Market Asymmetries as a Burden on Fiscal Policy*

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Abstract

Optimal fiscal policy in an open economy crucially depends on the market structure faced by both private agents and the government. I show that if the private sector has access to complete markets (or some source of partial risk sharing) but the government does not, households may be worse than if they did not have access to such a sophisticated financial structure. This is an application of the theorem of second best: removing one distortion can actually increase the burden of other distortions. In this case, allowing households to better hedge the risk makes the optimal allocation, given the original tax rate path, inconsistent with the government budget constraint. For this reason, the government is forced to choose an alternative tax schedule, with possibly significant welfare losses.

JEL classification: H21; E44; E62.

Keywords: fiscal policy; open economy; risk-insurance; optimal taxation.

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†The views expressed herein are those of the author and not necessarily coincident with those of the Portuguese Treasury and Government Debt Agency.

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1. INTRODUCTION

This paper discusses principles of optimal taxation in an open economy, when there are asymmetries in the structure of financial financial. The particular asymmetry considered is one in which private agents are better able to insure against aggregate risks than the government. I ask how such an asymmetry affects the conduct of optimal fiscal policy, and analyze its welfare implications.

Contrary to the common intuition, there are reasonable settings where having access to complete markets reduces welfare.

The result is an application of the general theory of second best, so elegantly laid down by Lipsey and Lancaster (1956-57): “(...) it is not true that a situation in which more, but not all, of the optimum conditions are fulfilled is necessarily, or is even likely to be, superior to a situation in which fewer are fulfilled. It follows, therefore, that in a situation in which there exist many constraints which prevent the fulfillment of the Paretian optimum conditions, the removal of any one constraint may affect welfare or efficiency either by raising it, by lowering it, or by leaving it unchanged.”.

This is precisely what happens in the (optimal) taxation problem laid down in this paper. Say we start from a case where both households and the government are trading under incomplete markets. If we now allow the private sector to have access to more risk insurance, say by trading state-contingent claims with some outside agent, we are removing one of the distortions of the economy. However, this may actually increase the burden of other distortions, namely the fact that government has no access to a similar insurance (neither through complete markets, nor through lump-sum taxes). I show examples in which this may then reduce welfare, but also examples in which welfare increases.

The intuition for a negative result may also be understood from the nature of the Stackelberg game played in a Ramsey problem as the one discussed here. In these settings, the government (player to move first) chooses the policy that maximizes welfare, subject to its own budget constraint and given the best response of private agents (player to move in the second place). Enlarging the set of strategies available to the second player alters the best response of this player. The intersection of the new set of best responses with the allocations that satisfy the government budget constraint may then be smaller or contain allocations that achieve a lower welfare.¹

The model is an open economy version of the Lucas and Stokey (1983) optimal

¹I am especially grateful to Nuno Alvim for helping me understand this intuition.
taxation problem, updated with the Aiyagari, Marcet, Sargent and Seppala (2002) incomplete markets assumption. The crucial assumption in this literature is the presence of labour income taxes that distort the intratemporal marginal rate of substitution between consumption and leisure. However, the results are significantly different depending on the available market structure. Under complete markets, as in Lucas and Stokey, the government is able to smooth out any shock to the economy and hence the optimal allocation (consumption, labour, tax rate) follows the statistical properties of any given shock (e.g. all variables have the same persistence of the underlying shocks).

Under incomplete markets, on the contrary, the optimal allocation shows a larger degree of persistence when compared with the underlying shock (e.g. even a temporary i.i.d. shock has very persistent effects). This is closer in spirit to Barro’s (1979) result of tax smoothing over time. Moreover, the empirical evidence suggests that the complete markets assumption is not a good description of reality, giving more support to the incomplete markets assumption.\(^2\)

In the baseline framework I consider an economy where asset prices are determined by a risk-neutral outside agent. Thus, agents choices do not influence asset prices, as is usual in a small open economy setting. I compare a situation in which all agents are constrained to some form of market incompleteness, with another where some agents, but crucially not the government, have access to complete markets.

The model is very closely related with a few recent contributions to discuss optimal taxation in a small open economy. Cortés-Espada (2007) discusses the main features of optimal taxation under the two extreme cases of complete markets and risk-free asset, with no asymmetry between private agents and government asset market structures, and finds similar results to Aiyagari et al. (2002). In Cardoso-Costa (2009) I consider the other type of market asymmetry, in order to understand how the government should manage the public debt portfolio to get more fiscal insurance. Numerical results suggest that the symmetric complete markets case can be approximated just allowing the government to trade state-contingent debt.

Angyridis (2005, 2007) work is even more closely related, as he discusses the same asymmetric case as the one considered here – households with access to complete markets and the government limited to trade only a risk-free bond. He shows that the market incompleteness of the government side is enough to obtain the main findings of Aiyagari et al. (2002), but does not compare this setting with a symmetric incomplete markets framework.

\(^2\)See, in particular, Marcet and Scott (2009), Scott (2007), and Faraglia, Marcet and Scott (2008a).
In an extension, I show that a similar result can appear in a general equilibrium two-country model. In this literature it is often assumed that households of both countries trade state-contingent assets, while the government is restricted to trade a risk-free bond. This is precisely the setting we are interested in. I set an example where country risks are idiosyncratic (i.e. risks in both countries are perfectly negatively correlated). In such circumstances, while it is impossible to obtain perfect insurance to a negative government expenditure shock (as was the case in the small open economy setting), the trade of a state-contingent asset allows the other country to provide some risk-insurance. I show that even then the access to this risk-sharing technology may impose a burden to fiscal policy.

The chapter is also related with a large literature on segmented markets. The crucial difference is that none of these papers discusses the case of a government with limited access to financial markets. As discussed above, Marcet and Scott (2009) and Faraglia, Marcet and Scott (2008) show compelling evidence in favour of the incomplete markets paradigm. Also, Heathcote and Perri (2002) find support for an autarky economy to explain international terms of trade. In any case, this evidence suggests that the government should not have access to complete markets in the small open economy case.

On the private sector side, there is some evidence against the life-cycle/permanent-income hypothesis, which also favours the incomplete markets assumption. This is the main argument for the introduction of market segmentation in the above cited body of work, but there is no suggestion that all agents face severe financial constraints. Moreover, the financial globalization of the past decades has surely made financial markets more available to a larger fraction of the world population. All in all, there seems to exist significant heterogeneity in the type of financial institutions across agents, so I also allow for the segmentation to occur across private agents, and show that welfare can be reduced even when a minority of agents have access to complete markets.

Furthermore, in an open economy a large proportion of the financial trading takes place with foreign agents and takes the form of many different kinds of financial applications. The government, however, is usually more conservative, issuing plain-vanilla government bonds. While more empirical evidence on the relative degree of insurance

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3See for example Adão, Correia and Teles (2009), Galf and Monacelli (2008), or Ferrero (2009).
obtained by private agents and the government would be welcome, it seems plausible to assume that at least some private agents are better able to insure against risks than the government. This is precisely the approach taken here.

The paper is organized as follows. In section 2 I set up a simplified version of the small open economy model, where the market asymmetry is very extreme: agents either trade a full array of state-contingent claims, or do not trade at all. I then show numerical examples where welfare decreases as we increase the fraction of traders in the economy, if the government is one of the non-traders. In section 3 I generalize this model to a case where market segmentation is not so abrupt: again some agents have access to complete markets, but the others now trade a risk-free bond. In section 4 I extend the idea to a two-country model, and study under which circumstances can the same negative result occur. Section 5 concludes and discusses the relevance of the results.

2. A "DETERMINISTIC" SMALL OPEN ECONOMY

I consider an infinite-horizon economy, where the interest rate is exogenous and constant (equal to the inverse of the discount factor).

The economy is subject to two types of exogenous shocks, government expenditures $g_t$ and productivity $z_t$, and hence is stochastic. However, I assume that agents either have access to complete markets, and hence solve for their optimal allocation as if they knew what nature would give them in the future; or they do not have access to financial markets at all, and thus behave "hand-to-mouth". The optimal allocation then only depends on the current realization of the shocks, so the competitive equilibrium of this economy has a static solution, and in this sense the economy is deterministic.

Households  Agents maximize their expected lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_i^t, l_i^t), \quad i = N, T.$$  \hspace{1cm} (1)

where $u(c, l)$ is the period utility function, which is increasing in consumption $c$, decreasing in labour $l$, continuous, strictly concave, and satisfies the Inada conditions.

There are two types of agents:

1. Non-traders ($N$) – agents who do not participate in the financial markets, and
hence simply consume their current after tax income

\[ c^N_t = (1 - \tau_t)z_t l^N_t, \quad \forall t, g_t, z_t. \] (2)

where \( \tau_t \) is a state-contingent labour income tax rate common to both agents.

This simple budget constraint together with the f.o.c. of the maximization problem

\[ (1 - \tau_t)z_t = -\frac{u^N_t}{u^N_{c,t}}, \quad \forall t, g_t, z_t, \] (3)

defines the optimal allocation of this agent as a function of the tax rate and the realization of the productivity shock.

2. Traders (T) – agents that have access to a full-array of state-contingent bonds. Assuming the usual transversality condition, the sequence of period by period budget constraints for this agent can then be condensed in the following present value formulation

\[ E_0 \sum_{t=0}^{\infty} \beta^t [c^T_t - (1 - \tau_t)z_t l^T_t] = a_{-1}, \] (4)

where I assume that traders have no initial wealth \( (a_{-1} = 0) \), in order to make them comparable with non-traders.

Apart from this present value budget constraint and the usual intratemporal f.o.c.

\[ (1 - \tau_t)z_t = -\frac{u^T_t}{u^T_{c,t}}, \quad \forall t, g_t, z_t, \] (5)

the optimal allocation of the trader is also defined by an intertemporal Euler equation, which in the complete markets case equates the marginal utility of consumption in all periods and states

\[ u^T_{c,t} = u^T_{c,t+1} = K, \quad \forall t, g_t, z_t. \] (6)

In all these conditions it is implicit the assumption of a linear production function in labour, which justifies the fact that the real wage equals the productivity level of each agent.

**Government** Analogously to the non-traders, the government does not participate in financial markets and balances the budget every period. Thus, it simply collects labour income taxes to pay for an exogenous and stochastic stream of government...
expenditures $g_t$

$$g_t = \tau_t \left[ (1 - \phi) z_t I_t^N + \phi z_t I_t^T \right], \quad \forall t, g_t, z_t,$$

(7)

where $\phi$ is the fraction of traders in the economy.

With $\phi = 0$, we have an autarkic economy in which both the households and the government behave in a "hand-to-mouth" way. When $\phi = 1$, on the contrary, we have households trading under complete markets, but not the government. I will now look at the competitive equilibrium of these 2 extreme cases and highlight that the competitive allocations of these two cases do not coincide in general. In the following sub-section I solve a few numerical examples to show that the competitive allocation achieved under the autarkic case can dominate the one that is achieved as households move closer to the complete markets case.

**Competitive equilibrium**

**Definition 1** Given $a_{-1}$ and exogenous sequences $\{z_t, g_t\}$, a competitive equilibrium $E = (X, G)$ is an allocation $X = \{c_t^N, l_t^N, c_t^T, l_t^T\}$ and a government policy $G = \{\tau_t\}$, such that: (i) given $G$, $X$ solves the households’ maximization problems; and (ii) the sequence of government budget constraints (7) is satisfied.

A competitive equilibrium of this economy is completely defined by equations (2) to (7) and, in general, these equations uniquely pin down the equilibrium.

**The two extreme cases** Moving from the $\phi = 0$ to the $\phi = 1$ case is like moving from autarky to a financially integrated small open economy, with the crucial difference from standard analysis that, in the second case, only some agents have access to these financial markets, namely the private sector, but not the government.

In the autarkic case ($\phi = 0$), the competitive equilibrium is simply defined by (2), (3) and $g_t = \tau_t z_t I_t^N$. In the complete markets case the competitive equilibrium is defined by (4) to (6), and $g_t = \tau_t z_t I_t^T$.

A comparison of these two sets of conditions tells us that, contrary to other common settings, if the government is a non-trader, the allocation obtained in the autarkic case is not attainable in the complete markets case. The government budget constraint is common to both cases, and clearly, an allocation that satisfies (2) and (3), also satisfies (4) and (5), however it may not satisfy (6).

As usual, the competitive allocation of the complete markets case will also not be attainable in the autarkic case (with separable utility, for instance, consumption is constant in the complete markets case, which is clearly not possible in autarky).
Hence, we need to resort to numerical examples in order to have an idea of which setting obtains higher welfare.

### 2.1. Numerical examples with CRRA preferences

I use CRRA preferences for the baseline numerical exercise

\[ u(c, l) = \frac{c^{1-\gamma_1} - 1}{1 - \gamma_1} + \nu \frac{(100 - l)^{1-\gamma_2} - 1}{1 - \gamma_2}. \]

I solve the model for different values of the coefficients of relative risk aversion and in each case parametrize \( \eta \), so that the representative agent is working roughly \( \frac{1}{3} \) of the time.

The time period of the model is 1 year and I assume a constant real interest rate of 2.5\%, so we set \( \beta^{-1} = 1.025 \).

Productivity is normalized to 1, and government expenditures are taken to be 20\% of output in the steady state (\( \bar{g} = 0.2 \bar{y} \)).

The two stochastic variables are generally defined by standard AR(1) processes:

\[
\begin{align*}
g_t &= (1 - \rho_g) \bar{g} + \rho_g g_{t-1} + u_{g,t}, \quad (8) \\
z_t &= (1 - \rho_z) \bar{z} + \rho_z z_{t-1} + u_{z,t}, \quad (9)
\end{align*}
\]

where \( u_{i,t} \) are normally distributed shocks with mean 0 and standard deviations \( \sigma_g = 0.03 \bar{g} \) and \( \sigma_z = 0.02 \). I compare results for two values of \( \rho_i \): \( \rho_i = 0 \) and \( \rho_i = 0.75 \).

The algorithm used to solve the system of non-linear equations that describe the equilibrium is described in Appendix A.

**Impulse responses and summary statistics** As pointed out before, in this economy the optimal allocation is only a function of the current state of the economy and thus inherits the statistical properties of the underlying shocks. In figures 2 and 3 in Appendix B, I plot impulse responses of the tax rate, consumption and labour supply to a government expenditure and a negative productivity shock. In both cases shocks are i.i.d. I include in the figures responses only in the two extreme cases (\( \phi = 0 \) and \( \phi = 1 \)), and assume log preferences (\( \sigma_1 = \sigma_2 = 1; \eta = 2 \)). As one can see, the response of all variables lasts only 1 period.

The interesting thing to notice, however, is that while the non-traders (\( \phi = 0 \)) have

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\(^5\)These values are similar to those estimated in Cardoso-Costa (2009) for an average euro area country.
Table 1. Welfare gains with i.i.d. government expenditure shocks: “deterministic” economy

<table>
<thead>
<tr>
<th>$f_i$</th>
<th>Non-traders</th>
<th>Traders</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000%</td>
<td>-</td>
<td>0.000%</td>
</tr>
<tr>
<td>0.25</td>
<td>-0.005%</td>
<td>0.005%</td>
<td>-0.003%</td>
</tr>
<tr>
<td>0.5</td>
<td>-0.014%</td>
<td>-0.001%</td>
<td>-0.007%</td>
</tr>
<tr>
<td>0.75</td>
<td>-0.031%</td>
<td>-0.011%</td>
<td>-0.016%</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>-0.036%</td>
<td>-0.036%</td>
</tr>
</tbody>
</table>

Legend: consumption equivalent gain from the autarkic ($\phi = 0$) case, when the economy faces i.i.d. government expenditure shocks and agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$).

to adjust their consumption to the shock, the traders ($\phi = 1$) perfectly smooth out consumption.\(^6\) This, however, imposes a burden on fiscal policy; because then, in order to finance their public outlays, the government is forced to change the tax rate more.

This idea is reinforced by looking at some summary statistics.\(^7\) Here we see that the average tax distortion increases as the fraction of traders increases. This translates in lower average output and consumption. Moreover, the variability of the tax distortion also raises with the number of traders, who face high variability of labour supply. As we will see, this has a negative impact on welfare that more than offsets the benefits of consumption smoothing.

**Welfare analysis** As suggested, welfare may be reduced when the economy is populated with more traders. Tables 1 and 2 suggest this welfare loss may be non-negligible.

Looking first at the 2 extreme cases, we see that if all agents are traders welfare relative to the autarkic case decreases between 0.036% and 0.072% in consumption equivalent terms. This is comparable with the numbers obtained by Aiyagari et al. (2002) when comparing complete and incomplete market economies.

One does not need to move between the two extreme cases, however, to find welfare losses. Under government expenditure shocks, if 25% of the population becomes a trader, this already imposes a welfare loss of 0.005% to the remaining 75% of non-traders. The new traders in the economy benefit from the better risk-sharing technol-

\(^6\)This is a direct reflection of equation (6) and having a utility function additive in consumption and labour supply.

\(^7\)See tables 6 and 7 in Appendix B.
Table 2. Welfare gains with i.i.d. productivity shocks: “deterministic” economy

<table>
<thead>
<tr>
<th>$fi$</th>
<th>Non-traders</th>
<th>Traders</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>-</td>
<td>0.000%</td>
</tr>
<tr>
<td>0.25</td>
<td>-0.023%</td>
<td>0.085%</td>
<td>0.004%</td>
</tr>
<tr>
<td>0.5</td>
<td>-0.080%</td>
<td>0.071%</td>
<td>-0.004%</td>
</tr>
<tr>
<td>0.75</td>
<td>-0.207%</td>
<td>0.016%</td>
<td>-0.040%</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>-0.072%</td>
<td>-0.072%</td>
</tr>
</tbody>
</table>

Legend: consumption equivalent gain from the autarkic ($\phi = 0$) case, when the economy faces i.i.d. productivity shocks and agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$).

ogy, but on average agents are worse. If 50% of the population becomes a trader, then even new traders lose by moving from the autarkic case to this situation.

The largest portion of this burden on fiscal policy, however, lies precisely in the last few non-traders. These are significantly worse than if we had only no traders in the economy, and even if they start trading they do not benefit at all from such a move, further deepening the welfare loss from having private insurance (in the case of government expenditure shocks).

With productivity shocks welfare losses are not so large if we have only a few traders. Actually, average welfare increases if there are only 25% of traders. But again, as the fraction of traders increases the burden on fiscal policy becomes larger.

**Laffer curve** This result stems from the fact that traders are able to achieve perfect consumption smoothing, which actually limits the set of allocations that satisfy the government budget constraint.

Another way to understand this is to look at the amount of tax revenues that the government is able to get for any given tax rate, and see how this changes as we move from an autarkic economy, to an economy where agents are able to insure against aggregate risk, but the government is not.

As one may observe, in an autarkic economy this curve does not have the shape that Arthur Laffer suggested in the 70s. In fact, the government may raise the tax rate as much as it wants that agents will continue working (they don’t have a choice) and tax revenues will continue increasing.

Traders, on the contrary, alter labour supply (significantly) for any change in the tax rate. So in the complete markets economy, we have the usual Laffer curve, which
Fig. 1. Laffer curves

Legend: Laffer curves for different fractions of traders in the economy, when agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$).

peaks with a tax rate of around 30%.

In the intermediate cases, the curve has a shape similar to the complete markets case for low tax rates, but for a sufficiently large tax rate it has a linear upward slope, as traders stop working and revenues continue coming only from working non-traders.

**Sensitivity analysis**

Results are highly robust to serially correlated shocks. For example, under government expenditure shocks, the consumption equivalent welfare difference between the two extreme cases ($\phi = 0$ and $\phi = 1$) was estimated at $-0.034\%$, almost the same as with i.i.d. shocks.

On the contrary, results are sensitive to the degree of relative risk aversion. For higher values of $\gamma_1$ and $\gamma_2$, agents are more averse to fluctuations, so the optimal response of consumption and labour supply to any kind of shock is more muted. Traders still perfectly smooth consumption and reduce the volatility of labour supply. Non-traders, in order to reduce consumption volatility, need to raise labour supply slightly, in response to a positive government expenditure shock, or a negative productivity shock. As a result, the volatility of labour supply is not so different across agents and the effect on the average distortions is less pronounced.

The results shown in table 3 for alternative values of $\gamma_i$ indicate that the welfare differences are significantly lower as we raise the degree of relative risk aversion. Per-
Table 3. Welfare gains with alternative degrees of relative risk aversion: “deterministic” economy

<table>
<thead>
<tr>
<th>$\gamma$</th>
<th>1</th>
<th>2</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000%</td>
<td>0.000%</td>
<td>0.000%</td>
</tr>
<tr>
<td>0.25</td>
<td>-0.003%</td>
<td>-0.001%</td>
<td>0.000%</td>
</tr>
<tr>
<td>0.5</td>
<td>-0.007%</td>
<td>-0.002%</td>
<td>0.001%</td>
</tr>
<tr>
<td>0.75</td>
<td>-0.016%</td>
<td>-0.003%</td>
<td>0.001%</td>
</tr>
<tr>
<td>1</td>
<td>-0.036%</td>
<td>-0.004%</td>
<td>0.002%</td>
</tr>
</tbody>
</table>

Legend: consumption equivalent gain from the autarkic ($\phi = 0$) case, for the average agent, when the economy faces i.i.d. government expenditure shocks.

haps more importantly, it is shown that for sufficiently high $\gamma$, the welfare implications may be actually reversed. In fact, with $\gamma_1 = \gamma_2 = 5$ agents are better off if they are all traders, than if they were all non-traders.

This precisely indicates that, as suggested above, the welfare implications of the different market settings considered crucially depend on the particular parameterization of the utility function used, as well as on the type of preferences considered.

2.2. Other preferences

**GHH preferences** This class of preferences was introduced by Greenwood, Hercowitz and Huffman (1988) in the business cycle literature and is usually presented in the following formulation:

$$u(c, l) = \left[ \frac{c - \eta l}{1 - \sigma} \right]^{1-\sigma} - 1.$$

These preferences have the special property that the marginal rate of intratemporal substitution does not depend on consumption, and hence labour supply is independent of the intertemporal consumption-saving choice. This means that independently of having access to financial markets, or not, the labour supply choice will be the same. Thus, the tax revenues from both types of agents are equal, so that the degree of accession to financial markets does not affect the Laffer curve.

Now, given the labour supply choice, it is clear that the trader can achieve more consumption smoothing, thus increasing welfare. Hence, in this case, as the fraction of traders increases, the labour supply allocation of each type of agent is unchanged.
(and so are tax revenues), but there are more agents obtaining more consumption smoothing and hence a higher welfare.

A similar argument follows for a linear utility function in consumption. Again the intratemporal wedge will not depend on consumption, so labour supply and tax revenues will be the same across agents. The difference is that now agents would be indifferent to achieve more consumption smoothing, since they are risk neutral with respect to consumption, so welfare would be unchanged across agents.

**Linear in labour supply** This case is not so interesting for the present discussion, because the intratemporal marginal rate of substitution will only depend on consumption. Since consumption of the traders must be constant (from equation 6), in equilibrium the tax rate would need to be constant. Hence, there is a unique level of the tax rate that satisfies a competitive equilibrium, so the Laffer curve would be a vertical line.

In the case of non-traders, the adjustment to any given shock would need to be made by directly changing the labour supply. Traders could smooth these shocks over time and have a constant level of labour supply. But, for a symmetric distribution of the shocks, the non-traders are actually indifferent to this uncertainty, since they are risk neutral with respect to labour supply. So welfare is the same in all cases.

### 3. A STOCHASTIC SMALL OPEN ECONOMY

The economy is in most respects similar to that described in section 2. The difference is that now both the non-traders and the government do have access to financial markets, although not to the same level of risk insurance: they are only allowed to trade a risk-free bond.

**Households** I now relabel the two agents using the type of market structure they face:

1. Under Incomplete Markets (IM) agents need to satisfy the following period by period budget constraint

\[
c_{t}^{IM} + a_{t}^{IM} + \varphi \left( a_{t}^{IM} - \overline{a}^{IM} \right) = (1 - \tau_{t})z_{t}l_{t}^{IM} + Ra_{t-1}^{IM}, \quad \forall t, g, z, t,
\]

where \(a_{t}^{IM}\) is the amount of a risk-free bond chosen by this household at time \(t\), which costs one unit of consumption today, and pays a constant gross interest
rate of \( R \) tomorrow. These agents also have to pay a cost \( \varphi (a^t_{IM} - \bar{a}^M) \) for holding a different amount than the steady state level of these bonds, where \( \varphi(.) \) is convex. This feature is introduced to guarantee stationarity, as suggested by Neumeyer and Perri (2005).\(^8\)

Then, the f.o.c. of the households’ problem are again (3) and

\[
(1 + \varphi'(a^t_{IM} - \bar{a}^M)) u_{c,t}^{IM} = E_t [u_{c,t+1}^{IM}], \quad \forall t, g_t, z_t. \tag{11}
\]

2. Under Complete Markets (CM) households just need to satisfy a present value budget constraint

\[
E_0 \sum_{t=0}^{\infty} \beta^t [c_t^{CM} - (1 - \tau_t) z_t l_t^{CM}] = a_{-1}^{CM}. \tag{12}
\]

So, just as the traders in section 2, the f.o.c. for these agents are given by (5) and (6).

**Government** I also allow the government to trade a risk-free bond. The budget constraint is then the following

\[
g_t + R d_{t-1} + \varphi (d_t - \bar{d}) = \tau_t [(1 - \phi) z_t l_t^{IM} + \phi z_t l_t^{CM}] + d_t, \quad \forall t, g_t, z_t, \tag{13}
\]

where, analogously to the budget constraint of the household facing incomplete markets, \( d_t \) is the amount of public debt chosen by the government at time \( t \), which costs one unit of consumption today, and pays a constant gross interest rate of \( R \) tomorrow and \( \varphi (d_t - \bar{d}) \) is an adjustment cost introduced to guarantee stationarity of the model.

**Ramsey equilibrium**

**Definition 2** Given \( (a^t_{IM}, a^t_{CM}, d_{-1}) \) and exogenous sequences \( \{z_t, g_t\} \), a competitive equilibrium in this economy \( E = (X, G) \) is an allocation \( X = \{c^t_{IM}, l^t_{IM}, c^t_{CM}, l^t_{CM}, a^t_{IM}, a^t_{CM}\} \) and a government policy \( G = \{\tau_t, d_t\} \), such that: (i) given \( G \), \( X \) solves the households’ maximization problems; and (ii) the sequence of government budget constraints (13) is satisfied.

\(^8\)For a discussion of this and alternative methods of closing this class of models see Schmitt-Grohé and Uribe (2003).
A competitive equilibrium of this economy is completely described by equations (10), (3), (11), (12), (5), (6), and (13), together with the No-Ponzi-games conditions for the risk-free bonds.\(^9\)

**Definition 3** The Ramsey equilibrium is the competitive equilibrium that maximizes the following utilitarian welfare function

\[
W = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ (1 - \phi)u(c_t^{IM}, l_t^{IM}) + \phi u(c_t^{CM}, l_t^{CM}) \right\} .
\] (14)

As is usual in this type of settings, it will be useful to recast the Ramsey problem using the primal approach as in Lucas and Stokey (1983). Since the interest rates are defined exogenously, in our case we simply need to substitute the tax rate in both the households’ and the government’s budget constraint, using the households’ f.o.c. (3) or (5). I also use (6) to define \(c_t^{CM} = c(t^{CM}_t, K)\), so that we can drop this constraint and substitute \(c_t^{CM}\) by \(K\) – the constant marginal utility of consumption – in the list of control variables. Then we have a simpler problem, which is characterized only on the allocations of consumption, labour, private assets and public debt:

\[
\max_{\{c_t^{IM}, l_t^{IM}, c_t^{CM}, a_t^{IM}, a_t^{CM}, d_t\}} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ (1 - \phi)u(c_t^{IM}, l_t^{IM}) + \phi u(c(t^{CM}_t, K), l_t^{CM}) \right\}
\]

s. to

\[
c_t^{IM} + a_t^{IM} + \varphi \left( a_t^{IM} - \overline{a}^{IM} \right) = -\frac{u_{t,t}^{IM}}{u_{c,t}^{IM}} l_t^{IM} + Rd_{t-1}^{IM}, \quad \forall_{t,gr,zt}, \tag{15}
\]

\[
E_0 \sum_{t=0}^{\infty} \beta^t \left[ c(t^{CM}_t, K) + \frac{u_{t,t}^{CM}}{K} l_t^{CM} \right] = a_{-1}^{CM}, \tag{16}
\]

\[
\frac{u_{t,t}^{IM}}{u_{c,t}^{IM}} = \frac{u_{t,t}^{CM}}{K}, \quad \forall_{t,gr,zt}, \tag{17}
\]

\[
g_t + Rd_{t-1} + \varphi (d_t - \overline{d}) = (1 - \phi) \left( z_t + \frac{u_{t,t}^{IM}}{u_{c,t}^{IM}} \right) l_t^{IM} + \phi \left( z_t + \frac{u_{t,t}^{CM}}{K} \right) l_t^{CM} + d_t, \quad \forall_{t,gr,zt}, \tag{18}
\]

\[
\left( 1 + \varphi' (a_t^{IM} - \overline{a}^{IM}) \right) u_{c,t}^{IM} = E_t \left[ u_{c,t+1}^{IM} \right], \quad \forall_{t,gr,zt}, \tag{19}
\]

\(a_{-1}^{IM}, a_{-1}^{CM}, d_{-1}\) given.

\(^9\)In order to prevent this economy from entering in Ponzi schemes, we must also include the following transversality conditions:

\[
\lim_{j \to \infty} R^{-j} a_{t+j}^{IM} = 0, \quad \forall_{t,gr,zt}, \tag{20}
\]

\[
\lim_{j \to \infty} R^{-j} d_{t+j} = 0, \quad \forall_{t,gr,zt}. \tag{21}
\]
The presence of equation (19) does not allow us to define the solution as a policy function of the natural set of state variables – i.e. the exogenous shocks and the level of private assets and public liabilities from the previous period –, since it incorporates expectations about future variables.

In order to address this issue I resort to Marcet and Marimon’s (1998) recursive contracts methodology. This amounts to add the Lagrange multiplier of the last constraint to the set of state variables, and transform the original problem into a saddle point problem by appropriately re-writing the Lagrangian function:

\[
L = E_0 \sum_{t=0}^{\infty} \beta^t [(1 - \phi) \{ u(c_{t}^{IM}, t_{t}^{IM}) + \gamma_t u_{c,t}^{IM} \left( 1 + \phi' (a_t^{IM} - a_{IM}) \right) \} - \gamma_t \beta^{-1} u_{c,t}^{IM} + \\
+ \psi_t^{IM} \left[ c_t^{IM} + a_t^{IM} + \varphi (a_t^{IM} - a_{IM}) - Ra_t^{IM} + u_{IM}^{IM} \right] + \xi_t \left[ \frac{u_{IM}^{IM}}{u_{c,t}^{IM}} - \frac{u_{CM}^{CM}}{K} \right] + \\
+ \lambda_t [g_t + Rd_{t-1} + \varphi (d_t - \bar{d}) - \left( z_t + \frac{u_{IM}^{IM}}{u_{c,t}^{IM}} \right) t_{t}^{IM} - d_t ] + \\
+ \phi \{ u(c(t_t^{CM}, K), t_t^{CM}) + \xi_t \left[ \frac{u_{IM}^{CM}}{u_{c,t}^{IM}} - \frac{u_{CM}^{CM}}{K} \right] + \psi^{CM} \left[ c(t_t^{IM}, K) + \frac{u_{CM}^{CM}}{u_{IM}^{IM}} \right] + \\
+ \lambda_t [g_t + Rd_{t-1} + \varphi (d_t - \bar{d}) - \left( z_t + \frac{u_{CM}^{CM}}{K} \right) t_{t}^{CM} - d_t ] \}],
\]

with \( \gamma_{-1} = 0 \).

Here \((1 - \phi)\beta^t \psi_t^{IM}, \phi \psi_t^{CM}, \beta^t \xi_t, \beta^t \lambda_t, \) and \((1 - \phi)\beta^t \gamma_t\) are the state-contingent Lagrange multipliers associated with each of the above 5 constraints. A sufficient set of state variables comprises \((a_{t-1}, d_{t-1}, \gamma_{t-1}; g_t, z_t)\).

The Ramsey equilibrium is defined by equations (15) to (19), plus the respective first order conditions and the equations governing the stochastic processes of the shocks (8) and (9).

As is usual in this kind of setting, the optimal solution to this problem is not time consistent. I abstract from this by assuming that the government is able to commit to the policy chosen initially.

3.1. A numerical example to compare the two extreme cases

I solve for the optimal allocation in the two extreme cases \((\phi = 0 \text{ and } \phi = 1)\) for an example where we have uncertainty only in period 1. This gives us a first indication on
whether a negative result such as that obtained in section 2.1 with CRRA preferences can still show up in this more general framework.

There are only two possible states of nature with equal probability: high productivity or low productivity. Preferences and the interest rate are parameterized as in section 2.1. As is common in the optimal taxation literature, in this model the steady state level of private assets and public debt is not pinned down. Hence, I show results for 3 alternative levels of the initial public debt to GDP ratio: 0, 60%, and 120%, and assume the natural case of a balanced foreign asset position (i.e. $a_{-1} = d_{-1}$).

The figures from table 4 show that, as in section 2.1, completing the markets of the private sector leads to a welfare loss. The magnitude of the welfare difference increases substantially for higher levels of public debt.

The impulse response functions shown in figure 4 in Appendix B indicate why this may be the case. Under complete markets, the consumption path is perfectly smoothed, but in order to satisfy its budget constraint, the government now chooses a more volatile tax rate schedule, which implies a more volatile sub-optimal path for the labour supply.

### 4. A GENERAL EQUILIBRIUM TWO-COUNTRY MODEL

I now extend the simple setting of section 2 to a general equilibrium framework two-country model, where the interest rate is endogenously determined by the market equilibrium of a common bond market.

I construct the simplest possible two-country model, just to show how the result from the previous section can still emerge in a general equilibrium setting. I thus abstract from differences in sizes, monopolistic competition, home biases, or non-tradable goods, features that are usually introduced in a two-country model. I assume that labour

<table>
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<th>Households' asset structure</th>
<th>Public debt level (% GDP)</th>
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<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>IM</td>
<td>0.0%</td>
</tr>
<tr>
<td>CM</td>
<td>-0.000014%</td>
</tr>
</tbody>
</table>

Legend: consumption equivalent welfare gain relative to the symmetric incomplete markets case, with log preferences.
is immobile across countries, and also retain the barter economy formulation of the previous sections. So we should think of this setting as representative of two regions integrated in a monetary union. Since nominal exchange rate is fixed and there are no non-tradable goods, nor home biases, the real exchange rate is also constant.

**Households** Each country is identical to the economy described in section 2, comprising both traders and non-traders. The difference is that now state-contingent assets are not traded with some risk-neutral outside agent, but with traders from the other country. The period by period budget constraint of a domestic trader is given by:

\[ c_t^T + \sum_{s_{t+1}|s^t} q(s_{t+1}|s^t) a^T(s_{t+1}|s^t) = (1 - \tau_t) z_t l_t^T + a^T(s^t), \quad \forall t, g_t, z_t. \tag{20} \]

The f.o.c. of the maximization problem of this agent are (5) and

\[ q(s_{t+1}|s^t) = \beta \frac{u_{c,t+1}}{u_{c,t}}, \quad \forall t, s_{t+1}|s^t. \tag{21} \]

Without loss of generality, I assume that the initial conditions are such that the initial allocation is equal across traders of the two economies (namely, foreign asset positions are balanced). Hence, the intertemporal f.o.c. of traders in both economies (foreign variables denominated with *) implies that

\[ u_{c,t}^T = u_{c,t}^{T*}, \quad \forall t, g_t, z_t. \tag{22} \]

**Government** Governments need to satisfy a budget balance rule as (7), where again \( \phi \) is the fraction of traders in the economy.

**Market clearing** The market clearing condition in the goods market is the following

\[ (1 - \phi) \left( c_t^N + c_t^{N*} \right) + \phi \left( c_t^T + c_t^{T*} \right) + g_t + g_t^* = (1 - \phi) \left( z_t l_t^N + z_t^* l_t^{N*} \right) + \phi \left( z_t l_t^T + z_t^* l_t^{T*} \right), \tag{23} \]

and in asset markets is simply

\[ a^T(s_{t+1}|s^t) + a^{T*}(s_{t+1}|s^t) = 0, \quad \forall t, s_{t+1}|s^t. \tag{24} \]

**Competitive equilibrium**

**Definition 4** Given \((a_{-1}, a_{-1}^*)\) and exogenous sequences \(\{z_t, g_t, z_t^*, g_t^*\}\), a competitive
equilibrium \( E = (X, G, X^*, G^*, Q) \) is an allocation \( X = \{ c_t^N, l_t^N, c_t^T, l_t^T \} \), a government policy \( G = \{ \tau_t \} \), and a sequence of asset prices \( Q = \{ q(s_{t+1}|s') \} \), such that: (i) given \( Q \) and \( G \) (\( G^* \)), \( X \) (\( X^* \)) solves the households’ maximization problems, in the home (foreign) country; (ii) the sequence of government budget constraints is satisfied; and (iii) goods and asset markets clear.

The competitive equilibrium of this economy is completely defined by equations (2), (3), (20), (5), (21), (7) in both countries, together with (23) and (24). As in section 2, in general this system of equations pins down a unique competitive equilibrium.

In this section I will only concentrate in the two extreme case (\( \phi = 0 \) and \( \phi = 1 \)).

The two extreme cases The autarkic case is exactly as the one described in section 2. For each country the system of equations defining equilibrium is simply:

\[
g_t = \left( z_t + \frac{u_{l,t}}{u_{c,t}} \right) l_t, \quad \text{and} \quad c_t + g_t = z_t l_t.\]

In the other extreme case, when all households are able to trade a full set of state-contingent assets, equilibrium is described by

\[
g_t = \left( z_t + \frac{u_{l,t}}{u_{c,t}} \right) l_t, \quad \text{and} \quad c_t + c_t^* + g_t + g_t^* = z_t l_t + z_t^* l_t^*, \quad \text{and} \quad u_{c,t} = u_{c,t}^*.\]

Again, there is no general knowledge of which economy dominates, so we need to resort to some numerical examples.

4.1. Numerical examples

I use the exact same specification and parameterization of preferences as used in section 2.

The assumption on the distribution of shocks is now crucial. If the shocks are common to both economies (i.e. \( z_t = z_t^* \), and \( g_t = g_t^* \)), the two extreme cases are actually equivalent. In such circumstances there is no room for risk-sharing across countries, so even having access to complete markets, agents would behave as in an
autarkic economy.

In order to have room for some risk-sharing across countries we naturally need to allow the shocks to be asymmetric. I discuss here a simple asymmetric case, namely that shocks are idiosyncratic from the perspective of the world economy (i.e. $z_t + z_t^* = 1$, and $g_t + g_t^* = \overline{g}$). While naturally extreme, this assumption allows us to analyse the effects of asymmetric market structures in the simplest possible risk-sharing framework.

**Impulse responses and summary statistics** As pointed out before, in this economy the optimal allocation is only a function of the current state of the economy and thus inherits the statistical properties of the underlying shocks. In figures 2 and 3 in Appendix B, I plot impulse responses of the tax rate, consumption and labour supply to a government expenditure and a negative productivity shock. In both cases shocks are i.i.d. I include in the figures responses only in the two extreme cases ($\phi = 0$ and $\phi = 1$), and assume log preferences ($\sigma_1 = \sigma_2 = 1; \eta = 2$). As one can see, the response of all variables lasts only 1 period.

The interesting thing to notice, however, is that while the non-traders ($\phi = 0$) have to adjust their consumption to the shock, the traders ($\phi = 1$) perfectly smooth out consumption. This, however, imposes a burden on fiscal policy, because then, in order to finance their public outlays, the government is forced to change the tax rate more.

This idea is reinforced by looking at some summary statistics. Here we see that the average tax distortion increases as the fraction of traders increases. This translates in lower average output and consumption. Moreover, the variability of the tax distortion also raises with the number of traders, who face high variability of labour supply. As we will see, this has a negative impact on welfare that more than offsets the benefits of consumption smoothing.

In Appendix B I plot impulse responses to a government expenditure and a negative productivity shock, respectively in figures 5 and 6. The main difference with respect to the analogous figures of section 2 is that now consumption is not perfectly smoothed. Nevertheless, there is still considerable consumption smoothing, which again implies a more variable tax rate and labour supply.

The summary statistics shown in tables 8 and 9 confirm that the average tax dis-
Table 5. Welfare gains in the two-country model

<table>
<thead>
<tr>
<th>$f_l$</th>
<th>gov. exp. shocks</th>
<th>productivity shocks</th>
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</thead>
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<tr>
<td>0</td>
<td>0.000%</td>
<td>0.000%</td>
</tr>
<tr>
<td>1</td>
<td>-0.017%</td>
<td>-0.244%</td>
</tr>
</tbody>
</table>

Legend: consumption equivalent gain from the autarkic ($\phi = 0$) case when the agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$).

tortion increases with the number of traders, which reduces average output and consumption. Again, tax rates and labour supply variability is much higher in the 'traders' economy, and this may more than offset the benefits of a smoother consumption path.

Welfare analysis  The expected welfare differences across the two extreme cases are shown in table 5.

These figures show that the intuition obtained from the small open economy setting may go through in a general equilibrium two-country framework subject to idiosyncratic shocks. In particular, it is interesting to notice that the welfare loss from productivity shocks is actually significantly higher in this two-country case (0.244%), than in the small open economy (0.072%).

5. CONCLUSION

This paper shows examples of economies in which private insurance of aggregate risk imposes a significant burden on fiscal policy, making it harder for the government to satisfy its budget constraint. Thus, allowing a few agents to trade a full array of state-contingent assets may reduce welfare.

It should be clear that this analysis is not suggesting that policy makers should promote lower private risk-insurance. The results do highlight how a market asymmetry where the private sector is better able to insure against aggregate risks may limit the government’s options to finance a given level of public outlays. This mechanism should be understood, as it may be part of an explanation for some sovereign debt crises observed in the past.

Having this said, the analysis does suggest that it is quite important that governments are able to smooth out its fiscal risks as much as private agents are. If this was

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12To the extent that this prevents some decision makers to extract private rents from public resources, this could actually be welfare improving
the case, then more risk insurance would naturally improve welfare.

Faraglia, Marcet and Scott (2008) document that governments have not been able (or willing) to achieve a lot of fiscal insurance. With this respect, more empirical work on the relative performance of government vs. private sector insurance would be welcome.
Appendix A – Algorithm to solve the "deterministic" small open economy

Additive utility function In the case of a utility function separable in its arguments $c$ and $l$, equation (6) implies that traders choose a constant level of consumption equal to a fraction of their time-0 permanent income, so the optimal allocation of this agent is defined by

$$c^T = (1 - \beta) \left[ a_{-1}^T + E_0 \sum_{t=0}^{\infty} \beta^t (1 - \tau_t) z_t l_t^T \right]. \quad (25)$$

The equilibrium is then defined by equations (2), (3), (5), (7), and (25), together with the law of motion of the two exogenous shocks (8) and (9). The algorithm used to solve this system is as follows:

1. Guess a value for $c^T$.
2. Draw several simulations for the exogenous shocks.
3. Use equations (2), (3), (5), and (7) to solve for $(c^N_t, l^N_t, l^T_t, \tau_t)$ as a function of $(c^T, g_t, z_t)$.
4. Substitute in (25) and check this equality.
5. Iterate on $c^T$ and repeat steps 2. to 4. until convergence.

Non additive utility function In this case $c^T_t$ need not be constant over time, so it is useful to use equation (6) to solve for $c^T_t = c(l^T_t, K)$. Substitute this in all equations. Then use the same algorithm, only now we have to iterate in $K$ to verify equation (4), instead of (25).
Appendix B – Tables and figures

**Fig. 2.** Responses to a government expenditure shock: “deterministic” economy

Legend: impulse response function to a 1 standard deviation government expenditure shock, when agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$). Comparison of two extreme cases ($\phi = 0$ and $\phi = 1$) in the “deterministic” small open economy.

Table 6. Summary statistics with i.i.d. government expenditure shocks: “deterministic” economy

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>cons$_T$</th>
<th>lab$_T$</th>
<th>cons$_N$</th>
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<th>z</th>
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<tr>
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<td>-</td>
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<td>33.333</td>
<td>0.200</td>
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<td>1.000</td>
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<td>0.25</td>
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Panel 1: Average

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<tr>
<th>$\mu$</th>
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<th>lab$_T$</th>
<th>cons$_N$</th>
<th>lab$_N$</th>
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Panel 2: Standard deviation

Legend: summary statistics when the economy faces i.i.d. government expenditure shocks and agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$) in the “deterministic” small open economy.
Fig. 3. Responses to a negative productivity shock: “deterministic” economy

Legend: impulse response function to a 1 standard deviation negative productivity shock, when agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$). Comparison of two extreme cases ($\phi = 0$ and $\phi = 1$) in the “deterministic” small open economy.

Table 7. Summary statistics with i.i.d. productivity shocks: “deterministic” economy

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</table>

Legend: summary statistics when the economy faces i.i.d. productivity shocks and agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$) in the “deterministic” small open economy.
Fig. 4. Responses to a negative productivity shock: stochastic economy

Legend: impulse response function to a 1 standard deviation negative productivity shock, when agents have log preferences ($\gamma_1 = \gamma_2 = 1; \nu = 2$). Comparison of two extreme cases ($\phi = 0$ and $\phi = 1$) in the stochastic small open economy.
**Fig. 5.** Responses to a government expenditure shock: two-country model

Legend: impulse response function to a 1 standard deviation government expenditure shock, when agents have log preferences \( \gamma_1 = \gamma_2 = 1; \nu = 2 \). Comparison of two extreme cases \( (\phi = 0 \text{ and } \phi = 1) \) in the “deterministic” two-country economy.

**Table 8.** Summary statistics with i.i.d. government expenditure shocks: two-country model

<table>
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<tr>
<th>Panel 1: Average</th>
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<th>lab</th>
<th>tau</th>
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<td>26.650</td>
<td>33.313</td>
<td>0.200</td>
<td>33.320</td>
<td>6.667</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel 2: Standard deviation</th>
<th>( f_t )</th>
<th>cons</th>
<th>lab</th>
<th>tau</th>
<th>y</th>
<th>g</th>
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<td>0.000</td>
<td>0.006</td>
<td>0.000</td>
<td>0.199</td>
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<tr>
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<td>0.025</td>
<td>1.016</td>
<td>0.012</td>
<td>1.016</td>
<td>0.199</td>
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Legend: summary statistics when the economy faces i.i.d. government expenditure shocks and agents have log preferences \( \gamma_1 = \gamma_2 = 1; \nu = 2 \). Comparison of two extreme cases \( (\phi = 0 \text{ and } \phi = 1) \) in the “deterministic” two-country economy.
Fig. 6. Responses to a negative productivity shock: two-country model

Legend: impulse response function to a 1 standard deviation negative productivity shock, when agents have log preferences ($\gamma_1 = \gamma_2 = 1$; $\nu = 2$). Comparison of two extreme cases ($\phi = 0$ and $\phi = 1$) in the “deterministic” two-country economy.

Table 9. Summary statistics with i.i.d. productivity shocks: two-country model

<table>
<thead>
<tr>
<th>$fl$</th>
<th>cons</th>
<th>lab</th>
<th>tau</th>
<th>$y$</th>
<th>$z$</th>
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</thead>
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<td>33.336</td>
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<td>33.081</td>
<td>0.206</td>
<td>33.137</td>
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</table>

<table>
<thead>
<tr>
<th>$fl$</th>
<th>cons</th>
<th>lab</th>
<th>tau</th>
<th>$y$</th>
<th>$z$</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.004</td>
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<td>0.020</td>
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<td>4.037</td>
<td>0.032</td>
<td>4.672</td>
<td>0.020</td>
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</tbody>
</table>

Legend: summary statistics when the economy faces i.i.d. productivity shocks and agents have log preferences ($\gamma_1 = \gamma_2 = 1$; $\nu = 2$). Comparison of two extreme cases ($\phi = 0$ and $\phi = 1$) in the “deterministic” two-country economy.
REFERENCES


