Journal of International Economics 83 (2011) 53–69

Contents lists available at ScienceDirect

Journal of International Economics

journal homepage: www.elsevier.com/locate/jie

How do fiscal and technology shocks affect real exchange rates? New evidence for the United States

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ARTICLE INFO

Article history:
Received 9 May 2010
Received in revised form 21 August 2010
Accepted 24 August 2010
Available online 22 September 2010

JEL classification:
F41
F42
E32

Keywords:
Real exchange rate
Terms of trade
Government spending shocks
Technology shocks
VAR
Sign restrictions

ABSTRACT

Using vector autoregressions on U.S. time series relative to an aggregate of industrialized countries, this paper provides new evidence on the dynamic effects of government spending and technology shocks on the real exchange rate and the terms of trade. To achieve identification, we derive robust restrictions on the sign of several impulse responses from a two-country general equilibrium model. We find that both the real exchange rate and the terms of trade—whose responses are left unrestricted—depreciate in response to expansionary government spending shocks and appreciate in response to positive technology shocks.

1. Introduction

How do international relative prices adjust to country-specific fiscal measures and productivity gains? This question is pivotal to understanding the international transmission mechanism; and yet, theoretical and empirical approaches tend to provide conflicting answers. Business cycle models under conventional calibrations predict that government spending raises the relative price of domestic goods, while productivity gains lower it—reflecting, respectively, an increase in relative demand and supply of domestic goods.[1] Recent empirical studies based on estimated vector autoregressive (VAR) models suggest the opposite. Kim and Roubini (2008), Monacelli and Perotti (2006), and Ravn et al. (2007), among others, find that government spending depreciates the real exchange rate. Corsetti et al. (2008b), Kim and Lee (2008), and Enders and Müller (2009) document that productivity gains (or "technology shocks") appreciate real exchange rates, measured by the terms of trade or the relative price of consumption across countries.[2]

In order to reassess these puzzling findings, the present paper employs a new methodological approach: while existing studies identify exogenous structural innovations through either short-run or long-run restrictions, we follow Uhlig (2005) and restrict the sign of the responses to the shocks we seek to identify.[3] Importantly, and in

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[1] See, e.g., Backus et al. (1994) and Erceg et al. (2005). Assuming debt-finance, textbook versions of the Mundell–Fleming model also predict that an exogenous increase in government spending appreciates exchange rates. In the case of tax finance, results differ as disposable income and money demand fall if money supply is unchanged, see Frenkel and Razin (1987). For similar reasons, government spending depreciates the nominal exchange rate in Obstfeld and Rogoff (1995).

[2] The aforementioned studies on fiscal shocks focus on the real exchange rate and consider data for Australia, Canada, the U.K. and the U.S. Evidence on the effect of government spending shocks on the terms of trade is somewhat mixed, see, for instance, Corsetti and Müller (2006) or Monacelli and Perotti (2008). Regarding technology shocks, evidence for an appreciation is established for U.S. data. Corsetti et al. (2008b) find an appreciation in Japan as well, while Kim and Lee (2008) report a depreciation for the Euro area and Japan.

[3] An increasing number of studies have recently employed sign restrictions. They are used, for instance, to identify government spending and technology shocks in a closed economy context by Mountford and Uhlig (2009) and Peersman and Straub (2009). In an open economy context, with a focus on identifying monetary policy shocks, sign restrictions are employed by Faust and Rogers (2003), Farrant and Peersman (2006), and Scholl and Uhlig (2008) among others.

0022-1996/$ – see front matter
doi:10.1016/j.jinteco.2010.08.005

contrast to a closely related study by Corsetti et al. (2009a), we use a quantitative general equilibrium model to formally derive the sign and the time horizon of the identification restrictions. Our model is richly specified and nests distinct transmission mechanisms, once we consider the entire range of plausible parameterizations. Specifically, while the model delivers robust predictions for the behavior of several macroeconomic variables, it does not yield clear-cut predictions for how exchange rates respond to government spending and technology shocks. This result is key to our identification strategy: we derive sign restrictions for several variables from the model, while remaining agnostic about exchange rate dynamics.[4]

We establish new evidence on how productivity gains and government spending impact U.S. exchange rates. In contrast to existing studies, which analyze the effect of either government spending or productivity gains in isolation, we assess their effects jointly in order to establish encompassing evidence on the international transmission mechanism. Specifically, we estimate our VAR model on quarterly time series for the U.S. relative to an aggregate of industrialized countries for the post-Bretton-Woods period 1975Q1–2005Q4. The VAR includes data for consumption, output, investment, government spending, the government budget balance, inflation, the short-term interest rate and exchange rates. As a measure for the latter, we consider both the real effective exchange rate and the terms of trade, in order to control for the possibility that exchange rate changes merely reflect fluctuations in the price of non-traded goods.

We find that exogenous expansions of government spending depreciate the real exchange rate as well as the terms of trade. Positive innovations to technology, instead, appreciate the real exchange rate and the terms of trade in the short-run. While the terms of trade converge back to their initial value, the real exchange rate depreciates in the medium-run after a positive technology shock. Sensitivity analysis, accounting for various complications such as possible anticipation effects of government spending, monetary policy shocks, or variations in the sample period, shows that these results are robust.

Overall, our results corroborate the findings of existing studies regarding the effects of government spending and technology shocks on exchange rates, even though we employ an identification scheme which is conceptually quite distinct. Identification assumptions are, by their very nature, controversial, and evidence on exchange rate dynamics which is robust across identification schemes seems particular relevant in assessing conflicting theoretical accounts of the international transmission mechanism. Specifically, international relative prices play an important role in allocating country-specific risk in the absence of explicit risk-sharing. Cole and Obstfeld (1991) identify conditions under which international price movements fully insure country-specific risk, thereby supporting the efficient allocation. Yet, as shown in a recent theoretical contribution by Corsetti et al. (2008a), to the extent that technology shocks appreciate the real exchange rate, country-specific consumption risk is actually amplified. The reverse holds for government spending shocks. Our empirical findings are thus consistent with the notion that, in the short-run, international price movements tend to amplify rather than to mitigate country-specific consumption risk.

The remainder of the paper is organized as follows. In Section 2 we describe our identification strategy and outline a quantitative business cycle model from which we derive sign restrictions. In Section 3 we discuss our VAR specification and results. Section 4 discusses sensitivity and Section 5 concludes.

2. Identifying government spending and technology shocks

2.1. Sign restrictions

As discussed above, several studies use VAR models to document the effects of government spending and technology shocks on exchange rates. In these studies identification is based on either short-run or long-run restrictions. In the following we propose to bring an alternative identification scheme to bear on the question, because the evidence established to date conflicts with the predictions of business cycle models, at least if standard calibrations are considered. In the following we briefly outline our approach. We start from the following reduced-form VAR model

$$Y_t = \mu + B_{(1)}Y_{t-1} + B_{(2)}Y_{t-2} + \dots + B_{(m)}Y_{t-m} + u_t, \quad E\left[u_t u_t'\right] = \Sigma, \tag{1}$$

$t=1,...,T$, for some ℓ-dimensional vector of variables Y_t, coefficient matrices $B_{(i)}$ of size $\ell\times\ell$ and a variance–covariance matrix for the one-step ahead prediction error Σ. Letting υ_t, with $E[\upsilon_t\upsilon_t']=I_\ell$, denote the vector of structural shocks, we need to find a matrix A such that $u_t=A\upsilon_t$ in order to achieve identification.

Instead of restricting the matrix A a priori, we follow Uhlig (2005) and Mountford and Uhlig (2009) and identify structural shocks by imposing sign restrictions on impulse–response functions of selected variables for a certain period $k=\underline{k},\dots,\overline{k}$ following the shock. Intuitively, we consider various matrices A and check, for each case, whether the sign restrictions are fulfilled and dismiss the matrix if this is not the case. Below, we derive the sign restrictions on the basis of a quantitative business cycle model. Specifically, we assess—for a wide range of model parameterizations—whether the response of a variable to a particular shock is either robustly negative or positive for a specific time period k after the shock impacts the model economy.

To fix ideas, let n be the number of structural shocks that we seek to identify. Mountford and Uhlig (2009) show that identifying n shocks is equivalent to identifying an impulse matrix of rank n that is a sub-matrix of matrix A satisfying $AA'=\Sigma$. Any impulse matrix can be written as

$$\left[a^{(1)},\dots,a^{(n)}\right] = \tilde{A}Q \tag{2}$$

where $\tilde{A}$ is the lower triangular Cholesky factor of Σ and $Q=[q^{(1)},\dots,q^{(n)}]$ is a $n\times\ell$ matrix consisting of orthonormal rows $q^{(s)}$, $s=1,\dots,n$, such that $QQ'=I_n$.

Similarly to Uhlig (2005), one can show that the impulse response to $a^{(s)}$ can be written as linear combination of the impulse responses obtained under a Cholesky decomposition of Σ. Let $c_{ji}(k)$ be the impulse response of the jth variable at horizon k to the ith shock in the Cholesky decomposition of Σ and define $c_i(k)\in\mathbb{R}^\ell$ to be the vector response $[c_{1i}(k),...,c_{\ell i}(k)]$. Then the impulse response $r_a^{(s)}(k)$ to the impulse vector $a^{(s)}$ is given by

$$r_a^{(s)}(k) = \sum_{i=1}^{\ell} q_i^{(s)} \; c_i(k). \tag{3}$$

The restrictions we impose to identify an impulse vector characterizing shock s are that $\left(r_a^{(s)}(k)\right)_j\geq 0, j\in\mathcal{J}_+$ and $\left(r_a^{(s)}(k)\right)_j\leq 0, j\in\mathcal{J}_-$ for some subsets of variables $\mathcal{J}_+$ and $\mathcal{J}_-$ and some horizon $k=\underline{k},\dots,\ \overline{k}$.

[4] The validity of our identification assumptions thus rests on the plausibility of our theoretical framework. Yet working with a fully specified general equilibrium model imposes discipline on how to specify sign restrictions. By the same token, it allows for a quantification of the time horizon for which restrictions may be imposed as well as for an explicit treatment of a possible anticipation of government spending shocks. We therefore consider our study complementary to Corsetti et al. (2009a) who employ sign restrictions to identify demand and technology shocks in the manufacturing sector and study their effect on the real exchange rate. Rather than using a fully specified general equilibrium model, they use sector-specific information to achieve identification.