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Fiscal Policy and Regional Inflation in a Currency Union*

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Abstract

This paper investigates the ability of a region participating in a currency union to affect its inflation differential with respect to the union through fiscal policy. We study the interaction between regional fiscal policy and inflation differentials in a flexible-price, two-region model with both traded and nontraded goods. For symmetric regions, changes in one region's tax rule that decrease the volatility of its inflation differential also decrease the volatility of its output. The decrease in the volatility of the inflation differential is brought about by an increase in the volatility of tax rates. The effect of the tax rule on output volatility – but not inflation volatility – depends on country size. For a small country lower volatility of inflation differentials is associated with higher volatility of output. This relationship results from the fact that small countries are more open, and hence there is a greater role for traded goods productivity shocks.

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1. Introduction

Regions participating in a currency union delegate monetary policy – the principal tool for controlling their inflation rate – to a central authority. However, a currency union typically does not involve homogeneous, perfectly integrated regions, and inflation rates therefore vary across regions. The currency union comprising the United States is homogeneous and integrated enough that no attention is paid to inflation differentials across regions; state-level consumer price index data is not even collected. The European Monetary Union is another matter. Domestic inflation rates continue to play an important role in discussions of individual countries' economic conditions. And at the EU level, Ireland was reprimanded by the European Union's finance ministers in 2001 for pursuing easy fiscal policy in the face of a high inflation rate. More recently, Pedro Solbes, the European Commissioner for Economic and Monetary Affairs, stated that for Ireland today, "the inflation question, as in Spain, has to be tackled on the national level."[1]

Should a region in a currency union wish to exert influence over its own inflation rate – or its inflation differential relative to the rest of the union – it must turn to fiscal policy. When fiscal policy is its only available instrument, several questions arise. Can the regional fiscal authority affect its inflation differential? If so, what types of policies are effective, and what consequences do they have for real economic activity?

This paper investigates the ability of a region participating in a currency union to affect its inflation differential with respect to the union through fiscal policy. We study the interaction between regional fiscal policy and inflation differentials in a flexible-price, two-region model with both traded and nontraded goods. In our framework, price (and inflation) differentials arise from both movements in the relative price of nontraded goods across countries and deviations from the law of one price for traded goods. There is an exogenous stream of government expenditures, and the regional fiscal authority has access to a labor income tax, seigniorage revenue, and debt to finance these expenditures. The model is driven by shocks to government expenditures and to productivity.

Because regional fiscal authorities can issue debt, they have some flexibility as to the pattern of distortionary taxes. We assume that the tax rate is determined by a rule that responds to the level and change in the stock of outstanding government debt.[2] We study the implications of modifications to the benchmark

[1] Irish Times, January 31, 2003, page 51.

[2] This type of rule has been commonly used in large, quantitative models (see Johnson, 2001).

tax rule that are aimed at influencing the region's inflation differential. The tax rate is distortionary, so changes in its cyclical behavior alter the behavior of real variables, including the price of the home consumption basket relative to the foreign consumption basket. Thus, regional fiscal authorities do have the ability to affect the regional inflation differential. Specifically, by lowering (raising) the distortionary tax rate in response to positive (negative) inflation differentials, a regional fiscal authority can decrease the absolute value of its inflation differential in response to the shocks driving the model.

We find that for symmetric regions, changes in one region's tax rule that decrease the volatility of its inflation differential also decrease the volatility of its output. The decrease in the volatility of the inflation differential is brought about by an increase in the volatility of tax rates. We also consider the behavior of the smaller of two regions in an asymmetric currency union. For small countries, the relationship between the tax rule and volatility of inflation differentials is similar to the symmetric case. Likewise, small countries experience essentially the same relationship between the tax rule and tax rate volatility. However, the effect of the tax rule on output volatility depends on country size. For a small country lower volatility of inflation differentials is associated with higher volatility of output. This relationship results from the fact that small countries are more open, and hence there is a greater role for traded goods productivity shocks.

Early research on currency unions, dating back to Mundell (1961), concerns the optimal composition of a currency area. In modern dynamic equilibrium models, it has been difficult to find conditions under which it is optimal for a region to delegate its monetary policy (see, for example, Monacelli, 2001). Given the existence of a currency union, Benigno (2002) studies optimal monetary policy and Bergin (2001) shows how non-constant demand elasticities can generate inflation differentials through deviations from the law of one price.

We use a general equilibrium model to study how regional fiscal policy affects regional inflation differentials.[3] [4] Beetsma and Jensen (2002) also study regional fiscal policy in a general equilibrium model of a currency union. They describe

[3] An empirical literature documents regional variation in inflation within currency unions. Cecchetti, Mark, and Sonora (2002), Parsley and Wei (1996), and Rogers (2001) study price level convergence, and Canova and Pappa (2003) study the effects of fiscal shocks on price dispersion.

[4] Bergin (2000) and Sims (1999) consider implications of the fiscal theory of the price level for a monetary union. We focus on monetary and fiscal policy regimes in which there is a unique equilibrium. Nonetheless, the particular form of a region's fiscal policy rule affects the equilibrium behavior of inflation.

the optimal coordinated monetary and fiscal policies whereas we treat policy as exogenous. In addition, the models differ in their assumptions about the instruments of fiscal policy and the role of government spending. Beetsma and Jensen allow for lump-sum taxes and assume that government spending yields utility to consumers. We assume that the government must rely on a labor income tax and debt to fund spending that is a pure resource drain. Furthermore, in Beetsma and Jensen consumer price levels are identical across countries and inflation is measured by the change in the producer price index.

The paper proceeds as follows. In section 2 we present the model. Section 3 describes the model's calibration. Section 4 is devoted to developing a basic understanding of the model; we describe the channels which lead inflation to vary across countries, and discuss the dynamic responses to productivity and government spending shocks. Section 5 contains our results for symmetric regions on the implications of using fiscal policy to affect the inflation differential, and section 6 is devoted to the small country case. Section 7 concludes.

2. Model

The currency union is composed of two regions, denoted home and foreign, that share the same currency. A central monetary authority issues the currency and conducts monetary policy. Each region has a fiscal authority, which is responsible for fiscal policy in the region.

The two regions share the same structure but may differ in size. Each region is specialized in the production of a continuum of varieties of a tradable and nontradable good. Monopolistically competitive firms produce these goods using labor, which is immobile across regions. Prices are flexible.

The regions are populated by a continuum of households of measure N (home) and N^* (foreign). Households in each region supply labor to domestic firms and consume all varieties of both home and foreign tradable goods, as well as all varieties of the region's nontradable good. We assume that, in order to consume a traded good, agents need to combine it with nontraded goods.[5] That is, a consumer must purchase η additional units of the local nontraded good in order to obtain utility from a traded good. Hence nontraded goods are used both for

[5] This assumption reflects the need to combine differentiated traded goods with distribution services (intensive in local nontraded goods) before households can consume the former. This corresponds to the setup in Corsetti and Dedola (2002), except that for the purpose of our paper, and without any loss of generality we do not need to model the distribution sector separately.

consumption and distribution purposes. Households also demand real balances, which are an argument in their utility function.

We assume that asset markets are complete. Thus, in every state of the world the ratio of marginal utilities of per capita consumption across regions is equated to the ratio of consumption price levels across regions.[6]

We describe only the home region's economy. An analogous description applies to the foreign region. The subscript f (or h) denotes a good's country of origin, whereas the superscript $*$ denotes a foreign region variable; for example, $P^*_{T,h}$ is the price of a traded good produced in the home country and consumed in the foreign country.

2.1. Households

Households derive utility from consuming a composite good (c_t), leisure time ($1 - l_t$), and from holding real money balances ($\frac{M_t}{P_t}$). Households maximize the expected discounted value of the utility flow,

$$U_0 = E_0 \left[\sum_{t=0}^{\infty} \beta^t u \left(c_t, 1 - l_t, \frac{M_t}{P_t} \right) \right] \tag{2.1}$$

where E_0 denotes the mathematical expectation conditional on information available in period $t = 0$, $\beta \in (0, 1)$ is the discount rate, and u is the momentary utility function, assumed to be concave and twice continuously differentiable.

2.1.1. The Composition of Consumption

The composite consumption good is an aggregate of traded and nontraded goods ($c_{T,t}$ and $c_{N,t}$) as follows:

$$c_t = \left[\kappa_T c_{T,t}^{\frac{\xi-1}{\xi}} + \kappa_N c_{N,t}^{\frac{\xi-1}{\xi}} \right]^{\frac{\xi}{\xi-1}}. \tag{2.2}$$

The elasticity of substitution between the traded and nontraded good is ξ, and κ_T and κ_N determine the agent's bias towards the traded good. Consumption of traded goods is a similar aggregate of home- and foreign- produced traded goods ($c_{T,h,t}$ and $c_{T,f,t}$):

$$c_{T,t} = \left[\kappa_{T,h} c_{T,h,t}^{\frac{\gamma-1}{\gamma}} + \kappa_{T,f} c_{T,f,t}^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}, \tag{2.3}$$

[6] See, for example, Chari, Kehoe, and McGrattan (2002).

where $\gamma > 0$ denotes the elasticity of substitution between the home and foreign composite traded goods, and the weights $\kappa_{T,h}$ and $\kappa_{T,f}$ determine the agent's bias for the domestic traded good.

Each country produces a continuum of varieties of the traded good, indexed by $i \in [0,1]$, and a continuum of varieties of the nontraded good, indexed by $j \in [0,1]$. The local nontraded good and the local and imported traded goods in (2.2) and (2.3) are aggregates of these continua of varieties:

$$c_{N,t} = \left(\int_0^1 c_{N,t}(j)^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}}, \tag{2.4}$$

$$c_{T,h,t} = \left(\int_0^1 c_{T,h,t}(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}}, \tag{2.5}$$

and

$$c_{T,f,t} = \left(\int_0^1 c_{T,f,t}(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}}, \tag{2.6}$$

where $\theta > 1$ is the elasticity of substitution between any two varieties of the same good, and the price elasticity of demand for a given variety.

2.1.2. Demands and Price Indices

The numeraire we will work with is the common currency. Let P_t denote the price of the composite consumption good and $P_{T,t}$ and $P_{N,t}$ denote the prices of the composite traded and nontraded goods, respectively. And let $P_{T,h,t}(i)$, $P_{T,f,t}(i)$, and $P_{N,t}(i)$ denote the prices set by the producers of the home and foreign traded goods and of the local nontraded good of type i, respectively. Since η units of the nontraded composite good need to be purchased for every unit consumed of traded good i, the cost to the household to consume one unit of traded good i is effectively $P_{T,h,t}(i) + \eta P_{N,t}$ for the home good and $P_{T,f,t}(i) + \eta P_{N,t}$ for the foreign good.[7]

Given the consumer's demand for the composite consumption good, the demand for each lower level good can be determined by solving a cost minimization problem. Substituting these demands back into the appropriate consumption aggregator then yields the corresponding price index.

[7] More formally, consumers should be viewed as having Leontief preferences over any individual traded good and η times the composite nontraded good.

Composite Goods The price index for the composite consumption good, P_t, is

$$P_t = \left(\kappa_T^{\xi} \left(P_{T,t}\right)^{1-\xi} + \kappa_N^{\xi} \left(P_{N,t}\right)^{1-\xi}\right)^{1/(1-\xi)},$$

where the price indices for the traded and nontraded goods aggregates are given by

$$P_{T,t} = \left(\kappa_{T,h}^{\gamma} \left(P_{T,h,t}\right)^{1-\gamma} + \kappa_{T,f}^{\gamma} \left(P_{T,f,t}\right)^{1-\gamma}\right)^{1/(1-\gamma)}$$

and

$$P_{N,t} = \left(\int_0^1 P_{N,t}\left(i\right)^{1-\theta} dj\right)^{\frac{1}{1-\theta}}.$$

In addition, the price indices $P_{T,h,t}$ and $P_{f,t}^{T}$ for the local and imported composite traded goods are given by

$$P_{T,h,t} = \left(\int_0^1 \left(P_{T,h,t}\left(i\right) + \eta P_{N,t}\right)^{1-\theta} di\right)^{\frac{1}{1-\theta}}$$

and

$$P_{T,f,t} = \left(\int_0^1 \left(P_{T,f,t}\left(i\right) + \eta P_{N,t}\right)^{1-\theta} di\right)^{\frac{1}{1-\theta}}.$$

These price indices reflect the requirement that η units of the nontraded composite good be purchased for every unit consumed of traded good i.

The demand functions for each variety of each good are given by

$$c_{N,t}\left(i\right) = \left(\frac{P_{N,t}\left(i\right)}{P_{N,t}}\right)^{-\theta} c_{N,t}, \tag{2.7}$$

$$c_{T,h,t}\left(i\right) = \left(\frac{P_{T,h,t}\left(i\right) + \eta P_{N,t}}{P_{h,t}^{T}}\right)^{-\theta} c_{T,h,t}. \tag{2.8}$$

and

$$c_{T,f,t}\left(i\right) = \left(\frac{P_{T,f,t}\left(i\right) + \eta P_{N,t}}{P_{f,t}^{T}}\right)^{-\theta} c_{T,f,t}. \tag{2.9}$$

Naturally, the demands for traded goods depend on the cost to the household of consuming one unit of the good and therefore reflect the price of nontraded goods. The terms $c_{N,t}$, $c_{T,h,t}$, $c_{T,f,t}$ denote the demand for the relevant composite good and are derived analogously. For example, $c_{N,t} = k_N^{\xi}(P_{N,t}/P_t)^{-\xi} c_t$.

2.1.3. The Budget Constraint

The representative consumer in the home region holds currency, M_t, issued by the central monetary authority and trades a complete set of state contingent nominal bonds with the consumer in the foreign region. We denote the price at date t when the state of the world is s_t of a bond paying one unit of currency at date $t+1$ if the state of the world is s_{t+1} by $Q(s_{t+1}|s_t)$ and we denote the number of these bonds purchased by the home agent at date t by $D(s_{t+1})$. The home consumer also holds riskless nominal bonds issued by the home and foreign fiscal authorities, $B_{h,t}$ and $B_{f,t}$, both paying $(1+R_t)$ currency units in period $t+1$.[8]

The agent's intertemporal budget constraint, expressed in currency units, is

$$\begin{aligned} & P_t c_t + M_t + B_{h,t} + B_{f,t} + \sum_{s_{t+1}} Q(s_{t+1}|s_t) D(s_{t+1}) \\ \leq \; & (1-\tau_t) P_t w_t l_t + M_{t-1} + D(s_t) + \Pi_t + (1+R_{t-1})(B_{h,t-1} + B_{f,t-1}), \end{aligned} \tag{2.10}$$

where Π_t represents profits of domestic firms (assumed to be owned by the domestic consumer) and $(1-\tau_t) P_t w_t l_t$ represents nominal labor earnings after tax.

The consumer chooses sequences for consumption, c_t, labor, l_t, state contingent bonds, $D(s_{t+1})$, government bonds, $B_{h,t}$ and $B_{f,t}$, and money holdings, M_t, in order to maximize the expected discounted utility (2.1) subject to the budget constraint (2.10).

2.2. The Regional Fiscal Authority

The fiscal authority in the home region issues nominal debt, B_t, taxes labor income at rate τ_t, and receives seigniorage revenues from the central monetary authority, Z_t. These revenues are spent on public consumption, g_t, and interest payments on the debt. Public consumption does not yield utility to households in our model. The region's government budget constraint is given by

$$B_t + N\tau_t P_t w_t l_t + Z_t = (1+R_{t-1}) B_{t-1} + P_t g_t. \tag{2.11}$$

The government has the same preferences as the consumer for the different varieties of the local nontraded good and both traded goods. Therefore, given

[8] Because home and foreign agents can both freely buy and sell home and foreign government bonds, arbitrage ensures that there is a common nominal interest rate. Our assumption of complete asset markets independently guarantees that the nominal interest rate is common across countries.

a level of total government consumption g_t, government demands for individual goods are given by expressions analogous to the individual consumption demands (2.7), (2.8), and (2.9); for example, $g_{N,t}(i) = \left(P_{N,t}(i)/P_{N,t}\right)^{-\theta} g_{N,t} = \left(P_{N,t}(i)/P_{N,t}\right)^{-\theta} k_N^{\xi} (P_{N,t}/P_t)^{-\xi} g_t$.

We are interested in studying the roles of both regional fiscal policy shocks and systematic fiscal policy in affecting inflation differentials across regions. Fiscal policy shocks can be associated with either taxation or spending, and likewise systematic fiscal policy can be associated with either taxation or spending. We follow much of the literature in assuming that the ratio of government spending to output follows an exogenous stochastic process, whereas the labor income tax rate is determined by a feedback rule that incorporates a response to the stock of debt.[9] This response insures that the government will be able to pay the interest on its debts.

The share of total public consumption in output, g/y, is given by

$$\left(\frac{g}{y}\right)_t = c_g + \rho_g \left(\frac{g}{y}\right)_{t-1} + \varepsilon_{g,t}, \tag{2.12}$$

where $\left|\rho_g\right| < 1$ and $\varepsilon_{g,t} \sim N(0, \sigma_g)$. The tax rate τ_t on labor income is determined by a feedback rule that targets the debt/GDP ratio $\overline{b}$ according to

$$\tau_t = \tau_{t-1} + \alpha_{b,\tau}\left(b_t - \overline{b}\right) + \alpha_{\Delta b,\tau}\left(b_t - b_{t-1}\right) + \alpha_{p,\tau}\left(\pi_t - \pi_t^U\right). \tag{2.13}$$

Note that we have allowed for a response of the tax rate to the inflation differential (π_t^U denotes union-wide inflation, to be defined below). This response is how we model fiscal policy as attempting to affect inflation differentials.

2.3. Firms

There are two sectors of production in each region, the traded, T, and nontraded, N, sector. The production function for each firm i in each sector is given by $z_t l_t(i)$, where $l_t(i)$ represents labor input and z_t is a sector- and country-specific productivity shock. We denote the real marginal cost by $\psi_t = w_t/z_t$. Note that marginal cost is "country-sector specific;" two firms in the same country in the same sector have the same level of productivity and hence (since they face the same wage) the same marginal cost. Firms are monopolistically competitive and prices are flexible.

[9] Johnson (2001) criticizes the arbitrariness of the approach taken by much of the literature (and by us). See Mitchell, Sault, and Wallis (2000) for a study of different rules used in the literature.

2.3.1. The Tradable Goods Sector

Firm i chooses $P_{T,h,t}(i)$ and $P^*_{T,h,t}(i)$, the prices to charge in each market for its good. We assume that home and foreign markets are segmented; thus, the law of one price need not hold for traded goods. As it will become clear below, due to the need to use η units of the local nontraded good in order to derive utility from traded goods, firms producing these goods may find it optimal to price discriminate across the two markets, setting $P_{T,h,t}(i) \neq P^*_{T,h,t}(i)$.

The profit maximization problems for the producer of traded good i are

$$\max_{P_{T,h,t}(i)} \left(\frac{P_{T,h,t}(i)}{P_t} - \psi_{T,t}\right)\left(\frac{P_{T,h,t}(i) + \eta P_{N,t}}{P_{T,h,t}}\right)^{-\theta} y_{T,h,t} \tag{2.14}$$

and

$$\max_{P^*_{T,h,t}(i)} \left(\frac{P^*_{T,h,t}(i)}{P_t} - \psi_{T,t}\right)\left(\frac{P^*_{T,h,t}(i) + \eta P^*_{N,t}}{P^*_{T,h,t}}\right)^{-\theta} y^*_{T,h,t},$$

where $y_{T,h,t} = Nc_{T,h,t} + g_{T,h,t}$ denotes home demand in period t for the composite home traded good and $y^*_{T,h,t} = N^*c^*_{T,h,t} + g^*_{T,h,t}$ denotes foreign demand. These problems imply that the price of a domestically produced traded good in the home and foreign markets is, respectively

$$\frac{P_{T,h,t}(i)}{P_t} = \frac{\theta}{\theta-1}\left(1 + \frac{\eta}{\theta\psi_{T,t}}\frac{P_{N,t}}{P_t}\right)\psi_{T,t} \tag{2.15}$$

and

$$\frac{P^*_{T,h,t}(i)}{P_t} = \frac{\theta}{\theta-1}\left(1 + \frac{\eta}{\theta\psi_{T,t}}\frac{P^*_{N,t}}{P_t}\right)\psi_{T,t}. \tag{2.16}$$

That is, prices are a markup over the standard measure of marginal cost, where the markup is increasing in the relative price of nontraded goods. Increases in the relative price of nontraded goods raise the market power of a traded goods producer, by decreasing the traded goods producer's share of the traded goods consumer price.

As shown in Corsetti and Dedola (2002), with $\eta > 0$, the elasticity of demand for home traded goods is not necessarily the same across countries and it will differ if the relative price of nontraded goods differs across countries. The monopolistic firm takes this fact into account when choosing its prices and may find it optimal to charge different prices across markets.

The market clearing condition for home traded good i is given by

$$Nc_{T,h,t}(i) + N^* c^*_{T,h,t}(i) + g_{T,h,t}(i) + g^*_{Th,t}(i) = z_{T,t} l_{T,t}(i) \equiv y_{T,t}(i), \qquad (2.17)$$

and, similarly, the market clearing condition for foreign traded good i is

$$Nc_{T,f,t}(i) + N^* c^*_{T,f,t}(i) + g_{T,f,t}(i) + g^*_{T,f,t}(i) = z^*_{T,t} l^*_{T,t}(i) \equiv y^*_{T,t}(i). \qquad (2.18)$$

Note that individual household demands are expressed in per capita terms whereas government demands and firm-level labor inputs are not.

2.3.2. The Nontraded Goods Sector

The profit maximization problem for a producer of nontraded good i is

$$\max_{P_{N,t}(i)} \left(\frac{P_{N,t}(i)}{P_t} - \psi_{N,t} \right) \left(\frac{P_{N,t}(i)}{P_{N,t}} \right)^{-\theta} y_{N,t},$$

where $y_{N,t}$ denotes total demand for the composite nontraded good. This term has two components since nontraded goods are demanded by households and government for both consumption and distribution purposes. This problem implies the usual pricing condition

$$\frac{P_{N,t}(i)}{P_t} = \frac{\theta}{\theta - 1} \psi_{N,t}. \qquad (2.19)$$

The market clearing condition for nontraded goods is different from the one for traded goods, as it reflects the quantity of nontraded goods demanded for "distribution" purposes as well as the quantity demanded for consumption. The market clearing condition for home nontraded good i is then given by

$$(Nc_{N,t}(i) + g_{N,t}(i)) \left(1 + \eta \frac{c_{T,h,t}(i) + c_{T,f,t}(i)}{c_{N,t}} \right) = z_{N,t} l_{N,t}(i) \equiv y_{N,t}(i).$$

It is important to note that the variable $c_{N,t}(i)$ does not include the nontraded goods purchased for their role in distribution; these goods are accounted for by the term in η.

2.4. The Central Monetary Authority

The central monetary authority issues non-interest bearing money and allocates seigniorage revenue to the regions. Let the superscript U denote a *union-wide* variable; for example total nominal money balances in the union are $M_t^U = M_t + M_t^*$.

In period t, the monetary authority earns revenue from printing money equal to $M_t^U - M_{t-1}^U$ and it distributes this revenue among the regional fiscal authorities.[10] Recalling that Z denotes seigniorage, we have

$$M_t^U - M_{t-1}^U \equiv Z_t^U = Z_t + Z_t^*. \tag{2.20}$$

We have to specify the rule for allocating seigniorage. We will assume that seigniorage is allocated according to each country's share of nominal consumption in the stationary steady-state, s_c, so that

$$Z_t = s_c Z_t^U. \tag{2.21}$$

The monetary authority is assumed to follow an interest rate rule similar to the rules studied by Taylor (1993) and Clarida, Gali, and Gertler (1998). In particular, the nominal interest rate R_t is set as a function of the lagged nominal rate, next period's expected inflation rate in the union, and union-wide real output,

$$R_t = (1-\rho_R)\,\bar{R} + \rho_R R_{t-1} + (1-\rho_R)\left[\alpha_\pi\left(E_t\pi_{t+1}^U - \overline{\pi}^U\right) + \alpha_y \ln\left(y_t^U/\overline{y}^U\right)\right], \tag{2.22}$$

where a bar over a variable denotes its target value. In order to implement this rule, the central monetary authority needs a measure both for the price level and real output in the whole currency union, P_t^U and y_t^U, respectively.

We define the "union-wide" price level, P_t^U, as a weighted average of each region's price level, where the weight is determined by the region's share of nominal consumption. That is,

$$P_t^U = s_{c,t} P_t + (1-s_{c,t})\, P_t^*.$$

[10] In the description central monetary authority we abstract, without loss of generality, from the monetary authority's balance sheet and from each government's borrowing from the monetary authority. To solve the model, we need to specify how the revenue from money creation is allocated across regions. We do this by choosing a rule for the allocation of the change in the monetary base. This choice eliminates the need to keep track of the central bank's balance sheet. If we were, instead, to specify the allocation rule in terms of the central bank's interest revenues, we would need to keep track of its balance sheet.

In order to define "union-wide" real output, we first define union nominal output as the sum of each region's nominal output, $y_t^{Un} = y_t^n + y_t^{*n}$. Union real output is obtained by deflating union nominal output by the union price level, $y_t^U = \frac{y_t^{Un}}{P_t^U}$.

2.5. Equilibrium and Model Solution

We focus on the symmetric equilibrium of the model in which all firms in the same sector choose the same price. An equilibrium for this economy is defined as a collection of allocations for home and foreign consumers, allocations and prices for home and foreign firms, composite good prices, real wages, and bond prices that satisfy the efficiency conditions for households and firms (first-order conditions for the maximization problems stated above) and market clearing conditions, given the policy rules assumed for the monetary and fiscal authorities.[11] The remaining market clearing conditions needed to solve the model are for the labor markets in the two countries:

$$Nl_t = l_{h,t}^T(i) + l_t^N(i). \tag{2.23}$$

As before, individual household labor supply in period t, l_t, is expressed in per capita terms, whereas firm-level labor inputs $l_t^T(i)$ and $l_t^N(i)$ are not. We approximate the equilibrium linearly around its steady-state.

3. Calibration

In this section we report the parameter values used in solving the model. Our benchmark calibration assumes that the regions in the currency union are symmetric and share the same structure and parameter values. The model is calibrated using German data, unless otherwise noted, and we assume that a time period in the model corresponds to one quarter.

3.1. Preferences and Production

We follow Chari, Kehoe, and McGrattan (2002) closely in the preference specification. The momentary utility function is given by

$$U\left(c, l, \frac{M}{P}\right) = \frac{1}{1-\sigma}\left(ac^{\delta} + (1-a)\left(\frac{M}{P}\right)^{\delta}\right)^{\frac{1-\sigma}{\delta}} + \psi\frac{(1-l)^{1-\nu}}{1-\nu}.$$

[11] In the interest of space we do not present the efficiency conditions.

We set the curvature parameter, σ, equal to two. The parameters ψ and ν are set to 17.4 and 1.5, respectively, so that the fraction of working time in steady-state is 0.25 and the elasticity of labor supply, with marginal utility of consumption held constant, is 2.

The parameters a and δ are obtained from estimating the money demand equation implied by the first-order condition for bond holdings. Using the utility function defined above, this equation can be written as

$$\log \frac{M_t}{P_t} = \frac{1}{\delta - 1} \log \frac{a}{1-a} + \log c_t + \frac{1}{\delta - 1} \log \frac{R_t - 1}{R_t}.$$

To estimate δ and a we used German quarterly data from 1995:01 to 2000:01 for M1, CPI, real private consumption and the three-month Libor rate. We set $\frac{1}{\delta-1}$ equal to our estimate of the interest elasticity, -0.45, and obtain $\delta = -1.22$. The value for the weight coefficient a was set to 0.91 and it was derived from the estimate for the intercept, -1.026. The discount factor, β, is set to 0.99, implying a 4% annual real rate in the stationary economy.

For the consumption index c_T we need to assign values to γ, the elasticity of substitution between domestic and imported traded goods, and to κ_{Th} and κ_{Tf}, the weights on consumption of home and foreign traded goods. Collard and Dellas (2002) estimate γ for France and Germany using data from 1975:1 to 1990:4. Their estimate for France is 1.35 while their point estimate for Germany is substantially higher (2.33) but also very uncertain. In the benchmark calibration we set γ equal to 1.5, which is also the standard value used in models calibrated for US data. The weight κ_{Th} is set equal to 0.63 so that the import share in steady state is 25% of GDP and we use the normalization $\kappa_{Th}^{\gamma} + \kappa_{Tf}^{\gamma} = 1$ to obtain κ_{Tf}.

The consumption index for c depends on ξ, the elasticity of substitution between traded and nontraded goods, and on κ_T and κ_N, the weights on consumption of traded and nontraded goods. We use Mendoza's (1995) estimate of the elasticity of substitution between traded and nontraded goods for industrialized countries and set ξ equal to 0.74.[12] To set the weight κ_T we refer to Stockman and Tesar (1995) who report that nontraded goods account for about half of output in OECD countries. We set $\kappa_T = 0.86$ to match this ratio and use the normalization $\kappa_T^{\xi} + \kappa_N^{\xi} = 1$ to obtain κ_N.

Finally, we need to choose the values for the distribution parameter η and for θ, the elasticity of substitution across varieties of goods. Based on Burstein, Neves,

[12] This estimate is bigger than the one found by Stockman and Tesar (1995), who use data from both developing and industrialized countries.

and Rebelo (2000), we set η equal to 0.9 so that distribution services represent 45% of the retail price of traded goods in steady state.

The elasticity of substitution between different varieties of a given good, θ, is related to the markup chosen when firms adjust their prices. The markup for firms in the nontraded sector is simply $\theta/(\theta-1)$. We set $\theta=10$, which is a representative value in the literature. It implies a markup of 1.11, which is consistent with the empirical work of Basu and Fernald (1997) and Basu and Kimball (1997). For the same elasticity of substitution among varieties of traded goods, the steady state markup for firms in the traded goods sector is larger due to the presence of distribution costs. In steady state, the markup for firms in the traded sector is 1.22, about 10% higher than in the nontraded goods sector because of the added market power generated by the distribution costs.

3.2. Monetary and Fiscal Policy Rules

The parameters of the nominal interest rate rule are taken from the estimates in Clarida, Gali, and Gertler (1998, Table I) for the Bundesbank. We set $\rho_r=0.91$, $\alpha_{p,r}=1.31$, and $\alpha_{y,r}=0.25/4$, where this last term is converted for quarterly data. The target values for R, π^U, and y^U are their steady-state values. We assume that in steady-state prices grow at 2% per year (or 0.5% per quarter).

The parameters for the tax rule are taken from Mitchell, Sault, and Wallis (2000). We convert their values for quarterly data and set $\alpha_{b,\tau}=0.04/16$ and $\alpha_{\Delta b,\tau}=0.3/4$.

3.3. Exogenous processes

The technology shocks are assumed to follow an $AR(1)$ process $z_{t+1}=A^z z_t+\varepsilon_t^z$, where z_t is the vector $\left[z_t^T, z_t^N, z_t^{*T}, z_t^{*N}\right]$ and A^z is a 4×4 matrix. The vector ε_t^z represents the innovation to z. Stockman and Tesar (1995) provide estimates for a joint productivity process such as this one, but that process is annual, and the home and foreign countries are interpreted as symmetric and together comprising the entire industrialized world. Our model is quarterly, and the home and foreign countries are loosely interpreted as Germany and France, which likely experience higher correlation of productivity shocks. We adjust the Stockman and Tesar process to account for these two differences, and end up with

$$A^z = \begin{bmatrix} 0.199 & 0.249 & \text{-}0.010 & 0.094 \\ 0.176 & 0.593 & 0.036 & 0.044 \\ \text{-}0.010 & 0.094 & 0.199 & 0.249 \\ 0.036 & 0.044 & 0.176 & 0.593 \end{bmatrix}$$

and

$$\varepsilon_t^z = \begin{bmatrix} \epsilon_t^{T,h} \\ \epsilon_t^{N,h} \\ \epsilon_t^{T,f} \\ \epsilon_t^{N,f} \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \epsilon_t^{T,c} \\ \epsilon_t^{N,c} \end{bmatrix},$$

with each ϵ independently distributed across both time and sectors and $\sigma^2_{\epsilon^{T,i}} = 0.0242^2$, $\sigma^2_{\epsilon^{N,i}} = 0.0123^2$, and $\frac{\sigma^2_{\epsilon^c}}{\sigma^2_{\epsilon^i}} = 0.3636$, for $i = h, f$.[13]

Shocks to government expenditures in each country are assumed to follow the same independent $AR(1)$ process $g_{t+1} = c + A^g g_t + \varepsilon_t^g$, where g_t represents the share of government expenditures in GDP. We estimated this process using quarterly data for Germany from 1991:2 to 2001:3. The estimate for A^g is 0.57 and the estimate for $\sigma^2_{\varepsilon^g}$ is 0.000166.

4. The Mechanisms Behind Regional Price Differentials

The model contains three distinct mechanisms that can generate price (and inflation) differentials across regions. Each mechanism works through the presence of local nontraded goods. First, households consume both traded and nontraded goods, implying that the consumption price indices in the two countries correspond to distinct baskets of goods. Even if the law of one price holds for all traded varieties, the consumption price indices differ in the two countries in response to

[13] We arrived at this representation for productivity in two steps. First, we computed a quarterly productivity process that came close to replicating the Stockman-Tesar process when it was time-aggregated. Next, we imposed the common shock structure of Collard and Dellas, who estimate a joint AR(1) process for aggregate productivity for Germany and France. We assumed that the variance ratio of common to idiosyncratic shocks was as they report for Germany. We chose the levels of idiosyncatic shock variances so that, (i) when combined with our A^z matrix, the ratio of own variances of traded and non-traded productivity was that implied by the original Stockman and Tesar process, and (ii), the standard deviation of hp-filtered output relative to its mean was 1.1%, which is what we estimated for Germany. We intend to estimate this process directly in future work.

movements in the relative price of nontraded goods across countries. Second, due to the need to use local nontraded goods for the consumption of traded goods, the consumer price of traded varieties depends on the price of the local nontraded composite good. Third, movements in the relative price of nontraded goods across countries will lead traded goods' producers to price discriminate across markets (equations (2.15) and (2.16)). For these reasons, the consumer price of traded goods (and thus the consumption price indices) differs in the two countries in response to movements in the relative price of nontraded goods across countries.[14]

Any exogenous shock which affects the relative price of nontraded goods across regions generates an equilibrium price differential across regions through the mechanisms just described. We now look at the equilibrium price differential associated with permanent shocks to government spending and home nontraded productivity. In these experiments we assume that countries are equal-sized and monetary policy is given by a constant money growth rate.[15] We consider different alternatives for the options available to the fiscal authority to balance its budget each period.

Government Expenditure Shock Fiscal policy in each region is summarized by an exogenous process for government expenditures as a share of output and by a feedback rule for the labor income tax. Here we illustrate the effects of permanent shocks to government spending on price differentials for different assumptions on the tools available to the government to finance its budget. Recall that in our setup government spending is a pure resource drain on the economy.

Figure 1 displays the response of selected variables to a one percentage point permanent increase in the share of government spending in output, when government spending is financed by lump-sum taxes. The shock generates an increase in government spending of about 5.8%, increasing demand for both home and foreign traded goods as well as for the local nontraded goods (partly to be used for the distribution of traded goods). Domestic real output increases by less than 1% and the transmission of the shock to foreign output is even smaller.[16] The shock has

[14] In the presence of nontraded goods, distribution costs are not necessary for generating relative price changes across countries. However, they do generate deviations from the law of one price, which have been documented to contribute importantly to the observed movements in relative prices across countries.

[15] The analysis of relative price levels across countries does not require the use of a monetary model. In a real two-country model of relative national price levels Duarte (2003) finds results analogous to those presented in this section.

[16] Betts and Devereux (1999) find identical responses of home and foreign output to government

a negative effect on private consumption, bigger in the home country than in the foreign country, and it generates a one time permanent positive price differential with respect to the foreign region of about 0.15 percentage points.[17] The real wage increases in the home country while it decreases in the foreign country.

Since the relative price of home traded goods to foreign traded goods increases, home and foreign households and governments substitute consumption away from home traded goods towards foreign traded goods. This substitution effect leads to the relative expansion of the traded goods sector in the foreign country, while the nontraded goods sector expands relatively more in the home country.

Figure 2 displays the response to the same shock when the government finances its spending with labor income taxes instead of lump-sum taxes. The effect on the price differential generated by the shock is now about 0.8 percentage points, substantially higher than in the previous case. Due to the higher labor income taxes in the home country (needed to finance the increased government spending), the (pre-tax) real wage required by home households to work more and meet the increased demand for home goods increases more than in the previous case. In equilibrium, the home household works less and consumes less. Prices of home goods now increase more relative to the price of foreign goods than before, implying that agents substitute even more towards foreign goods.

In the benchmark model we allow for the government to finance its spending with both labor income taxes and debt. Each period labor income taxes are determined by the tax feedback rule (2.13) that depends on that period's net change and level of public debt, as well as the previous period's tax rate; public debt, in turn, adjusts to insure that the government's intertemporal budget constraint holds. In response to a government spending shock, the regional fiscal authority issues new debt and raises labor income taxes. The tax feedback rule introduces dynamics to the shock response, absent in the cases where the increase in government spending is financed period-by-period by either lump-sum or labor income taxes.[18]

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spending shocks. In our model the response of home and foreign outputs is not identical because there are nontraded goods.

[17] As mentioned above, the assumption of complete asset markets implies that $u_c/P = u_c^*/P^*$ every period. This condition implies that the ratio of price levels moves together with the ratio of marginal utilities of consumption. Abstracting from the presence of money in the utility function, this condition implies a negative relationship between price differentials and consumption differentials.

[18] In their analysis of the government's financing decision, Baxter and King (1993) abstract from government debt, arguing that any path for debt can be replicated with transfers, for a

Figure 3 displays the response to the same shock in the benchmark environment with debt. In the period of the shock, the government issues new public debt and increases the labor income tax slightly as well. Therefore, the impact effect of the shock resembles its effect when government expenditure is financed with lump-sum taxes (figure 1). In the following periods, both public debt and labor income taxes increase; as taxes increase the behavior of the model resembles that in the case where labor income taxes finance government spending (figure 2). After the public debt returns to its steady-state level, the response of all variables equals the impact response from figure 2. The overshooting that occurs in intermediate periods is generated by the dynamics of the tax rule.

Productivity shock to nontraded goods sector Figure 4 plots the response to a 1% permanent increase in productivity in the home nontraded goods sector when the government balances its budget with lump-sum taxes. This shock generates a negative price differential, with the home price level decreasing about 0.5% and the foreign price level increasing about 0.15%. With optimal risk sharing, the fall in the home relative price is associated with a fall in the ratio of marginal utilities of consumption across countries and an increase in home relative consumption.

In response to this shock, home producers of nontraded goods lower their prices. Due to the presence of distribution costs, the fall in nontraded goods prices also reduces the consumer price of home and foreign traded goods in the home country, but relatively less than the fall in the price of nontraded goods. Home consumption increases for all goods and real output increases in the home country; increased home demand for foreign traded goods also raises foreign real output. The foreign household, whose productivity has not changed, works more and the home household works less by substituting hours away from the relatively more productive sector.

The magnitude of the response to this shock changes little when we consider the alternative options for public revenue, namely distortionary taxes and public debt. In fact, when labor income taxes are the only source of public revenue available, the response of these taxes to the shock is small, implying that the response of all variables is not affected significantly by the revenue sources at the government's disposal.

given sequence of distortionary taxes. We are explicitly concerned with the interaction between debt and tax rates, as parameterized in equation (2.13); debt matters because the tax rate responds to it.

In contrast to a shock to nontraded goods productivity, a permanent productivity shock to the traded goods sector in one country generates a small price differential. In fact, for our benchmark calibration, a 1% increase in productivity in the home traded goods sector generates a negative home price differential of 0.03 percentage points. The sign of this price differential contrasts with the textbook Balassa-Samuelson effect, where, in response to higher productivity in the traded goods sector, a country experiences an increase in its price level relative to the foreign country.[19] In our model, the sign of the price differential associated with a shock to productivity in the traded goods sector hinges on the value of the elasticity of substitution between home and foreign traded goods, γ.

A permanent shock to home productivity in the traded goods sector leads a producer of these goods to lower its price relative to the price of foreign traded goods. For high values of γ, or high elasticity of substitution between home and foreign goods, both home and foreign agents substitute more towards the home traded good and away from the foreign traded good in response to a given decline in the relative price of home traded goods. Therefore, the higher is γ, the bigger is the response of home traded goods output relative to foreign traded goods output and the bigger is the increase in home wage relative to foreign wage to induce the home households to produce relatively more traded goods. That is, for high values of γ the real wage increases relatively more in the home country and the home price level increases relative to the foreign price level, a prediction in line with the textbook Balassa-Samuelson effect. For low values of γ, the real wage increases relatively more in the foreign country because agents do not substitute as much towards home traded goods, and the price level increases in the foreign country relative to the home country. We choose a value of γ – 1.5 – that is standard in the literature. Yet, in our model this implies that the conventional Balassa-Samuelson effect does not hold.

5. Fiscal Policy and Inflation Differentials

Because we model the government spending process as exogenous, if a regional fiscal authority wishes to influence the behavior of regional inflation relative to the rest of the monetary union, its sole means for doing so is to move the labor income tax.[20] To study the feasibility and effectiveness of policies aimed at stabi-

[19] See, for example, Obstfeld and Rogoff (1995), page 210.

[20] We assume that if a region wishes to affects its inflation rate, it recognizes the dominance of the central bank in determining the overall level of inflation, and concentrates on the regional

lizing inflation relative to the union, we vary the parameter α_{pt}, which represents feedback from the regional inflation differential to the tax rate.[21] To summarize the effects of changes in the policy rule, we simulate the model using the shock processes described above, and illustrate the relationship between the volatility of the inflation differential and that of output, the deficit/GDP ratio, and the tax rate.

For our benchmark case of equal sized countries, the results are presented in figure 5. Figure 5.b displays the relationship between α_{pt} and the endogenous volatility of the inflation differential, as measured by its standard deviation in percentage points.[22] Figure 5.b shows that a region within a currency union can reduce the volatility of its inflation differential relative to the rest of the union by responding to the inflation differential with a negative coefficient in the tax rule. In fact, by choosing a strongly negative coefficient on the inflation differential, a region can essentially force its inflation rate to move with that of the rest of the union. Furthermore, this nominal stability does not carry with it instability in real output; figures 5.A and 5.B together show that as the tax rule coefficient on the inflation differential is reduced, both the variance of the inflation differential and the variance of output fall. However, output volatility is an equilibrium response to given shock processes; decreases in output volatility should not be thought of as necessarily welfare-enhancing. This idea is reinforced by figure 5.C, which shows the locus of tax rate and inflation differential variances. Locally, introducing a negative coefficient on inflation in the tax rule reduces the variance of the tax rate, but changes in the tax rule that lead to significant stabilization of the inflation differential also lead to significantly greater volatility of the *distortionary* tax rate. Finally, figure 5.D illustrates the relationship between the volatility of the inflation differential and the frequency with which an arbitrary 3% deficit to GDP ratio is exceeded.[23] The Stability and Growth Pact imposes a 3% limit on the deficit to GDP ratio for member countries of the European Monetary Union. Even

inflation differential relative to the unionwide average.

[21] In terms of units, α_{pt} is the level derivative of the tax rate with respect to the inflation differential. For example, if $\alpha_{pt} = -1.0$, then an inflation differential of one percentage point would decrease the tax rate by one percentage point compared to a situation with zero inflation differential.

[22] We plot this relationship with the inflation volatility on the horizontal axis, instead of the tax rule parameter, because the other panels relate inflation volatility to other statistics involving endogenous variables.

[23] The probability that the deficit exceeds three percent of GDP is a monotonic transformation of the volatility of the deficit to gdp ratio.

without a tax rule response to inflation, the 3% bound is violated quite frequently – almost 40% of the time – and the frequency increases slightly with policies which substantially reduce the volatility of the inflation differential.

Fundamentally, volatility in any of the endogenous variables is a result of volatility in productivity and government spending. Thus, the tax rule alters endogenous volatility by altering the response to productivity shocks and government spending shocks. Recall from above that shocks to nontraded productivity and to government spending, as opposed to traded goods productivity, are primarily responsible for the volatility of price differentials.[24] In response to a shock to home nontraded productivity, we saw that the home country's output rose and its relative inflation rate fell. This was in response to a simple permanent shock, as opposed to a shock to the more complicated calibrated process. However, the same qualitative response occurs to a calibrated shock. When the home fiscal authority responds with a negative coefficient on the inflation differential, this tends to raise the home tax rate relative to the benchmark case. The higher tax rate inhibits labor supply, consumption rises less than in the benchmark case, and output actually falls. In addition, home relative to foreign consumption rises less than in the benchmark case. Complete risk sharing implies that the smaller increase in home relative consumption translates into a smaller decrease in the home relative price level. In response to non-traded goods productivity shocks then, a regional fiscal policy that responds to inflation differentials with a negative sign has the effect of decreasing the variance of inflation differentials and output.

In the case of government spending, we saw above that a simple random walk shock raised home output. Relative to the foreign country, the shock lowered home consumption and raised the home price level and tax rate. The same qualitative response occurs with our calibrated shock. When the regional fiscal authority puts a negative coefficient on the inflation differential, it responds by decreasing the home tax rate. This increases labor supply, amplifying the increase in output in the home country. But, the tax response also has the effect of decreasing the consumption differential across countries, and with complete risk-sharing this translates into a decrease in the inflation differential. Thus, with respect to government spending shocks, fiscal policy that responds to inflation differentials induces a negative relationship between volatility of output and that of inflation

[24] It is worth (foot)noting, however, that this does not imply that volatility of the price differential for nontraded goods accounts for the volatility of overall inflation differentials. In fact, most of the volatility of price differentials across countries in the model is attributable to volatility of the price differential for traded goods.

differentials. Because the positive relationship attributable to productivity shocks is stronger, the overall effect of the fiscal response to inflation is to affect volatility of output and the inflation differential in the same direction.

Conventional wisdom – associated with a Phillips curve – would say that in order to decrease the volatility of the inflation differential a region's fiscal authority should respond to inflation differentials with contractionary policy. Without a Phillips curve we find that in order to decrease the volatility of the inflation differential, the regional fiscal authority lowers the tax rate in response to a positive inflation differential.

6. Country Size and Inflation Differentials

Within the European Monetary Union, many of the discussions of regional inflation differentials have concerned small countries, for example Ireland and Portugal. To study the role of country size, we vary the home country's relative population, $N/(N+N^*)$.

Figure 6 displays the same loci as Figure 5, this time for a country that comprises one-third of the union's population, compared to one-half in the previous figures. First, note that in Figure 6.B, changes in the tax feedback rule have roughly the same effect on the inflation differential for the small country as they do in the symmetric case. And, tax rate volatility has a similar relationship to inflation differential volatility as in the symmetric case. However, for a small country the relationship between the variances of output and the inflation differential is u-shaped instead of positive; decreasing the standard deviation of the inflation differential by more than about 30% means increasing the variance of output.

To understand the difference between the small and symmetric cases we focus on the interaction of traded goods productivity shocks with country size. A decrease in relative population raises the country's level of openness, as measured by its export share of GDP.[25] Greater openness leads to increased importance of traded goods productivity shocks in accounting for volatility of inflation differentials. We might then expect that when fiscal policy responds to inflation differentials, traded goods productivity shocks drive the relationship between the

[25] The relationship between country size and export share follows from the risk sharing condition which equates per capita marginal utilities. In the case in which $\sigma = a = 1$, this condition equates per capita nominal expenditure across countries. Then, to the extent that per capita expenditure is equated for each traded good, smaller countries must have higher export shares. For our calibration, this simple condition does not hold but we find the same qualitative result.

volatility of inflation differentials and the volatility of output. This is indeed the case. The dashed line in figure 6 shows that, with only traded goods productivity shocks, there would be a negative relationship between the volatilities of the inflation differential and output. For symmetric countries this relationship would be positive. For other shocks there are no significant differences between the small country and symmetric cases.

To understand why the dashed line has a negative slope for a small country we turn to the response to a traded productivity shock. For a small country, such a shock causes a positive inflation differential, whereas for the symmetric case it generates a tiny negative inflation differential.[26] Thus, when we allow the tax rule to respond to the inflation differential with a negative coefficient, for the small country this means the tax rate falls in response to a traded goods productivity shock. For the large country the tax rate instead rises slightly, and output does not rise as much as in the small country.

7. Conclusion

This paper investigates the extent to which regional fiscal policy can affect the behavior of regional inflation in a general equilibrium model of a two-region currency union. We find that a regional fiscal authority can decrease the absolute value of its inflation differential in response to the shocks driving the model by lowering (raising) the distortionary tax rate in response to positive (negative) inflation differentials. By simulating the model with calibrated exogenous processes we find that the effect on the volatility of output of fiscal policies that lower the volatility of the inflation differential depends critically on the relative size of the two regions. While for symmetric regions lower volatility of inflation differentials is associated with lower volatility of output, in the case of a small region the former comes about with an increase in the volatility of output.

An alternative specification of the fiscal policy response to inflation would work through government spending. There is a tradition of treating government spending as exogenous; we followed this tradition and thus it was natural for taxes to be the instrument of fiscal policy. We conjecture that under the alternative specification, the implications of fiscal policy responding to inflation differentials would mirror those described here.[27]

[26] The small country thus experiences a traditional Balassa-Samuelson effect. It appears that the value of γ above which there is a Balassa-Samuelson effect is increasing in country size.

[27] We have in mind that decreases in government spending would imply decreases in the tax

We assumed that prices are flexible. Our focus on the behavior of inflation *differentials* does not require that the model contain any mechanism for monetary non-neutrality. Flexible prices simplify the model substantially while allowing us to address our question of interest. Nevertheless, it would be natural to add price stickiness to the model. Our model predicts too much variability of the inflation differential when compared to the data. Price stickiness might be necessary for the model to match the observed variability of inflation differentials. In addition, price stickiness would lead to meaningful time-variation in distortions. It would be interesting to study the effect on these distortions of fiscal policies that respond to inflation differentials. We are pursuing these issues in ongoing work (see Duarte and Wolman [2002] for a preliminary version).

This paper addressed solely positive questions raised by the use of fiscal policy to affect inflation differentials in a currency union. Our emphasis on positive questions was motivated by the attention that has been focused recently on national inflation in EMU member countries. Specifically, there have been suggestions that countries should pursue policies aimed at affecting their national inflation rates. We study the feasibility and effectiveness of such policies. Nonetheless, the same developments in Europe also naturally motivate studying optimal fiscal and monetary policies in a currency union.

rate. Therefore, responding to inflation differentials by decreasing government spending would be equivalent to responding by decreasing the tax rate directly.

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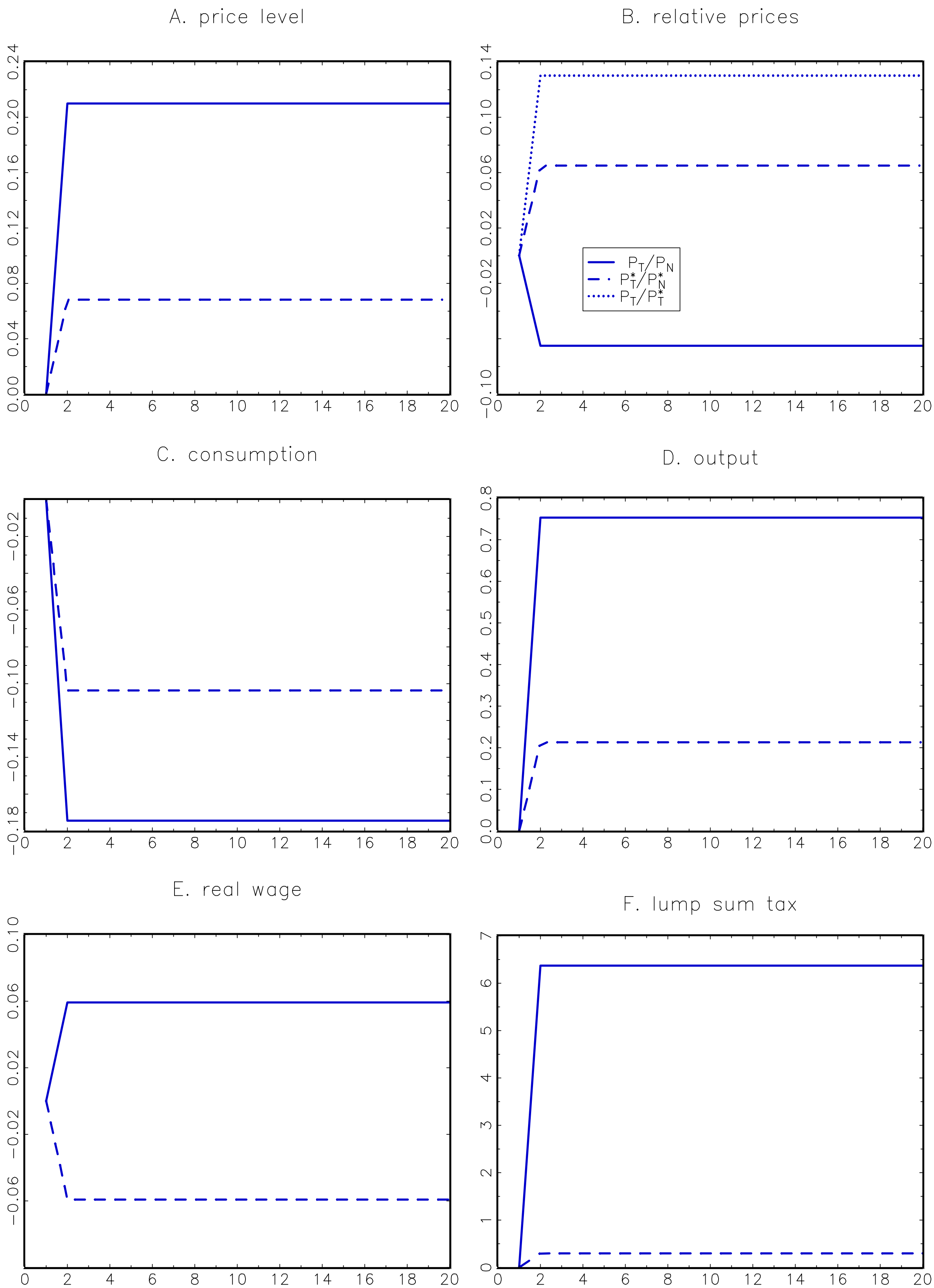
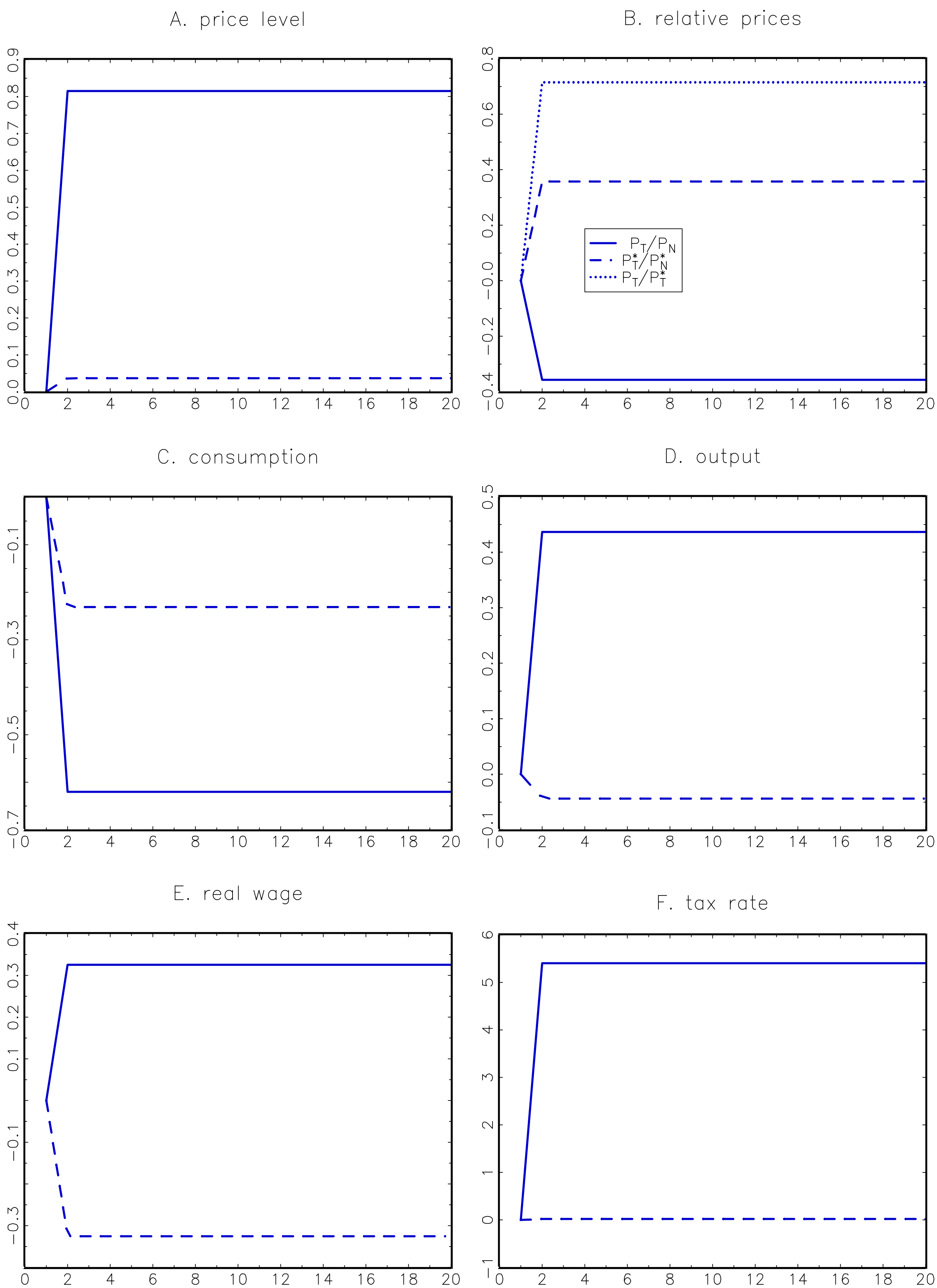
Figure 1. Response to a government spending shock, with lump sum taxes
(home = solid foreign = dashed)



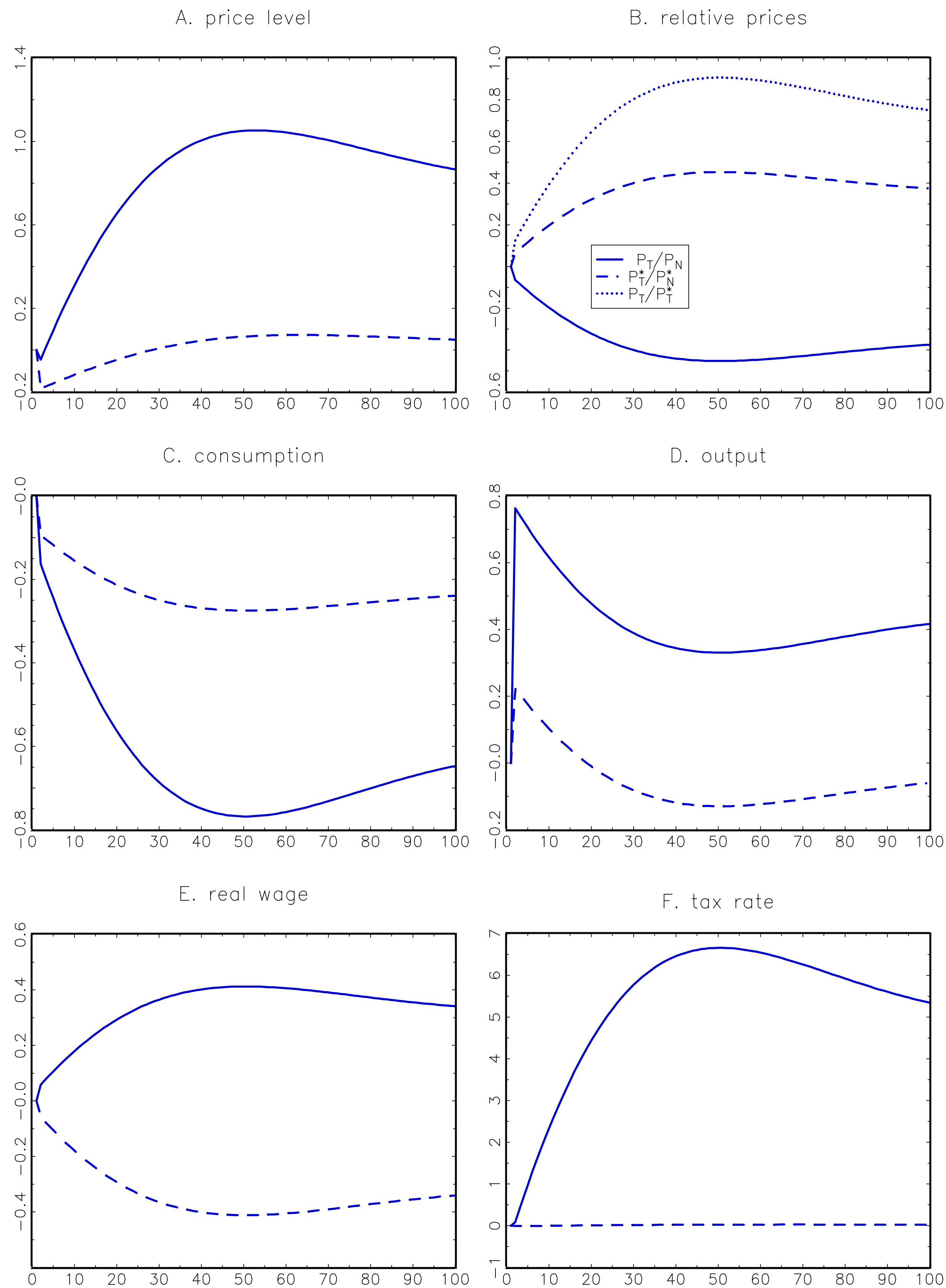
all variables are measured in percent deviations from steady state

Figure 2. Response to a government spending shock, with distortionary taxes (home = solid foreign = dashed)



all variables are measured in percent deviations from steady state

Figure 3. Response to a government spending shock; distortionary taxes respond to debt
(home = solid foreign = dashed)



all variables are measured in percent deviations from steady state

Figure 4. Response to a nontraded productivity shock, with lump sum taxes
(home = solid foreign = dashed)

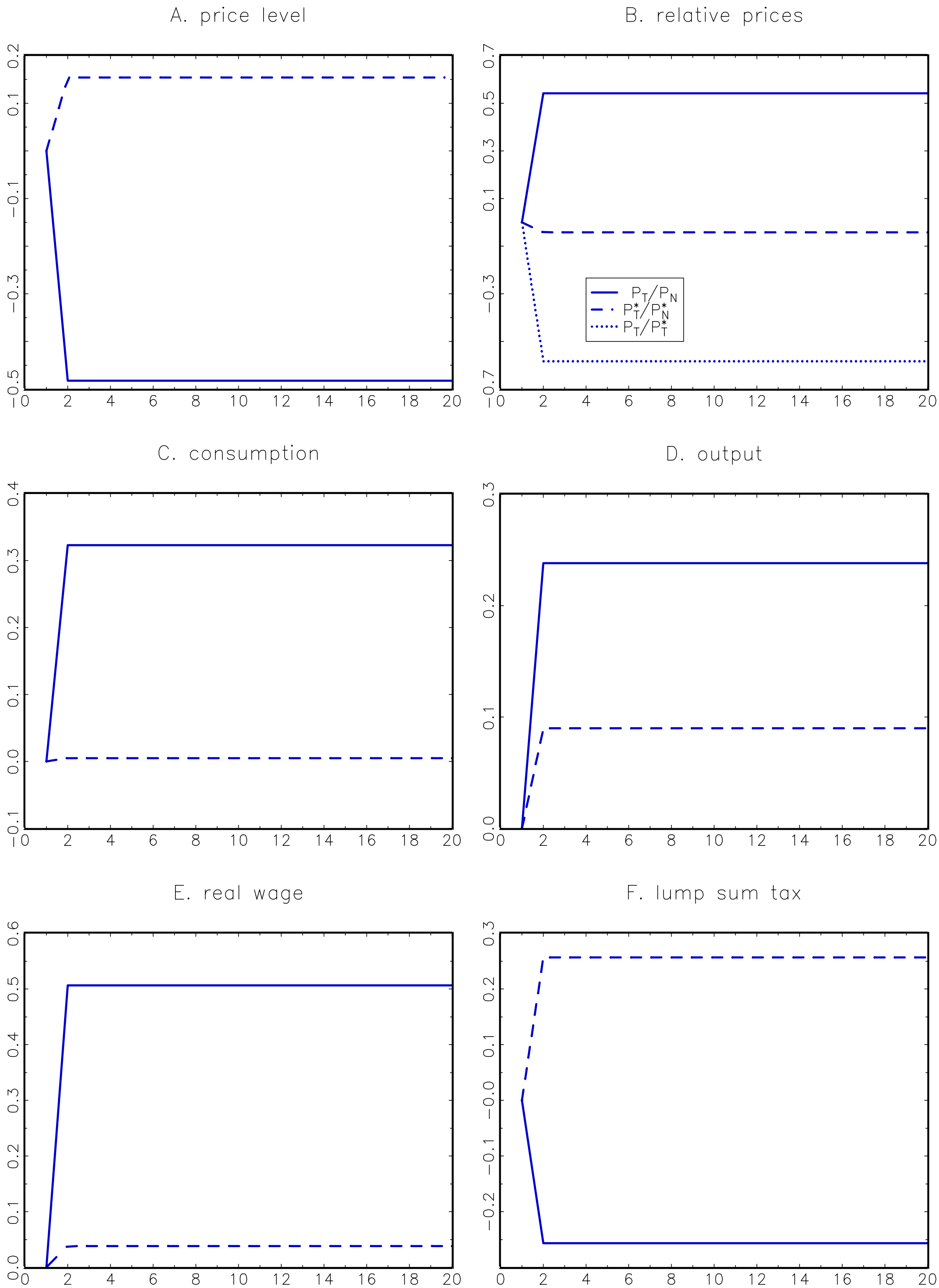


Figure 5. Implications of varying degrees of tax rule response to the regional inflation differential (x-axis is standard dev. of inflation differential)

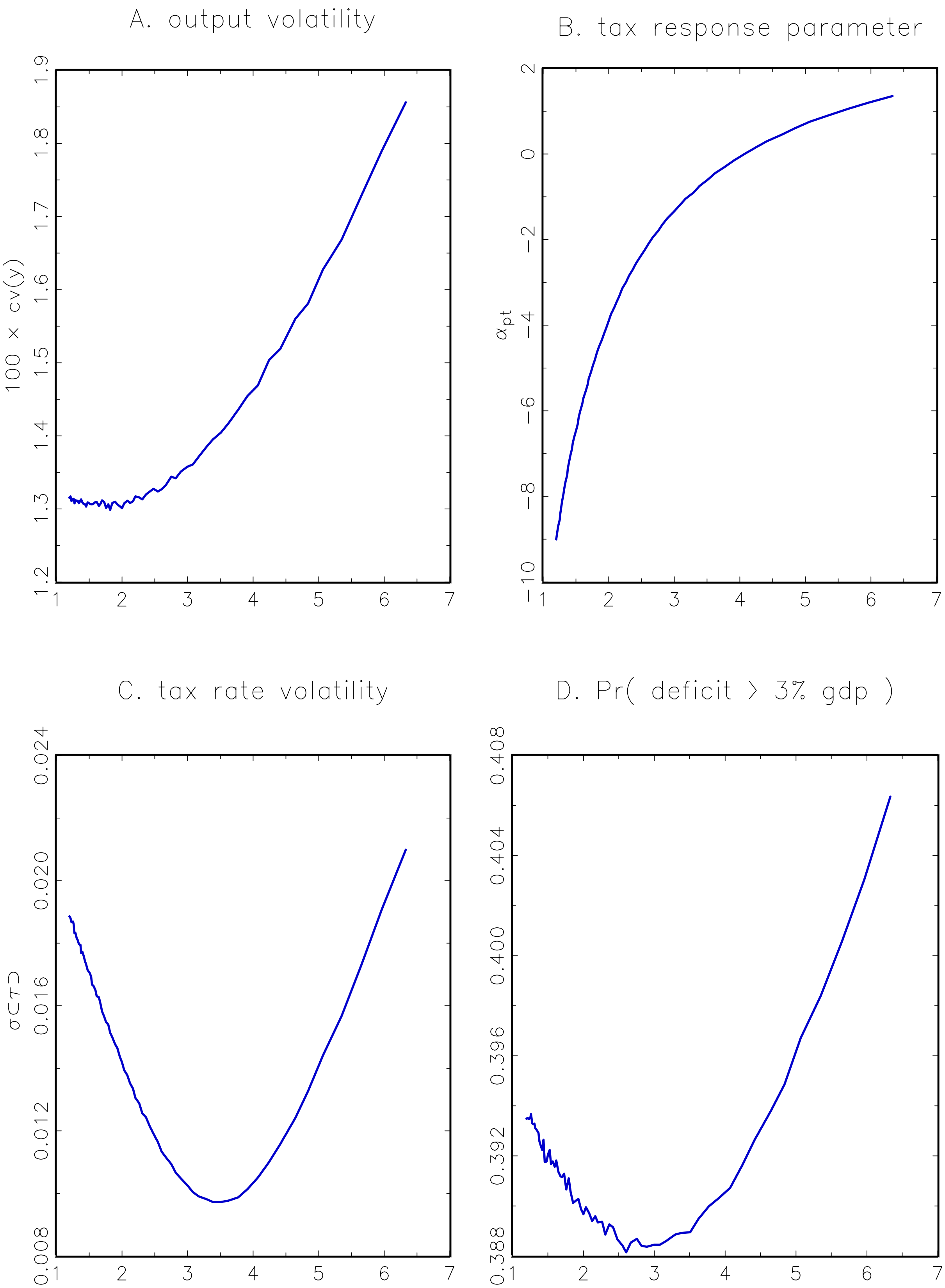


Figure 6. Small country, with tax rule response to inflation differential

(x-axis is standard dev. of inflation differential)