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# ECB-Global: Introducing the ECB's global macroeconomic model for spillover analysis

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## ABSTRACT

In a highly interlinked global economy a key question is how foreign shocks transmit to the domestic economy, how domestic shocks affect the rest of the world, and how policy actions mitigate or amplify spillovers. For policy analysis in such a context, global multi-country macroeconomic models that allow a structural interpretation are needed. In this paper we introduce the European Central Bank's global macroeconomic model: ECB-Global, a semi-structural, global multi-country model for the euro area, the US, Japan, the UK, China, oil-exporting economies, Emerging Asia and a rest-of-the-world block. ECB-Global features rich channels of international shock propagation through trade, oil prices and global financial markets. We illustrate the range of applications of ECB-Global in the context of policy analysis by presenting its predictions for global spillovers from a US monetary policy tightening, a growth slowdown in China, and a drop in oil prices. In contrast to many existing structural models, ECB-Global implies large spillovers from US monetary policy and oil price shocks, which transmit through trade and financial cross-border interlinkages. Compared to these shocks, ECB-Global does not imply large spillovers from a slowdown in China, primarily because of the latter's still limited integration in global financial markets. We also illustrate how ECB-Global can be modified flexibly in order to address evolving questions relevant for policy makers by adding new features in an ad hoc manner.

## 1. Introduction

The rise of real and financial globalisation over the past decades has increased the importance of understanding the global transmission of local shocks and policy actions. Recent events including the normalisation of monetary policy in the US, swings in commodity prices as well as concerns about China's growth prospects demonstrate the importance of understanding how shocks in one economy transmit to the rest of the world. Consequently, there has been a growing interest in the use of global macroeconomic models for the assessment of the sign, the size and the transmission channels of cross-border spillovers, as well as the role of policy in this context. In this paper we present the ECB's new global macroeconomic model: ECB-Global, a rich multi-country model for the euro area, the US, Japan, the UK, China, oil-producing economies, Emerging Asia and the rest-of-the-world featuring diverse cross-border spillover channels through real and financial interlinkages.

The development of ECB-Global follows a semi-structural approach in order to combine the advantages of fully structural models and

those composed of reduced-form equations. Specifically, the design of ECB-Global is based on two considerations. First, the evolution of the economies in the model is determined by a set of core structural relationships, such as Phillips and IS curves. The advantage of the structural elements of ECB-Global is that shocks have a clean economic interpretation, which facilitates the interpretation of impulse response functions and the design of policy simulations. Second, reduced-form equations are added to enrich the core of the model. The advantage of the reduced-form elements of ECB-Global is that it facilitates modifying the model in a flexible manner so that it can be adapted relatively straightforwardly, which allows us to address evolving issues in the policy discussion. Moreover, the additional reduced-form elements improve the empirical fit of ECB-Global.<sup>1</sup> The parametrisation of ECB-Global is based on a combination of institutional knowledge as well as an informal impulse response matching procedure. Specifically, we parameterise ECB-Global by minimising the distance between its implied impulse response functions to key structural shocks — such as a US monetary policy, a demand shock in China, as well as a global

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<sup>1</sup> There is an increasing literature on the advantages of a more semi-structural approach, see for example McKibbin and Stoekel (2017) and Hendry and Muellbauer (2017).

oil price shock — and those found in the empirical literature. The parametrisation of ECB-Global is thus carried out in a similar manner as for other (semi-)structural models used at policy institutions, such as the Flexible System of Global Models (FSGM; [Andrle et al., 2015](#)).

ECB-Global is similar in spirit to other semi-structural models that have recently become popular at central banks and international organisations, such as the IMF's Global Projection Model (GPM7; [Blagrove et al., 2013](#)) and the FSGM, the Bank of England's COMPASS model ([Burgess et al., 2013](#)), the Reserve Bank of New Zealand's NZSIM ([Kamber et al., 2016](#)), and the global DSGE model developed at the Bank of Italy by [Cova et al. \(2015\)](#).<sup>2</sup> Compared to other semi-structural global models such as the GPM, ECB-Global has several features that set it apart. First, in order to be able to analyse a wider set of policy scenarios, ECB-Global features a more detailed financial and oil block. Second, in order to strengthen theoretical consistency, the equations in ECB-Global are more in line with those from fully micro-founded structural models such as the ECB's New Area Wide Model (NAWM; [Christoffel et al., 2008](#)) and the Euro Area and Global Economy model (EAGLE; [Gomes et al., 2012](#)). Compared to the FSGM, ECB-Global puts stronger emphasis on financial spillovers, and it is more useful for scenario analysis at the business cycle frequency given that it is a quarterly rather than an annual model. Compared to the model developed by [Cova et al. \(2015\)](#), ECB-Global is less structural but, in turn, more flexible.

We illustrate the dynamic properties of ECB-Global by examining the domestic and international responses of a set of policy-relevant scenarios: a US monetary policy shock, a China demand shock and an oil price shock. First, a US monetary policy tightening not only causes domestic output and inflation to decline through trade, oil and financial channels, but also leads to a decline in output in other economies, as tighter global financial conditions dominate expansionary spillovers through expenditure switching. In contrast, a slowdown in China's demand triggers limited international spillovers as negative domestic demand effects only transmit through lower oil prices and trade, reflecting China's limited integration into the global financial system. Finally, a decline in oil prices driven by a rise in oil supply raises output in oil-importing economies, while output in oil-exporting economies declines as government expenditures based on oil export revenues fall together with net exports. We also carry out a sensitivity analysis which demonstrates how the dynamics implied by ECB-Global vary with alternative values of key parameters. Moreover, we show that the effects of several shocks on global output implied by ECB-Global are generally well in line with those implied by other calibrated global (semi-)structural models such as NiGEM and the FSGM, with international spillovers in ECB-Global generally being on the high side. Finally, we discuss limitations of the current version of ECB-Global.

The remainder of the paper is organised as follows. Section 2 provides an intuitive graphical description of the structure of ECB-Global before Section 3 presents the model equations in detail. Section 4 discusses the parametrisation of the model. Section 5 presents the predictions of ECB-Global regarding three scenarios: (i) a tightening of monetary policy in the US, (ii) a slowdown of economic growth in China and (iii) a negative oil price shock. Finally, Section 6 discusses current

limitations of the model and possible future extensions and Section 7 concludes.

## 2. Intuitive overview

[Fig. 1](#) highlights the main building blocks of ECB-Global and indicates the channels through which spillovers arise. Although the chart is set up from a US perspective, the other country blocks (the euro area, Japan, the UK, Emerging Asia and the rest-of-the-world) are in general modelled symmetrically. Only China and the oil-exporting countries feature some country-specific structures, which are explained in more detail in Section 3.13 and 3.14.

In the domestic economy, ECB-Global features rich interrelationships between domestic output, inflation and the financial sector. Domestic output consists of consumption and investment, government spending and net exports, while domestic inflation is a combination of producer price inflation (determined by marginal costs) and imported oil price inflation. The central bank stabilises inflation and output by setting the policy rate, which, in turn, affects the financial sector. In the financial sector equity prices, the short-term interbank credit spread, bank-lending tightness and sovereign risk premia are determined. The interbank credit spread drives a wedge between the central bank's policy rate and the short-term interbank rate. The private-sector risk premium, defined as the sum of bank-lending tightness and the sovereign risk premium, drives a wedge between the interbank rate and the rate at which firms and households can borrow. The latter variables are important determinants of the dynamics of domestic output due to their role in financial accelerator feedback loops. Finally, net exports respond to changes in the exchange rate, which in turn is determined in the uncovered interest rate parity condition.

Cross-border spillovers in ECB-Global materialise through a multitude of real and financial channels. Real spillovers are based on countries being interlinked through global trade. Specifically, all economies import and export non-oil goods, whereas only the oil-exporting country block produces and exports oil. The price of oil is determined by oil demand (endogenous to global output) and oil supply (exogenously set by the oil-exporting countries), and affects the domestic economy through imported inflation. Finally, financial spillovers in ECB-Global occur through four channels: equity prices, the interbank rate spread, bank-lending tightness and sovereign risk premia.

## 3. The model

This section describes the model equations of ECB-Global in detail. We only report the equations for the euro area as most other countries represented in ECB-Global are modelled symmetrically (i.e. the US, Japan, the UK, Emerging Asia and the rest-of-the-world). Only China and the oil-producing (OP) country-block differ in structure. Specifically, China features a different monetary policy rule and UIP condition (as detailed in Section 3.13), and the OP differ in the sense that they receive oil export revenues which in turn determine government expenditures (as detailed in Section 3.14). For brevity, we only display the US and the OP as foreign economies in the equations in which variables appear that pertain to more than one economy (e.g. for the aggregation of an economy's total exports as the sum of other economies' bilateral imports). Moreover, we only show the log-linearised equations in this section and refer to [Dieppe et al. \(2017\)](#) for more details on the derivations of the equations as well as the trend specifications.

### 3.1. Notation

Uppercase (lowercase) letters represent aggregate (per capita) values; for example, while  $Y_t$  is aggregate GDP,  $y_t$  is per capita GDP. Variables with superscript  $ss$  represent steady state values and variables with bars represent trends. Percentage deviations from steady state or trend are denoted by hats, for example

<sup>2</sup> Other global models include the IMF's Global Economy Model (GEM; [Laxton and Pesenti, 2003](#)), the Global Integrated Monetary and Fiscal Model (GIMF; [Laxton and Kumhof, 2007](#)), NiGEM developed by the National Institute of Economic and Social Research as well as the global model of Oxford Economics. However, these models are more structural and therefore less flexible (GEM and GIMF), or are mostly reduced form and therefore do not allow a meaningful economic interpretation of scenarios (NiGEM and the Oxford model). Yet another approach to formulating multi-country semi-structural models based on the GVAR approach has been proposed by [Dees et al. \(2014\)](#). The main issue addressed by the latter approach concerns the estimation of the parameters in a high-dimensional multi-country model. However, in the current version ECB-Global is not estimated, so that the latter approach would not be helpful at this stage of the development of ECB-Global.

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