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

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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. 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.

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. 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.
describe our identification approach 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

$$Y_t = \mu + B_{12}Y_{t-1} + B_{13}Y_{t-2} + \ldots + B_{1m}Y_{t-m} + u_t, \quad E[u_t u'_t] = \Sigma,$$

(1)

$t = 1, \ldots, T$, for some $r$-dimensional vector of variables $Y_t$, coefficient matrices $B_{ij}$ of size $r \times r$ and a variance–covariance matrix for the one-step ahead prediction error $\Sigma$. Letting $u_t$ with $E[u_t u'_t] = I_r$, denote the vector of structural shocks, we need to find a matrix $A$ such that $u_t = Av_t$ 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 $k = k, \ldots, k$ 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

$$[a^{(1)}, \ldots, a^{(n)}] = \tilde{A}Q,$$

(2)

where $\tilde{A}$ is the lower triangular Cholesky factor of $\Sigma$ and $Q = [q^{(1)}, \ldots, q^{(n)}]$ is an $n \times r$ matrix consisting of orthonormal rows $q^{(s)}$, $s = 1, \ldots, n$, such that $QQ' = I_r$.

Similarly to Uhlig (2005), one can show that the impulse response to $a^{(1)}$ can be written as linear combination of the impulse responses obtained under a Cholesky decomposition of $\Sigma$. Let $c_j(k)$ be the impulse response of the $j$th variable at horizon $k$ to the $k$th shock in the Cholesky decomposition of $\Sigma$ and define $c_j(k) \in \mathbb{R}$ to be the vector response $[c_{1j}(k), \ldots, c_{nj}(k)]$. Then the impulse response $r_{ij}^{(s)}(k)$ to the impulse vector $a^{(s)}$ is given by

$$r_{ij}^{(s)}(k) = \sum_{i=1}^r q^{(i)}_j c_j(k).$$

(3)

The restrictions we impose to identify an impulse vector characterizing shock $s$ are that $(r_{ij}^{(s)}(k) \geq 0, j \in J_+)$ and $(r_{ij}^{(s)}(k) \leq 0, j \in J_-)$ for some subsets of variables $J_+$ and $J_-$ and some horizon $k = k, \ldots, k$.

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. (2008a) 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.

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