To bi, or not to bi? Differences between spillover estimates from bilateral and multilateral multi-country models ☆

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ABSTRACT

Asymptotic analysis and Monte Carlo simulations show that spillover estimates obtained from widely-used bilateral (such as two-country VAR) models are in general less accurate both in terms of bias and mean squared error than those obtained from multilateral (such as global VAR) models. In particular, the accuracy of spillover estimates obtained from bilateral models depends on two aspects of economies' integration with the rest of the world. First, accuracy worsens as direct bilateral transmission channels become less important, for example when the spillover-sender accounts only for a small share of the spillover-recipient's overall integration with the rest of the world. Second, accuracy worsens as indirect higher-order spillovers and spillbacks become more important, for example when the spillover-recipient is more integrated with the rest of the world overall. Empirical evidence on the global output spillovers from US monetary policy is consistent with these generic results: Spillover estimates obtained from two-country VAR models are systematically smaller than those obtained from a global VAR model; and the differences between spillover estimates obtained from two-country VAR models and a global VAR model are more pronounced for economies for which the US accounts for a smaller share of their overall trade and financial integration with the rest of the world, and for economies which are more integrated with the rest of the world overall.

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1. Introduction

Over the last decades the global economy has witnessed a dramatic deepening of trade and financial integration. The resulting growing potential for cross-country spillovers has given impetus to academics and practitioners alike to estimate the magnitude of this international transmission of country-specific shocks (see IMF, 2014). Examples for the prominence spillovers have gained recently are abundant, including the global effects of the exit from unconventional monetary policy in the US, the implications of the slowdown in China for world growth, or the concerns about the global fallout from the European sovereign debt crisis. Knowing how to estimate

spillovers and identify economies which are particularly exposed to shocks from abroad has become critical for policymakers.

Essentially two modelling frameworks have been put forth for the empirical analysis of cross-country spillovers. On the one hand, a number of studies uses bilateral models which only consider the spillover-sender and the spillover-recipient. For example, several papers study the global spillovers from US monetary policy in two-country VAR models that include the US and one non-US economy at a time (Kim, 2001; Canova, 2005; Nobili and Neri, 2006; Mackowiak, 2007; Bluedorn and Bowdler, 2011; Ilzetzki and Jin, 2013).[1] Another set of papers has used two-country VAR models to study the impact of monetary policy on exchange rates (Eichenbaum and Evans, 1995; Cushman and Zha, 1997; Kim and Roubini, 2000; Faust and Rogers, 2003; Faust et al., 2003; Bjørnland, 2009; Voss and Willard, 2009). While bilateral models are easy to implement, they do not capture

[1] Eickmeier (2007) considers a large-dimensional two-country factor model for the US and Germany in order to estimate the spillovers from US shocks. Jannsen and Klein (2011) as well as Babecka Kucharcukova et al. (2016) use two-country VAR models in order to examine the spillovers from Euro area monetary policy shocks to economies across Europe.

explicitly higher-order spillovers that reach the spillover-recipient through third and further economies. Despite not explicitly accounting for higher-order channels, it is believed that bilateral models still produce consistent spillover estimates.

On the other hand, some studies use multilateral models which consider a large number of economies jointly. For example, the global VAR (GVAR) model developed by Pesaran et al. (2004) has also been used to study the global effects of US monetary policy considering a large number of spillover-receiving economies simultaneously (Chen et al., 2012; Feldkircher and Huber, 2015; Georgiadis, 2016); and Binder et al. (2010) use a GVAR model in order to explore the effects of US monetary policy on exchange rates. In a similar vein, Canova and Ciccarelli (2009) put forth high-dimensional multi-country VAR models, which they suggest to estimate by Bayesian methods. Mumtaz and Surico (2009) consider an international factor-augmented VAR (FAVAR) model to study the effects of unanticipated rises in foreign interest rates on the UK economy.[2,3] In contrast to bilateral models, multilateral models account for higher-order spillovers explicitly but are technically more difficult to implement due to the need to address the curse of dimensionality.

The major conceptual difference between bilateral and multilateral models is thus that the former do not account – at least not explicitly – for higher-order spillover channels. As a consequence, bilateral models might produce biased spillover estimates, with the bias being larger for spillover-recipients which are more susceptible to higher-order spillovers. An empirical example which motivates this hypothesis is shown in Fig. 1, which displays the global output spillovers from a contractionary US monetary policy shock as estimated from a multilateral GVAR model and from bilateral two-country VAR models, respectively.[4] The spillover estimates obtained from the GVAR model are statistically and economically significantly larger than those obtained from the two-country VAR models. The literature has not investigated yet whether this difference is random and due to sampling uncertainty, or whether it reflects a systematic bias due to the mis-specification of bilateral models. This paper aims to fill this gap.

In particular, this paper advances our understanding of the empirical analysis of cross-country spillovers by investigating whether spillovers are estimated more accurately in terms of both bias and mean squared error (MSE) in multilateral than in bilateral models. The main result of the paper is that spillover estimates obtained from bilateral models are in general inconsistent asymptotically and subject to a larger bias and MSE than those obtained from a multilateral model in finite samples due to failure to account for higher-order spillovers. Importantly, the accuracy of the spillover estimates obtained from bilateral models depends on the relative importance of direct bilateral and higher-order spillover channels. In particular, spillover estimates obtained from bilateral models are particularly inaccurate relative to those obtained from a multilateral model when (i) the spillover-recipient is more sensitive to developments in the rest of the world overall, rendering it more susceptible to higher-order spillovers; and when (ii) the spillover-sender accounts only for a small share of the spillover-recipient's overall sensitivity to developments in the rest of the world, implying relatively less important direct bilateral spillovers.

I arrive at these conclusions in three steps. First, I explore whether the slope coefficient and spillover estimates obtained from
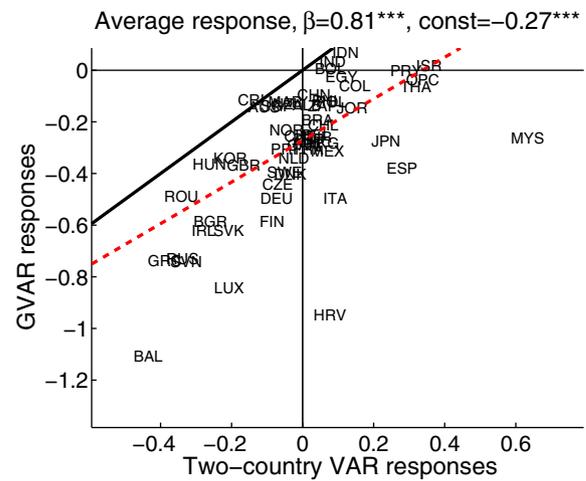
Fig. 1. Differences between estimates of the spillovers from US monetary policy obtained from the GVAR and the two-country VAR models. Note: The figure displays the average of the spillover estimates of real GDP to a 100 basis points contractionary US monetary policy shock over 12 quarters obtained from two-country VAR models (horizontal axis) and a GVAR model (vertical axis). The black solid line represents the 45-degree line and the red dashed line the fit from a regression of the spillover estimates obtained from the GVAR model on those obtained from the two-country models. The slope and intercept estimates from this regression are provided in the figure title. *** indicates statistical significance at the 1% significance level. The spillover estimates are based on the monetary policy shocks constructed by Bernanke and Kuttner (2005).

a bilateral model are asymptotically consistent if the true data-generating process is given by a multilateral model with higher-order spillover channels for N economies—arguably the most plausible data-generating process in an era of unprecedented trade and financial globalisation. The results suggest that the spillover estimates obtained from the bilateral model are in general inconsistent. Moreover, I find that the spillover-recipient's international integration properties determine the magnitude of the asymptotic bias in the spillover estimates obtained from the bilateral model. In particular, the asymptotic bias rises with the spillover-recipient's overall sensitivity to developments in the rest of the world, and thereby with its susceptibility to higher-order spillovers; and the asymptotic bias falls with the relative importance of the spillover-sender in the spillover-recipient's overall sensitivity to developments in the rest of the world, and thereby with the relative importance of direct bilateral spillovers.

Second, in order to evaluate the properties of spillover estimates obtained from bilateral models in finite samples and to assess how a bilateral model may be expected to perform relative to a practically relevant multilateral model, I carry out a Monte Carlo experiment. Specifically, I again consider a multilateral data-generating process with higher-order spillover channels and estimate spillovers using bilateral two-country VAR models and a multilateral GVAR or a FAVAR model. Consistent with the asymptotic results, I find that the finite sample bias and MSE of the spillover estimates obtained from the bilateral model rise relative to that obtained from the multilateral model with the spillover-recipient's overall sensitivity to developments in the rest of the world, and that they decrease with the relative importance of the spillover-sender in the spillover-recipient's overall sensitivity to the rest of the world. I obtain these Monte Carlo results for simulations with data-generating processes based both on a multilateral reduced-form and a structural macroeconomic multi-country model. In the Monte Carlo experiment I also show that a standard Wald-test for the exclusion of global variables in an extended bilateral model can guide researchers as to whether higher-order spillover channels are sufficiently important so as to

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[2] See also Liu et al. (2011) as well as Aastveit et al. (2016).
[3] Large Bayesian VAR models (Banbura et al., 2010) could also be used for spillover analysis in a multilateral multi-country framework, but have so far to the best of my knowledge been applied only to study the domestic transmission of shocks.
[4] The underlying model specifications are discussed in more detail in Section 4.