geq 0 \tag{13}
\]

for each \( t \) and all \( t \). The first-order condition for commodity consumption is

\[
 \frac{\beta^{s-t} u_{c,s}^i(\theta^s \mid \theta^t)}{u_{c,t}^i(\theta^t)} = \frac{q_s}{q_t} \quad \text{for each } i = 1, \ldots, N.
\]

The planner’s optimization problem is to maximize the objective

\[
 E_0 \sum_{i=1}^{N} \lambda_i \sum_{t=0}^{\infty} \beta^t u(c_{i,t}^i, 1 - n_{i,t}^i)
\]

with respect to the contingent consumptions and labor supplies, \( \{c_{i,t}^i, n_{i,t}^i\} \), for each country subject to conditions (13), (5), (1) and (12) given the allocation of initial financial wealth across households, \( \{a_{0,i}^i\} \), of initial public debt \( \{b_{0,i}^i\} \). The existence of a solution and sufficiency of the necessary conditions for an optimum are discussed in Aiyagari, et al. The extension to the multiple country economy involves a linear summation across countries that does not change properties such as concavity, compactness or differentiability so that their sufficient conditions carry over. The multipliers associated with the constraints are \( \mu_{i,t}^i \) for (13), \( c_{i,t}^i \) for (5), \( \eta_{i,t} \) for (1) and \( \nu_{1,ti}^i \) and \( \nu_{2,ti}^i \) for the upper and lower debt limits, respectively. As in Aiyagari, et al, new multiplier,

\[
 \psi_{i,t}^i = \psi_{i,t-1}^i + \mu_{i,t}^i - \nu_{1,ti}^i + \nu_{2,ti}^i \quad \text{and} \quad \psi_{0,i}^i = \mu_{0,i}^i
\]

is introduced to rearrange the summation of the government implementability conditions in the Lagrangian.
The Lagrangian for the Ramsey problem becomes

\[
L = E_0 \sum_{i=1}^{N} \sum_{t=0}^{\infty} \beta^t u(c_{i,t}, 1 - n_{i,t}^t) + \psi^i_q z_{i,t}^t - \mu^i_q b_{t}^i (\theta^{t-1}) + \nu^i_q q_{t}^i + \zeta^i_t \left( \frac{u^{i}_{c,t}}{u^{i}_{c,0}} - q_t^i \right) + \beta^t \eta^i c_{i,t},
\]

where

\[ x_{i,t}^t = n_{i,t} - c_{i,t} - g_{t}^i \]
is the trade balance for country \( i \) and

\[ z_{i,t}^t = \tau_{i}^{t} n_{i,t}^t - g_{t}^i = \left( 1 - \frac{u_{i,0}^{i,t}}{u_{i,0}^{i,t}} \right) n_{i,t} - g_{t}^i \]
is the primary surplus for government \( i \).

The first-order conditions with respect to tradable goods consumption and labor supply are

\[
\lambda_{i} u_{c,t} + \psi^i_{u} \left( \frac{u_{i,t}^{i} u_{i,c,t}^{i}}{u_{i,c,t}^{i}} - \frac{u_{i,c,t}^{i}}{u_{i,c,t}^{i}} \right) n_{i,t}^t + \zeta^i_t \left( \frac{u_{i,c,t}^{i}}{u_{i,c,t}^{i}} \right) = \eta_{t}^i
\]

and

\[
\lambda_{i} u_{t} + \psi^i_{u} \left( \frac{u_{i,t}^{i} u_{i,c,t}^{i}}{u_{i,c,t}^{i}} - \frac{u_{i,c,t}^{i}}{u_{i,c,t}^{i}} \right) n_{i,t}^t - 1 + \frac{u_{i,t}^{i}}{u_{i,c,t}^{i}} + \zeta^i_t \left( \frac{u_{i,c,t}^{i}}{u_{i,c,t}^{i}} \right) = \eta^i_t,
\]

respectively. The imposition of the competitive equilibrium first-order condition for household consumption of commodities requires that

\[
\chi^i = -\lambda_{i} + \psi^i_{u} \left( \frac{u_{i,t}^{i} n_{i,t}^t - \zeta^i_t}{u_{i,c,t}^{i}} \right) = 0,
\]

must be constant for each \( i \) over all histories.

The two first-order conditions for the planner (14) and (15) combine as

\[
\lambda_{i} (u_{i,t} - u_{i,c,t}) + \psi^i_{u} \left( \frac{u_{i,t}^{i} u_{i,c,t}^{i}}{u_{i,c,t}^{i}} - \frac{u_{i,c,t}^{i}}{u_{i,c,t}^{i}} \right) \left( n_{i,t}^t - 1 + \frac{u_{i,t}^{i}}{u_{i,c,t}^{i}} \right) + \zeta^i_t \left( \frac{u_{i,c,t}^{i}}{u_{i,c,t}^{i}} \right) = 0.
\]

The first-order condition with respect to the international prices, \( q_t^i \), is

\[
\sum_{i=1}^{N} \left( \psi^i_{q} z_{i,t}^t - \mu^i_{q} b_{t}^i (\theta^{t-1}) + \nu^i_{q} q_{t}^i - \zeta^i_t \right) = 0.
\]

As before, this condition incorporates the sharing of risk across households using the complete market structure they face. The shadow cost of national debts, deficits and when binding, debt limits, are shared by households across countries. The cross-partial derivative terms in equation (17) indicate the effect of the non-insurability of nontradable goods consumption across countries on risk sharing in commodities. In the state contingent debt case, the multipliers \( \mu^i_{t+1} = \nu^i_{q} = 0 \) for all \( t \geq 0 \), and the multiplier \( \mu^i_{0} \) is identical to the shadow price \( \varphi \) with complete markets for government debt.

Differentiation of the Lagrangian with respect to \( b_{t}^i \) leads to

\[
E_{t} q_{t+1} \mu_{t+1} = 0
\]
and

\[ \psi_t^i = E_t q_{t+1} \psi_{t+1}^i (E_t q_{t+1})^{-1}, \]

for positive debt below the debt limit \((\nu_{1t}^i = \nu_{2t}^i = 0)\). Aiyagari, et al explain how their analogous version for the closed economy is a risk-adjusted martingale that does not necessarily converge. Without a bound on public sector lending, each government will accumulate assets until \(\psi_t^i\) converges to zero and the excess burden of taxation vanishes along with the tax rate. In instances in which the excess burden of taxation converges, \(\psi_t^i\) is a nonnegative martingale, \(\psi_t^i = E_t \psi_{t+1}^i\). The multiplier \(\mu_0^i\) will be positive unless initial public debt, \(b_0^i\), is sufficiently large and negative to finance all future expenditures. \(\psi_t^i\) can be a martingale if the equilibrium process for the common stochastic discount factor converges. For example, when fluctuations in government expenditures vanish in finite time. If government expenditures follow an invariant non-trivial Markov chain, this is not assured and convergence with a no lending limit cannot occur. Aiyagari, et al also find that ad hoc debt limits are reached with positive probability in finite time for serially uncorrelated government expenditures. Since the necessary conditions with respect to outstanding public debt for the many government model with private risk sharing are the same, this result carries over immediately. With persistent randomness, non-contingent public debt does not converge if public credit accumulation is bounded.

The example with separable utilities displaying constant elasticities of substitution illustrates how the addition of the current account affects the first-order condition for the optimal tax rate. Substituting the solutions into equation \((?\?)\) if the debt limits do not bind leads to the expression for the labor income tax rate for country \(i\),

\[ \tau_t^i = \psi_t^i \left( \phi \left(n_t^i\right) - 1 \right) - \chi u_o^i - \psi_t^i \phi \left(n_t^i\right), \quad (18) \]

Contrasting this expression with the state-contingent debt case shows that the multiplier, \(\psi_t^i\), replaces the multiplier \(\phi_t\). The tax rate varies with the realized state, \(\theta_t\), at time \(t\). \(\mu_t^i\) measures the shadow cost of the restriction that the government can only issue non-contingent debt and can be either positive or negative. A positive realization at date \(t\) means that \(\psi_t^i > \psi_{t-1}^i\). Thus, the social cost of distortionary taxation for country \(i\) increases with a positive \(\mu_t^i\). The multiplier is positive for expenditure realizations such that the government would optimally issue less state-contingent debt and it is negative for realizations such that state-contingent debt would be higher than optimal non-contingent debt. With independently identically distributed \(q_t^i\), high expenditure states with outstanding public debt lead to an increasing excess burden of taxation measured by \(\psi_t^i\), and conversely for low expenditure states. If the government could issue state contingent debt, the planner would trade debt in high \(\mu_t^i\) states for debt in low \(\mu_t^i\) states, smoothing the excess burden of taxation across states \(\theta_t\) at each date \(t\). Doing so, the planner would equalize the shadow
price of public debt across each $\theta_t$ for each date $t$ and over all times. The multipliers $\psi^t_i$ all collapse to $\mu^t_0 = \varphi_i$.

5. Optimal Taxation and Increasing Public Debt

The economies with state-contingent debt and with non-contingent real debt are contrasting extreme cases. An intermediate approach allows for state-contingent debt but restricts the variation of debt payments across states endogenously. This version of the economy leads to very different dynamics for government debt than those generated by the exogenous non-contingent debt model. The idea is to limit the degree of public debt contingent payments by endogenizing market incompleteness. The model economy can be modified to endogenous risk sharing by assuming asymmetric information about government expenditures. The assumption that the government observes its expenditure shock but households do not is a simple way to introduce the notion that the government has more information about its activities than do the holders of public debt. This can be interpreted as the government having more information about how public spending choices are made. For example, the government may know the marginal social benefit of public expenditures in a political equilibrium but tax payers and creditors do not observe disturbances to the political value of public expenditures known to the government. In terms of the model, the government observes the realization of the random variable, $\theta$, privately each period. This variable gives the marginal benefit of public expenditure for the government.

In the spirit of applying models of borrowing with private information to a monetary union, I assume that the private sector can make transactions that the government cannot due to government moral hazard. The government has a disadvantage sharing risk relative to households who face complete markets. While the government has more information about its expenditures, which are the source of stochastic shocks in this economy, with endogenous market incompleteness it has less capacity to share the uncertain costs of expenditure shocks than do private agents. However, the government must choose a tax policy to minimize the social cost of tax distortions. Households can smooth their risk of post-tax income but they cannot reduce the excess burden of taxation. In the multiple country economy, households all have the same information about the realized state of nature. In an incentive compatible equilibrium under planner commitment, all governments truthfully report their private information. Households and firms then observe the state $\theta_t$ and can condition contracts among themselves on this information. There is no moral hazard in private transactions, so that there is no reason that households cannot share consumption risk contingent on histories $\theta^t$. I assume that private agents can trade on complete state contingent markets even though national governments cannot.
This approach starts by adding national public goods expenditure to the household utility function with stochastic marginal utility of public goods. By choosing a utility function that is additively separable in public goods, household optimization with respect to commodity and leisure consumption will not be affected directly by the government’s choices of public spending. Fiscal policies only affect households through taxes and the global resource constraint. This modification would be superfluous without private information as it does not affect in any way the analysis with and without contingent public debt in that case.

This model follows the approach to Ramsey taxation with private information developed by Sleet (2004) for the closed economy. Much of the analytics from Sleet (2004) and Sleet and Yeltekin (2006) apply to the global economy model with independent public sector budget constraints. Again, the planner’s optimization problem uses linear sums of the separate objectives and constraints for individual countries so that their proofs of existence and sufficient conditions for optimality of a solution to necessary conditions apply implicitly. Each household utility function is given by

$$W(c^i_t, n^i_t, g^i_t; \theta^i_t) = u(c^i_t, 1 - n^i_t) + \theta^i_t \frac{(g^i_t)^{1-\eta}}{1-\eta}$$

where the \(\{g^i_t\}\) for all \(N\) countries is taken as given by every household in the competitive equilibrium. The planner for the union will maximize the sum of these welfare functions over the \(N\) countries under the assumption that it has private information about the taste shocks \(\theta^i_t\), for each government. That problem seeks the constrained optimal fiscal policy that characterizes a cooperative equilibrium rather than a noncooperative equilibrium for a game played among national governments. The distribution of \(\theta_t\) can depend on \(\theta^{t-1}\) or be restricted for simplicity. For example, \(\theta^i_t\) can be independently and identically distributed over time for country \(i\) although each government faces its own distribution.

Thomas and Worrall (1990) model risk sharing with private information about the endowment of a risk-averse household trading with a risk neutral insurer. Risk sharing must be incentive compatible in equilibrium. Incentive compatibility constrains the degree of risk sharing that can be achieved so that the household faces residual risk in equilibrium. In essence, the financial wealth of the risk averse household declines stochastically and household debt converges to the natural debt limit as marginal utility diverges to infinity. The Thomas and Worrall economy is extended to general equilibrium with a continuum of identically risk-averse households by Atkeson and Lucas (1992) to show how the distribution of wealth evolves in the private information economy. When applied to the optimal tax problem by Sleet (2004), public debt converges toward the natural debt limit. The debt issued by the government can be contingent but the government’s policies must be incentive compatible and the government reveals the actual value of
θ it observes to its creditors in equilibrium.

In applying this literature to the interdependent global economy, the assumption that households are able to trade in complete contingent markets in private securities is important. It allows adoption of the analytics to find equilibrium with planner commitment when the countries are finite in number. I also assuming additively separable utility with constant elasticity of substitution from the outset since it allows linear aggregation across households in the different countries.

Begin with the incentive compatibility constraints for each government with respect to its report of its realized marginal benefit, \( \theta^i \). Each government draws its \( \theta_t \) independently from a common identical distribution at each date to simplify exposition. Qualitative conclusions will not differ in substance if the \( \theta_t \) are assumed to be independent Markov random variables. Aggregate uncertainty is allowed since countries are not infinitesimal. The welfare objective for government \( i \) is given by

\[
V^i \left( \{ c^i_t, n^i_t, g^i_t \}, \{ \hat{\theta}_t^i \} \right) = E_{-1} \sum_{t=0}^{\infty} \beta^t W \left( c^i_t \left( \hat{\theta}_t^i \right), n^i_t \left( \hat{\theta}_t^i \right), g^i_t \left( \hat{\theta}_t^i \right) ; \theta_t^i \right),
\]

where \( \hat{\theta}_t^i \) is a report to the planner of the actual \( \theta_t^i \) observed by government \( i \). The incentive compatibility constraint for government \( i \) is

\[
V^i \left( \{ c^i_t, n^i_t, g^i_t \}, \{ \theta_t^i \} \right) \geq V^i \left( \{ c^i_t, n^i_t, g^i_t \}, \{ \hat{\theta}_t^i \} \right)
\]

for all possible reporting strategies \( \{ \hat{\theta}_t^i \} \). The implementability condition is given by

\[
E_{-1} \sum_{t=0}^{\infty} q_t \left( \left( 1 - \frac{u^i_{t, t}}{u^i_{c, t}} \right) n^i_t - g^i_t \right) = b_0^i
\]

where the arguments depend on the history \( \theta^i \) (recall, this is the vector of the national histories \( \theta_t^i \) over all \( N \) governments). The resource constraint is still given by equation (1).

A no lending constraint for the planner is imposed to rule out solutions that converge to the accumulation of public credit sufficient to eliminate the labor income tax for each member country. For the closed economy with a representative household, Sleet (2004) demonstrates convergence to a zero tax steady state if the government is allowed to accumulate credit. Sleet and Yeltekin (2006) impose a no lending constraint on the government to eliminate these equilibria which occur if initial public debt is low enough. The same no lending constraint and an implicit upper bound on debt are imposed for the global model as in the previous case with exogenous incomplete public debt markets. The no lending constraint for government \( i \) is

\[
\left( 1 - \frac{u^i_{t, t}}{u^i_{c, t}} \right) n^i_t - g^i_t + E_t \sum_{s=t+1}^{\infty} q_s \left( \left( 1 - \frac{u^i_{t, s}}{u^i_{c, s}} \right) n^i_s - g^i_s \right) \geq 0.
\]

(22)
The upper bound on public debt is given by setting a lower bound on welfare for each national government,

\[ V^i \left( \{ c^i_t, n^i_t, g^i_t \}, \{ \theta^i_t \} \right) \geq V^i, \]  

where \( V^i \) represent the lowest level of utility for its residents that the government is willing to accept. This is a limited commitment constraint for each government.

The constrained optimum is found by maximizing the planner’s objective,

\[ \sum_{i=1}^{N} \lambda_i V^i \left( \{ c^i_t, n^i_t, g^i_t \}, \{ \theta^i_t \} \right), \]

with respect to the allocation of resources, \( \{ c^i_t, n^i_t, g^i_t \} \), subject to the constraint set described by conditions (20), (21), (22) and (23) for each country and the global resource constraint (1) and the first-order conditions for household consumption of commodities (5). The problem can be written recursively in standard form using the outstanding public debt for form a state variable for each government. The planner then allocates consumptions, labor supplies and government expenditures for date \( t \) and the contingent debt, \( b^i_{t+1} (\theta^i_t, \theta^i_{t+1}) \), for date \( t + 1 \).

The vector of the value of expected government debt, \( E_{t-1} q_t b^i_t \), over all countries is the state variable. The government’s budget identity is used to rewrite the government implementability condition (21) as a series of constraints as

\[ E_{t-1} \left( q_t \left( 1 - \frac{u^i_{t,t}}{u^i_{e,t}} n^i_t - g^i_t \right) + \beta q_{t+1} b^i_{t+1} \right) = E_{t-1} q_t b^i_t. \]

The state variable is denoted \( S^i_t = E_{t-1} q_t b^i_t \).

The optimization problem for the planner is to find the

\[ \max E_{t-1} \sum_{i=1}^{N} \lambda_i \left( W \left( c^i_t (\theta^i_t), n^i_t (\theta^i_t), g^i_t (\theta^i_t) ; \theta^i_t \right) + \beta E_t V^i (S^i_{t+1}) \right) \]  

with respect to the allocation \( \left\{ c^i_t (\theta^i_t), n^i_t (\theta^i_t), g^i_t (\theta^i_t), b^i_t \left( \{ \theta^i_t \}_{j=1}^{N} \right) \right\}_{i=1}^{N} \) subject to the following constraints for each \( i = 1, ..., N \):

\[ E_{t-1} \left( q_t \left( 1 - \frac{u^i_{t,t}}{u^i_{e,t}} n^i_t - g^i_t \right) + q_{t+1} b^i_{t+1} \right) = E_{t-1} q_t b^i_t, \]  

\[ W \left( c^i_t (\theta^i_t), n^i_t (\theta^i_t), g^i_t (\theta^i_t) ; \theta^i_t \right) + \beta E_t V^i (S^i_{t+1} | \theta^i_t) \]

\[ \geq W \left( c^i_t (\theta^i_t), n^i_t (\theta^i_t), g^i_t (\theta^i_t) ; \theta^i_t \right) + \beta E_t V^i (S^i_{t+1} | \theta^i_t), \]

for each \( \hat{\theta}^i_t \) in the support of \( \theta^i_t \),

\[ q_t \left( 1 - \frac{u^i_{t,t}}{u^i_{e,t}} n^i_t - g^i_t \right) + E_t q_{t+1} b^i_{t+1} \geq 0, \]
the inequality (23) and the global resource constraint (5) and the commodity market equilibrium condition (1). The notation in the continuation value function, \( \left( S_t \mid \hat{\theta}_t \right) = E_t \left( q_{t+1} \mid \hat{\theta}_t, ..., \hat{\theta}_t, ..., \hat{\theta}_t^N \right) \) which indicates how the continuation value for government \( i \)’s is conditioned on its report of the marginal benefit of public goods given the reports of the other governments. This expression provides the continuation values for deviations from truthful reporting.

The standard result that only downward incentive compatibility constraints ever bind in equilibrium allows further simplification. In this model, a downward false signal is a report that \( \theta_i \) is higher than its true value. The necessary conditions for an optimum include the first-order conditions with respect to the expected debt for the next date given by

\[
\left[ (\lambda_i + \nu^i_{1t}) \pi (\theta_k) + (\xi^i_t (\theta_k, \theta_{k+1}) - \xi^i_t (\theta_{k-1}, \theta_k)) \right] \frac{\partial V^i_t \left( S_{t+1}^i \right)}{\partial S_{t+1}^i} + (\mu^i_t + \nu^i_{2t}) \pi (\theta_k) = 0
\]

for each state \( \theta_k \) in the support of \( \theta \) where \( \pi (\theta_k) \) is the probability of that state. The multipliers \( \mu^i_t, \nu^i_{2t} \) and \( \nu^i_{1t} \) are associated with constraints (25), (27) and (23). The multiplier \( \xi^i_t (\theta_k, \theta_{k+1}) \) is associated with the downward incentive compatibility constraint for state \( \hat{\theta}_t = \theta_k \) keeping the government from untruthfully reporting the next highest possible realization \( \hat{\theta}_t = \theta_{k+1} \). For \( \theta_K = \max \{ \theta_k \}, \xi^i_t (\theta_k, \theta_{k+1}) = 0 \) and for \( \theta_1 = \min \{ \theta_k \}, \xi^i_t (\theta_{k-1}, \theta_k) = 0 \). Summing up each of these first-order conditions for country \( i \) leads to

\[
E_t \left( \lambda_i \frac{\partial V^i_t \left( S_{t+1}^i \right)}{\partial S_{t+1}^i} \right) = -\mu^i_t,
\]

for an interior solution such that the no lending constraint or the limited commitment constraint do not bind. Combining this condition with the envelope condition, \( \lambda_i \frac{\partial V^i_t \left( S_t^i \right)}{\partial S_t^i} = -\mu^i_t \), gives the inverse Euler condition,

\[
\frac{1}{\mu^i_t} = E_t \frac{1}{\mu^i_{t+1}}, \tag{29}
\]

for each country \( i \).

The inverse Euler condition demonstrated by Thomas and Worrall (1990) for the consumption smoothing problem characterizes the dynamics of optimal policies with private information under commitment. For the Ramsey tax problem with private information, it implies that the inverse of the excess burden of taxation for each government follows a marginale (for an interior solution). The agency problem solved by the planner allows state contingent debt with constraints. Each government can issue state contingent bonds, but it is not allowed to issue such bonds to diversify all its risk in tax distortions. Each government seeks to share the risk of the idiosyncratic excess burden of its taxation, but is unable to do so. The model with non-contingent debt shares this outcome, but incentive compatibility constraints are slack in that market structure. In the constrained optimum with private information, some of this surplus is exploited.

The implementability condition is evaluated in expectation conditional on the information available
to the planner at time $t$. This information set does not include the current state, $\theta_t^i$, because it is private information revealed in the choice of taxes and debt by the government. The planner assigns a policy contingent on $\theta_t^i$ given $\theta_t^{i-1}$. Thus, the expectation operator $E_t$ denotes the expectation conditional on $\theta_t^{i-1}$. The multiplier $\psi_t^i$ equals $-\partial V^i / \partial (E_{t-1} u_t^i \theta_t^i)$ by the envelope condition in an interior solution. The martingale converges toward zero until another constraint binds. Therefore, the marginal value of government debt declines towards its lowest value. When it reaches the debt level such that the value function for the government equals $\overline{V}^i$, then the martingale includes other non-zero multipliers and $\psi_t^i$ can no longer rise.

Taking the rest of the first-order conditions for the constrained optimum yields equations that implicitly determine the tax rate, $\tau_t^i$, for each country conditional on the information revealed up to and including date $t$, $\{\theta_t^i\}_{i=1}^N$. The first-order conditions for commodity and leisure consumption in an interior solution are

$$
\lambda_i u_{c,t}^i + \mu_i u_{c,t}^i = \lambda_i u_{c,t}^i - \hat{\mu}_i \left( \frac{u_{c,t}^i}{u_{c,t}^i} - \frac{u_{c,t}^i}{u_{c,t}^i} \right) = \left( \lambda_i u_{c,t}^i - \hat{\mu}_i \right) n_i^i - \left( \lambda_i u_{c,t}^i - \hat{\mu}_i \right) n_i^i + \zeta_i u_{c,t}^i u_{c,t}^i + \zeta_i u_{c,t}^i u_{c,t}^i \frac{1}{\pi_k} \left( \zeta_i \theta_k, \theta_{k+1} \right) = \eta_t, \tag{30}
$$

and

$$
\lambda_i u_{t,t} + \mu_i u_{t,t} = \lambda_i u_{t,t} - \left( \frac{u_{t,t}^i}{u_{t,t}^i} - \frac{u_{t,t}^i}{u_{t,t}^i} \right) = \left( \lambda_i u_{t,t} - \hat{\mu}_i \right) n_i^i - \left( \lambda_i u_{t,t} - \hat{\mu}_i \right) n_i^i + \zeta_i u_{t,t}^i u_{t,t}^i + \zeta_i u_{t,t}^i u_{t,t}^i \frac{1}{\pi_k} \left( \zeta_i \theta_k, \theta_{k+1} \right) = \eta_t. \tag{31}
$$

Summing over states leads to the versions

$$
E_{t-1} \left( \lambda_i u_{c,t}^i - \hat{\mu}_i \right) n_i^i - \left( \lambda_i u_{c,t}^i - \hat{\mu}_i \right) n_i^i + \zeta_i u_{c,t}^i u_{c,t}^i + \zeta_i u_{c,t}^i u_{c,t}^i \frac{1}{\pi_k} \left( \zeta_i \theta_k, \theta_{k+1} \right) = 0, \tag{32}
$$

and

$$
E_{t-1} \left( \lambda_i u_{c,t}^i - \hat{\mu}_i \right) n_i^i - \left( \lambda_i u_{c,t}^i - \hat{\mu}_i \right) n_i^i + \zeta_i u_{c,t}^i u_{c,t}^i + \zeta_i u_{c,t}^i u_{c,t}^i \frac{1}{\pi_k} \left( \zeta_i \theta_k, \theta_{k+1} \right) = 0. \tag{33}
$$

Combining these conditions gives an implicit equation for the labor income tax in terms of shadow prices in expectation. The first-order condition with respect to the competitive equilibrium prices of tradable commodities is

$$
E_{t-1} \sum_{i=1}^N \left( \mu_i^i L_k \left( \theta_k^i \right) - \zeta_i \right) = 0.
$$

Household hold government bonds in their savings and diversify the risk of the shadow cost of outstanding public debt through state contingent trading with other households, as in the economy with only non-contingent public debt.

Using the example with additively separable utility,

$$
u \left( c_t, \ell_t \right) = \alpha^{1-\sigma} + \alpha^{\ell_t^{1-\gamma}},$$

the closed-form expression for the tax rate for each country $i$ at date $t$ is given by the same formula for the
non-contingent debt version:

\[ \tau_t^i = \frac{\mu_t^i (\phi(n_t^i) - 1) - \chi_t^i u_o^i}{\lambda_t u_o^i + \mu_t^i \phi(n_t^i)}, \]

where \( \chi_t^i \) is defined by the same function (16). The multipliers are different for the two problems since the social cost of distortionary labor income taxes is lower when governments can issue constrained state contingent debt contracts.

Because the inverse of the excess burden of taxation is a non-negative martingale, it converges to zero when the limited commitment constraint (23) never binds. It will bind if \( \nabla V_t \) is positive for each country. The additively separable utilities example illustrates how taxes rise stochastically over time since the tax rate is rising in the shadow price of the excess burden of taxation. In the optimum when each government possesses private information about its public expenditure needs, public debt, taxes and the excess burden of taxation for each country all rise stochastically. Households hold a portfolio of the public debt issued by all governments and pay taxes to their government. Every household holds a share of the global portfolio of public debt with complete markets and a common constant elasticity of substitution for tradable goods. Household financial wealth rises as public debt rises in expectation. They are heterogeneous with respect to the taxes they face as well as initial wealth which together the weights \( \lambda_t \) in the planner’s objective. Because tax distortions rise over time stochastically, so does global private financial wealth. The expectation at date 0 of the discounted household utility from any future date \( t \) forward is less than household expected utility at date 0 because the excess burden of taxation rises shrinking utility possibilities for the global economy.

The reason incentive compatibility constraints lead to these dynamics is due to risk aversion. When a government desires high public expenditures, it will seek to reduce its current debt repayment to mitigate the excess burden of raising taxes. If this debt reduction came without a future cost, then the government would over report the marginal value of public expenditures and make a lower debt payment even when the true marginal benefit of expenditure is low. This is because the marginal benefit of spending more is positive and the cost is borne by bond holders lump sum. Incentive compatibility requires that the government pay a future cost to receive a debt reduction when its expenditures are high. If expenditures are low, it receives a future benefit. These incentives to the government lead to history dependence in the terms of borrowing and tax rates. In the complete information case of Lucas and Stokey, contingent debt payments and taxes do not need to be history dependent. The excess of burden of taxation can be smoothed across states of nature because these are observed directly by bond holders. In the private information economy, the expected welfare for the government for date \( t + 1 \) needs to depend on the outcome at date \( t \). The government’s expected welfare for \( t + 1 \) spreads apart with the state for period \( t \) (for the high realization, \( \theta_{k+1} \), it falls and conversely for \( \theta_k \)). With complete information it is smoothed instead.
The reason that debt rises over time in expectation is explained by Thomas and Worrall for the repeated moral hazard model. Expected marginal utility for a risk averse privately informed insuree rises over time because the marginal cost of spreading future utilities is given by the divergence of marginal utilities. This is a costly for a risk averse agent. The divergence of marginal utilities needed to provide incentives for truthfully revealing private information rises as utility falls for concave utility. The optimum postpones the costs of this spread with discounting by allocating high consumption to the insuree in the near term in exchange for lower consumption in the long term. The inverse Euler condition for the excess burden of taxation (29) implies that the expected future shadow price of tax distortions exceeds the current shadow price, \( E_t \mu_{t+1} > \mu_t \), by Jensen’s inequality. This means that the social rate of discount is higher than \( \beta \) because of the spreading of marginal utility. The return to public savings is reduced by the imposition of incentive compatibility.

The argument that issuing debt in non-contingent nominal bonds allows unanticipated inflation to implement state contingent real debt payments can be applied to incomplete risk sharing in this model. The addition is that with private information about the government’s perceived benefits of public expenditures, incentive compatible inflationary surprises must be smaller. In a monetary model, the incentives could be provided by imposing higher costs to borrowing for the future if current inflation today is higher than expected. Inflation below expected inflation could lead to improving terms for new public debt issues.

The two approaches for reducing the state-contingency of public debt, exogenously non-contingent debt or endogenously incomplete state-contingent debt, have very different implications for the dynamics of debt and taxes. The comparison between the economy when governments can only issue non-contingent bonds and when the government’s use of state-contingent debt is constrained by its private information is shown by comparing the dynamics for the shadow price of the excess burden of taxation. When limits on public debt or credit are not binding, the two stochastic processes side by side are

\[
\psi_t = E_t \psi_{t+1} \quad \text{and} \quad \frac{1}{\mu_t} = E_t \frac{1}{\mu_{t+1}},
\]

for the economy with risk-free bonds and with endogenous state-contingent bonds under private information, respectively. Both are nonnegative martingales and thus converge to finite limits for the case of natural debt limits. The shadow price of the excess burden, hence the tax rate, declines toward zero for the risk-free bonds model with persistent randomness in government expenditures\(^7\). Because the inverse of the shadow price follows the same process in the case of government private information, the excess burden and tax rate move the opposite direction, rising toward the limit in that economy. Public indebtedness falls stochastically along with the tax rate for exogenously imposed non-contingent bond financing unless the
government faces an upper bound on its ability to accumulate public credit. With upper limits imposed on public debt and credit, the cost of the excess burden does not follow the simple martingale when constraints bind. With persistent uncertainty about government spending needs, public debt will reach these limits but cannot remain there. In contrast, public debt rises to an imposed upper bound stochastically in the endogenous risk sharing model.

The stochastic rise in public debt to an exogenous or endogenous debt limit with bond holder uncertainty about the government’s spending decisions or expenditure motives has implications for the role of unanticipated inflation with a national currency and flexible nominal prices. If debt is issued as non-contingent in nominal terms, then private information for the government reduces the volatility of inflation relative to an economy with no asymmetry of information between the creditor and the debtor. Consider a comparison of the full information model (Lucas and Stokey) and the private information model for a given stochastic process for public expenditure for a single government. With non-contingent nominal debt, inflationary surprises in the full economy will implement the complete state-contingent debt policies in real terms and smooth tax rates across expenditure states. The volatility of inflation shocks will match the volatility of government expenditures.

With private information about public expenditures, the requirement that contingent real payments to bond holders be incentive compatible for the government reduces the extent to which inflationary surprises can be used to reduce real public debt service. For a positive government spending shock, unanticipated inflation can reduce real debt part of the way towards what could be accomplished with full information. The tax rate and future debt would also rise, thus smoothing taxes forward in time rather than just across states of nature. When debt is issued in non-contingent nominal terms, the incentive compatibility constraints apply to the unanticipated inflation. In such an economy, if the government inflates away part of the present value of its debt in real terms, then it must face harsher terms for new debt issues. Without consequences, the government would inflate freely whether government expenditures are high or low. That is, it lies. A real debt reducing inflationary shock will be followed by a higher nominal interest rate for the next debt issues to provide the right incentives. The volatility of unanticipated inflation will be lower under private information if conventional nominal public debt and monetary policy implement the optimal fiscal policy. Indeed, Sleet (2004) computes an example under private information in which contingent payments are quite small in comparison to the Lucas and Stokey model. The private information approach is one way to reduce the volatility of inflation predicted by the full information state-contingent optimal tax model with nominal public debt.

The major implication is that discretionary expenditure fluctuations that cannot be monitored by bond
holders lead to stochastically growing public debt in a constrained optimal fiscal policy regime. Private government information may be related to political economy and fiscal institutions. Less transparency of public budget decision making, off-balance sheet budgeting, greater influence over expenditures by lobbies, and so forth are reasons why governments may be more informed of expenditures and unable to communicate credibly this information to bond holders ex post. Uncertainty about public expenditures can higher if a government is more vulnerable to party turnover or faces a more divisive legislature. These are circumstances that can lead to greater uncertainty about priorities for government expenditures that a government may not be able to credibly communicate. An ex post real reduction in public debt that is met by a rise in the cost of future borrowing suggests an incentive problem. Private information is a sparse way to model this. It suggests that a government with less credibility about the source of shocks to its primary deficit could have a greater rate of drift towards higher outstanding debt that eventually reaches its limit with probability one.

6. Implications for Fiscal Insurance Schemes

The integrated global economy model incorporates a welfare improving role for public debt in fiscal policy due to fluctuations in public expenditure needs and the restriction to linear factor income taxation. In the Ramsey tax model, introducing state contingent debt enhances efficiency. The common interpretation that issuing debt denominated in domestic currency units allows state contingent real debt suggests that the adoption of a common currency across countries constrains fiscal policy if debt issued in the common currency remains non-contingent. The Ramsey model with uncertain government expenditure needs depicts the welfare consequences of this change in flexible price nonmonetary economy. The potential benefits of intergovernmental fiscal insurance are portrayed in this economy by constraining governments to issue non-contingent debt. The fiscal consequences of monetary unification are depicted by eliminating state contingent debt issues.

The previous sections presented the base model with non-contingent debt and two versions of state contingent debt. The first, due to Lucas and Stokey, gives the efficient solution subject to the constraints that governments must impose linear labor income taxes and leisure is a nontraded good. The second alternative includes the added constraint that the benefits of national public expenditures are private information of national governments. In this case, moral hazard plays a role and state contingent debt payments must be incentive compatible. The asymmetric model may be more attractive than the public information version if we think that local officials are better informed of, and interested in, the political consequences of public spending than are their foreign counterparts.
The state contingent debt optimal tax models for the interdependent global economy provide a starting point for insights. State contingent debt contracts implement the equivalent of a sequence of contingent lump-sum taxes and transfers with expected present value of zero at date 0. The fiscal policy is equivalent to one in which governments issue impose linear taxes, issue non-contingent debt and enter into fair insurance contracts. The insurance arrangements are made with households, not between governments. In this interpretation, households purchase both the non-contingent bonds and the insurance contracts in equilibrium. In this interpretation, the two parts of the contract can be viewed separately because households have access to complete markets for trade among each other. Cross-border insurance occurs through international financial integration, and the nationality of the insurer of any government is indeterminate.

Contingent debt contracts insure governments individually and in the aggregate. A fiscal transfer scheme across member governments of a currency union could not address the systemic component. To do so would require the ability to impose lump-sum taxes on households contrary to the restriction to Ramsey taxation that generates the efficiency enhancing role for public debt in the model economy. For a one country closed economy, any fiscal shock induces a net insurance payment, positive or negative, between households and the government. In the nominal debt and unanticipated inflation tax interpretation of non-contingent public debt issues, these lump-sum payments are eliminated with real indexation of non-contingent debt. In this interpretation for a currency union, the common monetary policy would address the systemic portions of fiscal shocks providing the equivalent insurance transfers in real terms through inflation surprises.

The distinction between idiosyncratic and aggregate fiscal shocks is important for the comparison of contingent and non-contingent debt versions of the global economy model used here. I will focus attention on the comparison under the assumption that all fiscal risk is diversified by households in competitive equilibrium. With complete information, the comparison between equilibrium with state contingent public debt and non-contingent public debt is straightforward, and the assumption just means that the sum of national public expenditures is certain. With linear taxes, private information and expenditure benefit shocks, the restrictions required to eliminate systemic fiscal risk are not simple and appear to be history dependent, so the assumption is not transparent.

As a starting point, consider a common fiscal authority is created that issues common debt, distributes funds for public expenditures and assigns tax rates to each member nation with complete information. The implementation of a constrained optimum includes issuing common bonds with payments contingent on systemic shocks. With no aggregate fiscal shocks, non-contingent common bonds suffice, and in a
static economy, no bonds need to be issued at all. The planner assigns tax rates to each country so that the shadow price of the excess burden of taxation for each country is constant over time and across states. The optimal tax rates can be chosen so that the present value of tax revenues equals the present value of public expenditures for each country. This implements the solution given in Section 3. As pointed out, it is not a full constrained optimum unless the shadow prices for the excess burden of taxation are equal. If public expenditures are chosen to maximize household welfare within each country, then the allocation of public goods would also be inefficient under the requirement that each government meets the cost of its expenditures in expected present value at date $0$ with national tax revenues. Subsequent net resource transfers are contingent on the state $(\theta^t)$ and implement fair insurance. Although efficiency could be enhanced by raising taxes in low tax countries, lowering them in high tax countries and allocating public expenditures to equalize marginal benefits, this requires permanent net transfers across countries that are associated with political unions.

The optimum with national budgetary balance can implemented by introducing mutual fiscal insurance with each government issuing conventional single maturity non-contingent debt if there is never any aggregate fiscal uncertainty. With aggregate uncertainty, the constraint that governments issue only risk-free debt binds. Mutual fiscal insurance diversifies all the idiosyncratic risk of tax distortions. Aggregate risk is shared in the decentralized complete information global economy between governments and households by using state contingent debt contracts. With contingent debt, idiosyncratic national fiscal risk is completely smoothed through household portfolio diversification. Fiscal insurance replaces the second role of contingent contracts but not the first, systemic, role.

Moral hazard may be a problem for the implementation of the optimum using fiscal insurance with non-contingent national public debts. A mutual insurance scheme would rely on reports from national governments regarding the benefits of their expenditures or social policies and capacities to raise tax revenue. In the model economy, asymmetric information is represented by private information about the marginal benefit of public goods expenditures. This is a starting point for considering the role of moral hazard and fiscal insurance.

The optimum described for the private information economy with complete markets available to households could be implemented by fiscal insurance with non-contingent government bonds if there is no aggregate fiscal uncertainty. The combination of the insurance contract and non-contingent public debt needs to satisfy the incentive compatibility constraints. The budget identities for country $i$ in the optimum
with contingent debt is

\[(1 - \tau^i_t (\theta^i)) n^i_t (\theta^i) - g^i_t (\theta^i) + E_t \frac{q_{i+1}}{q_i} \hat{b}^i_{t+1} (\theta^{i+1}) = \hat{b}^i_t (\theta^i) .\]

The constraint that there is no systemic risk means that total public debt is not contingent. This constraint can be written as

\[\sum_{i=1}^{N} \hat{b}^i_{t+1} (\theta^i, \theta_t) = B_{t+1} (\theta^i) ,\]

which says that aggregate public debt issued for date \(t+1\) depends only on history and not on new information at date \(t+1\). The sum of primary surpluses for date \(t\) in any state can depend on current information, \(\theta_t\).

Mutual fiscal insurance is modeled as a system of transfers \(\{T^i_t (\theta^i)\}_{i=1}^{N}\) such that \(\sum_{i=1}^{N} T^i_t (\theta^i) = 0\) for all \(t\) and \(\theta^i\). Substituting these into the government’s budget identity,

\[(T^i_t (\theta^i) + (1 - \tau^i_t (\theta^i)) n^i_t (\theta^i) - g^i_t (\theta^i)) + E_t \frac{q_{i+1}}{q_i} \hat{b}^i_{t+1} (\theta^{i+1}) = T^i_t (\theta^i) + \hat{b}^i_t (\theta^i)\]

and setting non-contingent debt as \(\tilde{b}^i_t (\theta^{i-1}) = E_{t-1} (T^i_t (\theta^i) + \hat{b}^i_t (\theta^i))\), leads to the identity for non-contingent debt,

\[(1 - \tau^i_t) n^i_t - g^i_t + T^i_t = E_{t-1} (\tilde{b}^i_t (\theta^{i-1}) - E_{t-1} \frac{q_{i+1}}{q_i} \hat{b}^i_{t+1} ) .\] (32)

The expected primary surplus for government \(i\) satisfies

\[E_{t-1} ((1 - \tau^i_t) n^i_t - g^i_t) = \tilde{b}^i_t (\theta^{i-1}) - E_{t-1} \frac{q_{i+1}}{q_i} \hat{b}^i_{t+1} .\]

The planner seeks to solve the maximize the utilitarian objective in recursive form,

\[E_{t-1} \sum_{i=1}^{N} \lambda_i \left( W \left( c^i_t (\hat{\theta}^i_t), n^i_t (\hat{\theta}^i_t), g^i_t (\hat{\theta}^i_t) ; \theta^i_t \right) + \beta E_t V^i (S_{t+1}^i) \right)\]

with respect to household consumptions and labor supplies, public expenditures, government debt and transfers. The constraints include the incentive compatibility constraints,

\[W \left( c^i_t (\hat{\theta}^i_t), n^i_t (\hat{\theta}^i_t), g^i_t (\hat{\theta}^i_t) ; \theta^i_t \right) + \beta E_t V^i (S_{t+1}^i | \theta^i_t) \geq W \left( c^i_t (\hat{\theta}^i_t), n^i_t (\hat{\theta}^i_t), g^i_t (\hat{\theta}^i_t) ; \theta^i_t \right) + \beta E_t V^i (S_{t+1}^i | \hat{\theta}^i_t) ,\] (33)

for each \(\hat{\theta}^i_t\) in the support of \(\theta\), where the state variable is now \(S^i_{t+1} = E_i \frac{q_{i+1}}{q_i} \tilde{b}_{t+1}^i\). The implementability condition for each government becomes

\[E_{t-1} \left( 1 - \frac{u^i_{t+1}}{u^i_{t+1,t}} n^i_t - g^i_t + \frac{q_{i+1,t+1}}{q_i} \hat{b}^i_{t+1} \right) = \bar{b}^i_t ,\] (34)

and the no lending constraint is just the bound on public credit, \(0 \leq \hat{b}^i_{t+1} (\theta^i)\), and the limited commitment constraint will imply a upper bound for government debt in the solution. For setting up the optimization
problem, this can be set as an ad hoc limit, \( \tilde{b}_{t+1}^i (\theta^i) \leq \tilde{b}^i \). The constraint for complete markets in commodities (5) and the global resource constraint (1) do not change. The additional constraint is the self-finance constraint for the transfer scheme,

\[
\sum_{i=1}^{N} T^i (\theta^i) = 0.
\]

The first-order conditions with respect to \( S_{t+1} \) are identical in form to the private information model. When the debt limits do not bind, combining these conditions across states, \( \theta_t \), for country \( i \) leads to the inverse Euler condition in the multiplier, \( \psi^i_t \), for the constraint (34),

\[
\frac{1}{\psi^i_t} = E_t \frac{1}{\psi^i_{t+1}}.
\]

The addition of fiscal insurance replicates the debt dynamics for the private information constrained contingent debt model for risk-free debt. The shadow price of the excess burden of taxation increases stochastically and debt issued in conventional risk-free bonds rises to its limit.

Replacing incentive compatible contingent debt contracts with conventional single-maturity debt combined with fiscal insurance supports the same equilibrium for the economy if there is no aggregate fiscal uncertainty. With systemic shocks, national government debt would need to be contingent on global shocks but not on idiosyncratic shocks under a continuously balanced fiscal insurance scheme. Adding fiscal insurance with private information to the interdependent economy when governments are a priori constrained to issuing non-contingent public debt significantly changes the equilibrium dynamics of public debt. While risk-free public debt does not converge downward without insurance, adding constrained optimal insurance leads to stochastically rising debt.

Commitment for the planner is a crucial assumption. The insurance transfers are not just contingent on the vector of current shocks \( \theta_t \) if these shocks are independent and identically distributed over time. In this case, equilibrium intergovernmental transfers at time \( t \) depend on the state, \( \left( \theta_t, \left\{ \bar{b}_t^i \right\}_{i=1}^{N} \right) \). Constrained optimal transfers are conditioned on outstanding public debt. Incentive compatibility imparts the downward drift to national government assets. In a state with an adverse shock (high \( \theta^i_t \)), a government receives net resources from the rest of the union and a lower continuation value for date \( t+1 \). When a government receives a transfer, its current tax rate on labor income is lower than it would have been without insurance. Because risk must be incompletely shared under private information, the tax rate still rises permanently with high shocks and falls with low shocks. The shadow price of the excess burden rises which means outstanding government debt rises. Conditioning transfers for date \( t+1 \) on the level of debt incurred at date \( t \) keeps the government from over reporting the benefit of current public goods and saving the proceeds by reducing its debt. This double deviation is addressed by incentive compatibility in the dynamic private
Throughout, commitment on the part of national governments has been assumed. A limitation on commitment is implicit in the upper bound on debt. Each government, however, sticks to the intertemporal contract in the complete information cases with and without contingent debt and in the private information economy. This is expressed by making debt meaningful. Governments repay it up to a point.

7. Self-enforcing Debt Limits and State Contingent Repayment

The imposition of natural debt limits under which governments are able to use all of the economy’s resources to service debt and remain solvent is common across models of public debt with optimal taxation. The prospect of default will lead to tighter debt limits as represented by ad hoc versions. Equilibrium debt limits can be generated by models of willingness to pay in the theoretical literature on sovereign debt and limited commitment in the literature on repeated agency and macroeconomics. In such models, governments can always opt to exit the debt market repudiating outstanding debt and running a balanced budget thereafter. In the optimal tax literature, Sleet and Yeltekin (2006) take this approach by imposing a limited commitment constraint for the government. In the stochastic economy, the gains to smoothing the excess burden of taxation by maintaining access to debt markets relative to maintaining a balanced budget at all times provides the incentives to repay. With contingent debt contracts, the repayments can be set so that the government realizes the same value continuing in the contractual relationship or reverting to financial autarchy when the lower bound on its value is reached. In the private information model, continuing in the relationship is incentive compatible.

The characterization of the contingent contract when a government is just indifferent between defaulting and continuing in the financial relationship with its creditors is helpful for understanding how fiscal insurance works. It is also informative about renegotiation of non-contingent debt and the usefulness of imposing debt limits in a currency union.

The lower bound for the value function for each government is found by solving for optimal tax rates and expenditures when the government must run a balanced budget for all states. Leaving out the first-order condition for optimal balanced-budget expenditures, the minimum welfare for government \( i \) is calculated using the balanced budget constraint,

\[
g^i_s = \left(1 - \frac{\nu^i_{\ell,s}}{\nu^i_{c,s}}\right) n^i_s
\]
and the budget constraint for residents under complete markets

\[ q_i a^i_t \geq E_t^{\infty} \sum_{s=t}^{\infty} q_s \left( c^i_s - \left( 1 - \frac{u^i_{t,s}}{u^i_{r,s}} \right) r^i_s \right) \]

to compute

\[ V^i_t = E_t^{\infty} \sum_{s=t}^{\infty} \beta^{s-t} \left( u (c^i_s, 1 - n^i_s) + \theta_s \frac{(g^i_s)^{1-\eta}}{1-\eta} \right). \]

The notation, \( \tilde{a}^i_t \), indicates domestic household financial wealth net of holdings of domestic government debt. This is a function (not a simple difference) of \( \tilde{a}^i_t \) and \( b^i_t \) because domestic households do not hold all of the domestic government debt in equilibrium. With complete markets in tradable goods between households, holdings of public debt are diversified. The change in domestic financial wealth when government \( i \) repudiates its debt is just the proportionate share of that debt in the home portfolio, \( \delta b^i_t \).

The lower bound on social welfare for the government of country \( i \) is given by the value function for the representative household with financial wealth \( \tilde{a}^i_t \) facing the equilibrium tax rate for a continuously balanced government budget. The function is denoted \( V^i (\tilde{a}^i_t, g^i_t) \), which assumes government expenditures are Markov. An increase in government expenditure reduces autarchy household welfare but can raise government welfare if it depends positively on public expenditure as in the model of the private information economy. Assume this is not increasing in government expenditure.

Consider how creditors and the government behave under complete information with non-contingent debt. The optimized value for the government if it continues to honor its debt is a function of domestic household financial wealth and current government expenses, \( b^i_{t-1} + g^i_t \), denoted \( V^i (a^i_t, b^i_{t-1} + g^i_t - p_t b^i_t) \).

It is increasing in household financial wealth, \( a^i_t \), and decreasing in the tax revenues required under the contract, \( b^i_{t-1} + g^i_t - p_t b^i_t \). When the value of this function equals the autarchy welfare of the government, then a reduction in debt repayments will be needed to avoid debt repudiation. The limited commitment constraint is

\[ V^i (a^i_t, b^i_{t-1} + g^i_t - p_t b^i_t) \geq V^i (a^i_t - \delta b^i_{t-1}, g^i_t) \, . \]

For given household financial wealth, setting the inequality to an equality solves for the maximum level of debt, \( \hat{b}^i_t \), that the government will repay in full for all realization of \( g^i_t \). When an ad hoc debt limit is imposed that is motivated by this condition, then the maximum level of debt is given by \( \hat{b}^i_t (1 - p_t) = g (\hat{\theta}^i) \) where \( \hat{\theta}^i \) is the highest marginal benefit of public goods in the support of \( \theta^i_t \). This is consistent with a creditor strategy in which they never lend to the government again if it pays anything less than the non-contingent repayment contracted.

Creditors can realize positive marginal gains by lending more with state contingent repayments. With state contingent debt, creditors will lend more than \( \hat{b}^i_t \). In low expenditure states, the government repays
more than in high states. When $\theta^i_t = \bar{\theta}^i$, the value of the outstanding will be $\hat{b}^i_t$. Another level debt, $\tilde{b}^i_t$, can be defined as the level that the government repays in state $\theta^i$, the lower bound of the support for $\theta^i$.

With incentive compatible contingent debt in the private information economy, a government will never realize lower welfare than $V^i_t$ and the state variable, $E_t q_{t+1} b^i_{t+1}$, will remain constant unless the value for $t+1$, $V^i_{t+1}$ rises above $\bar{V}$. The intuition from renegotiating non-contingent debt is that there is a state, $\bar{\theta}^i$, in the interior of the support for $\theta^i$ such that for $\theta^i_t$ satisfying $\bar{\theta}^i \geq \theta^i_t \geq \tilde{\theta}^i$, the value of outstanding debt replicates. The state variable for the government remains constant. For lower states, the value of debt for $t+1$ must decrease so that the government’s objective rises. The optimal policy must specify repayments vary with $\theta^i_t$ over the entire support, but the continuation values only vary with $\theta^i_t$ in the interval $[\tilde{\theta}^i, \bar{\theta}^i]$ of the support. The continuation values are independent of the current shock in the interval $[\tilde{\theta}^i, \bar{\theta}^i]$ of the support. This conclusion follows from the limited commitment constraint and holds when $\theta^i_t$ follows a Markov chain.

When the limited commitment constraint is attained in the fiscal insurance scheme, the government pays just the interest on its debt for realizations of $\theta^i_t \geq \bar{\theta}^i$. It receives a positive transfer to help it do so without preferring to default. When $\theta^i_t \leq \tilde{\theta}^i$, the government amortizes part of its outstanding risk-free debt. It may receive transfers to help out, and in equilibrium, it may or may not receive transfers for all $\theta^i_t$ depending on the stochastic process for $\theta^i_t$. In the optimum, the fiscal insurance scheme must provide resources for debt servicing for highly indebted governments with adverse fiscal shocks.

8. Conclusion

The approach taken to optimal taxation in a multiple country global economy emphasizes the role of public debt and tax smoothing for allocative efficiency. These models provide a benchmark case in which the economy is in competitive equilibrium for examining the consequences for fiscal policies of a currency union that leads to changes in the structure of public debt instruments. The costs of separate fiscal policies and requiring national governments to maintain solvency are simply present value costs when each government can issue state-contingent debt on complete asset markets under complete information. Only different levels of distortionary taxation due to variations in initial public debts or the stream of public expenditures across countries produce an efficiency case for fiscal unification under these conditions. With exogenous or endogenous restrictions on the access of fiscal authorities to risk markets, the excess burden of taxation cannot be fully smoothed across states of nature, and fluctuations can only be partly smoothed by using government debt. Under such constraints, fiscal unification provides additional benefits by allowing greater sharing of costs of stochastic excess burdens of taxation across governments.
The stochastic growth of public debt over time when governments have private information about their benefits of public expenditures suggests that differences in the environment of fiscal policy making within countries might help explain why some countries accumulate high debt and others do not. In this model, these differences arise just from risk sharing motives. A role of fiscal insurance with endogenous markets may exist for replicating the sharing of risk between governments and their creditors that may have been provided by unanticipated inflation with separate currencies. When governments issue non-contingent bonds, a mutual fiscal insurance scheme can improve efficiency in the presence of idiosyncratic national fiscal shocks. The idiosyncratic components can be pooled, but any systemic risk requires state contingent debt instruments. The systemic component of fiscal risk would be a union-wide fiscal responsibility, perhaps met through more expansive fiscal unification or a common monetary policy with nominal debt.

An interesting feature of the welfare-improving fiscal insurance scheme is that intergovernmental transfers are conditioned on both current requests (that is, the private information reported) and outstanding public debt. The conditionality on outstanding public debt arises from incentive compatibility of the scheme under commitment of the members of the union to the scheme. Commitment also arises in the issue of debt by the national governments but is limited by the prospect of sovereign default. When a government reaches the endogenous debt limit in equilibrium with risk-free bonds and constrained optimal fiscal insurance, it receives transfers that make up the shortfall in debt servicing. In equilibrium under commitment of the union to the fiscal scheme, this is sustainable. Without a fiscal scheme and lacking commitment, it foreshadows time inconsistent bailouts if defaults create social costs across borders. The absence of commitment will impair fiscal insurance schemes and imperfect commitment with external effects may interesting to consider in this context.
References


Endnotes


3 Benigno and Woodford (2005), Lustig, Sleet and Yeltekin (2008) and Benigno and De Paoli (2010) also analyze optimal taxation with noncontingent nominal public debt in the presence of sticky prices.

4 This follows when each government is restricted to borrowing and cannot accumulate public credit by lending to households up to household solvency.

5 Barro (1999 and 2003) also explains the role of nominal debt for achieving state contingencies with tax-smoothing. Calvo and Guidotti (1992) analyze the maturity structure of nominal debt in a tax-smoothing model.

6 Sleet and Yeltekin (2006) provide a proof for the representative agent model.

7 This statement holds if there is not a upper limit on public credit other than the natural debt limit for households.

8 The articulation of willingness to pay in sovereign borrowing is due to Eaton and Gersovitz (1981). The use of self-enforcement using commitment constraints in the same context is due to Kletzer and Wright (2000), and the literature on limited commitment in macroeconomics follows Kocherlakota (1996).

9 A similar formulation of the limited commitment constraint for the government is used by Sleet and Yeltekin (2006).