Global integrated monetary and fiscal model

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The Bank of Finland has adopted a new model of the international monetary and financial economy developed at the International Monetary Fund (IMF) for the analysis of political changes and shocks to the global economy. This article provides an introduction to the structure and key assumptions of the model and illustrates its properties through a more detailed presentation of the risk scenario discussed in the article 'Monetary policy and the global economy' (above).

The new global integrated monetary and fiscal (GIMF) model adopted at the Bank of Finland is a dynamic stochastic general equilibrium (DSGE) model developed for the purposes of global economic analysis.[1] The model covers the entire global economy but views it as distinct economic areas linked by trade flows and relative prices, such as exchange rates. The calculations in this article are based on a six-area model covering the United States, the euro area, Japan, China, Asia and the rest of the world.

In the GIMF model, households and non-financial corporations optimize their economic behaviour. Stock-flow accounting over the long term allows eg investment flows to be accumulated as capital stocks. As a result of built-in frictions in wage and price setting, wages and prices adjust to political changes and varying shocks in the global economy with a delay.

The model also takes into account a number of real adjustment costs, some households are liquidity-constrained, and all households have a finite planning horizon. Both monetary and fiscal policies thus play an important part in fiscal consolidation.

The assumption of finite planning horizons sets this model apart from traditional general equilibrium models. In the long-term steady state, each country has a uniquely defined net external asset balance. This gives fiscal policy and private sector saving a major role in both dynamic adjustment and defining long-term steady states.

The model is particularly useful in the analysis of fiscal policy issues, as it has properties that render both spending-based and revenue-based fiscal variables non-neutral. Fiscal policy can have a short-term impact on economic activity, but persistent general government deficits tend to crowd out private investment and net external financial assets in the long term.[2] Persistent general government deficits in larger economies can also lead to higher real interest rates at the global level and thus constrain global economic developments.

Asset markets in this model are incomplete. Sovereign debt is held domestically by private investors in the form of domestic-currency-denominated nominal government bonds with a maturity of one period. All non-financial corporations are domestically owned and their equity is not traded on domestic financial markets. Households receive dividends from the corporate sector.

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[1] Kumhof et al. (2010).

[2] As in eg Coenen et al. (2010), GIMF fiscal multipliers in an environment of temporary fiscal shocks are close to those of more traditional monetary models.

Household sector

There are two types of households in the model, both of which consume goods and supply labour. Overlapping-generations households (OLG) optimise their borrowing and saving over a planning horizon of 20 years.[3] Liquidity-constrained households' (LIQ) consumption equals their net income, ie they do not save and have no access to financial markets in the model. Both types of household pay income tax on labour income, value-added tax on consumption and a lump-sum tax. OLG households invest their savings in domestic sovereign bonds and US dollar-denominated international bonds as well as fixed-term deposits. They maximise their consumption and leisure within their dynamic budgetary constraints, and their aggregate consumption is thus a function of their financial wealth and the discounted current value of their labour and investment income after taxes. For LIQ households, consumption equals net income, putting their marginal propensity to consume at one. A large share of LIQ households in a population implies considerable fiscal multiplier effects from temporary changes in taxes and transfer payments.

The planning horizon of OLG households being finite, tax cuts have a positive impact on their consumption in the short term. These households discount future taxes at an above-market interest rate. Higher sovereign debt will thus increase their wealth – future taxes resulting from the debt will, at least in part, only be imposed beyond their planning horizon. If sovereign debt continues to grow, and taxes are assumed to rise accordingly to service the debt and keep the debt ratio stable over the long term, this will lead to higher real interest rates and a crowding out of private capital.[4]

Higher real interest rates have a negative impact on consumption, mainly through wealth effects. In the model, the intertemporal substitution effects of interest rate changes are small and calibrated to be consistent with empirical findings.

Productive sector

Non-financial corporations that produce intermediate inputs for production in both the tradables sector and the non-tradables sector are managed in accordance with the preferences of OLG households (their owners) and thus also have a finite planning horizon in the model.

These corporations face nominal rigidities in price setting and real adjustment costs in labour costs and investment. They pay capital income tax to the government and wages and dividends to households.

Their investments are financed by bank loans. When a corporation is financed with borrowed capital and its earnings fall below the threshold specified in its rate agreement, banks take control of its capital stock (less any auditing/insolvency costs) and reallocate it to OLG households (their depositors).

[3] With the stochastic life time assumption, derived in continuous time by Blanchard (1985), discount factors differ for households and the public sector and there is no Ricardian equivalence.

[4] For fiscal policy implications of the GIMF see eg Kumhof & Laxton (2007, 2009a and 2009b).

In a monopolistic market, corporations set the price of their goods at marginal cost plus a fixed profit margin. Export prices depend on the destination market, and import prices include quantity adjustment costs. Prices are sticky, as corporations also have to take into account nominal adjustment costs.

In addition to intermediate inputs, corporations also use public infrastructure inputs (public sector capital stock) in their production. Public capital thus promotes productivity in the economy.

Financial sector

The GIMF incorporates a compact set of financial assets. Sovereign debt consists of domestic-currency-denominated bonds with a maturity of one period.

The financial sector is modelled as in Bernanke et al.[5] and the external funding cost of a corporation depends on its indebtedness. Banks pay market interest rate on deposits and charge a risk premium on debt. The risk premium in their lending rates is directly linked to a borrower's leverage ratio to compensate for the risk of insolvency costs. The dynamics are non-linear, and a large net worth shock will cause much larger increases in risk premia.

Uncovered interest rate parity does not hold entirely; country-specific risk premia cause deviations between interest rates in different economic areas both in the short and in the long term, even though they are adjusted for expected changes in exchange rates.

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[5] Bernanke et al. (1999).

Global implications and economic interdependencies

As a multi-region model covering the entire world economy, the GIMF models bilateral trade flows and relative prices (also exchange rates) between the regions explicitly. Trade flows include import and export of intermediate and final goods. In this model, international trade linkages are based on global saving and investment decisions, building on households' finite planning horizon. Current account balance as a share of GDP and the net foreign asset position are uniquely defined for each economic area. With an incomplete market in financial assets, net foreign asset positions are expressed in nominal US-dollar-denominated bonds with a maturity of one period.

Other major factors determining the economic impact of shocks between economic areas are uncovered interest rate parity and long-term changes in the real international interest rate.

Monetary and fiscal policy

Fiscal policy in the model encompasses various expenditure and taxation instruments. Public expenditure can consist of public consumption or investment, or lump-sum income transfers either to all households or specifically to LIQ households. Income tax on labour and capital income, taxes on consumption and lump-sum taxes generate public revenue. It is also possible to set customs duties on imported goods to augment public revenue. Public investment demand is used to replenish public infrastructure, which depreciates at a constant rate over time.

The GIMF model is structured around several distinct economic areas and, as a whole, covers the entire global economy.

The fiscal policy rule is selected to guarantee the long-term sustainability of public debt while allowing counter-cyclical policies in the short term. In general, the rule is implemented through changes in income taxes, but for some economic areas other instruments may be more realistic.

With the fiscal rule in place, the long-term sovereign debt ratio and, by extension, the deficit ratio in each country and economic area remain stable, which eliminates the possibility of default. The rule also allows automatic stabilisers to operate (counter-cyclical fiscal policy).

In the model, central banks use an interest rate rule responding to inflation forecasts: they adjust the difference between their policy rate and a long-term equilibrium rate to keep inflation stable over the long term.

Scenario calculation: growing risk aversion

To illustrate the properties of the GIMF, this article presents a simulation examining the economic impacts of a sudden rise in euro area risk premia. In the scenario, the risk appetite of euro area investors diminishes, leading to a steeper yield curve for sovereign bonds and an increase in corporate bond risk premia. Risk premia in the euro area return to levels last seen in the early summer of 2012 before the gradual calming of the markets.

The following assumptions are made. The one-year risk premium on sovereign bonds suddenly increases by ½ of a percentage point and then begins a slow return to the starting level. The

increase is halved after approximately two years. The three-year and ten-year risk premia increase by 0.75 of a percentage point each. The risk premium on euro area corporate bonds suddenly increases by 2 percentage points, but the increase is temporary and will be halved after approximately two years. Monetary policy in both the euro area and the United States is assumed to be accommodative (close to the zero lower bound) for the next two years. In Japan, monetary policy is assumed to be at the zero lower bound for the next four years. In addition, the ECB is assumed to communicate that monetary policy should remain accommodative for a number of years to come. Interest rate cuts are possible after two years, but any easing of monetary policy in this scenario is gradual. Policy rates will fall slightly with respect to the baseline after two years. With the rising yield curve affecting the baseline, this means that policy rates will remain close to the zero lower bound for quite some time. Forward guidance is assumed to have full credibility.

Changes in risk appetite can be highly non-linear. Reductions are often swift, whereas recovery can be a very slow process under current conditions. Hence, once risk appetite wanes, investors may require an extra exchange rate premium on euro-denominated financial assets. In the scenario, this possibility is accounted for by including an immediate temporary exchange rate premium that will be halved after two years and will alone reduce the nominal exchange rate by an

approximate ½% with respect to the baseline.

The main result of this scenario (Chart 1) is a reduction in euro area GDP with respect to the baseline of just over 1% over two years. Prices fall, and in the most extreme case, inflation slows down by ¼ of a percentage point over the second, third and fourth years.

A steeper yield curve and higher corporate risk premia lead to lower domestic consumption in the euro area. In the first two years, monetary policy easing is not possible using conventional measures because of the zero lower bound.

Higher corporate risk premia and real interest rates result in higher capital utilisation costs and thereby lower investment demand. Waning domestic demand causes a contraction in output, which in turn weakens labour demand. As a consequence, wage levels fall. This drives down marginal costs for non-financial corporations, and they begin to let the reduction be transmitted into their price setting. For all these reasons, inflation will slow down slightly over the medium term.

Household labour income will contract because of lower labour demand and lower wages. The weakening financial position of non-financial corporations will adversely affect corporate profits and the flow of dividends to households. The public sector will allow automatic stabilisers to operate, providing additional income to households. In the short term, higher real interest rates will also reduce consumption through substitution effects. All in all, these factors will

reduce private consumption by 1% over the medium term.

The zero lower bound, on one hand, and forward guidance signalling accommodation, on the other, contribute to keeping nominal interest rates stable in the long term. Although, in this way, the central bank is effectively keeping the real interest rate as low as possible, the real interest rate does rise in this calculation over the short and medium term.

Fiscal policy supports consumption by letting automatic stabilisers operate. Counter-cyclical fiscal policy leads to rising deficits, and the sovereign debt ratio grows by nearly 2% in the short term.

Central banks in emerging economies still have room for manoeuvre: they lower their policy rates and use conventional monetary policy measures to alleviate the adverse effects of the shock. The real effective exchange rate of the euro weakens as increasingly risk-averse euro area investors begin to shun euro-denominated assets.

Import prices rise as the euro depreciates against other currencies, helping to curb deflationary pressures. As import prices rise and domestic demand shrinks, imports contract. A depreciating exchange rate leads to an increase in foreign demand. Overall, the current account turns positive mainly on account of weaker imports.

Diminished risk appetite in the euro area is felt in the global economy via cross exchange rates, trade flows and the real international interest rate. The assumed zero lower bound in the

The scenario considers a situation in which the risk appetite of euro area investors diminishes.

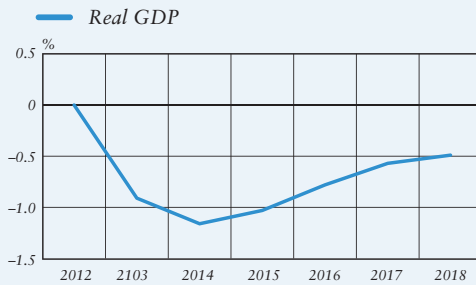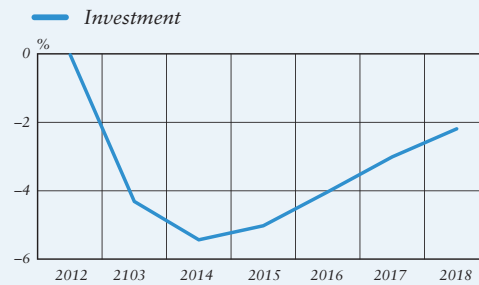**Risk appetite in the euro area**

Chart 1a.

— *Real GDP*

Chart 1b.

— *Investment*

Chart 1c.

1. — *Underlying inflation*
2. — *Nominal policy rate*
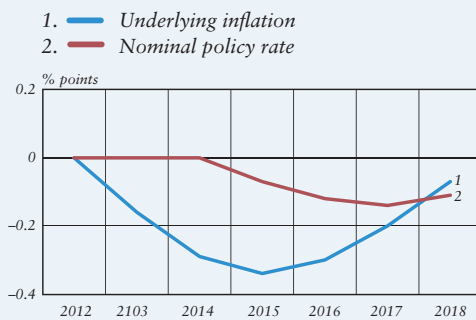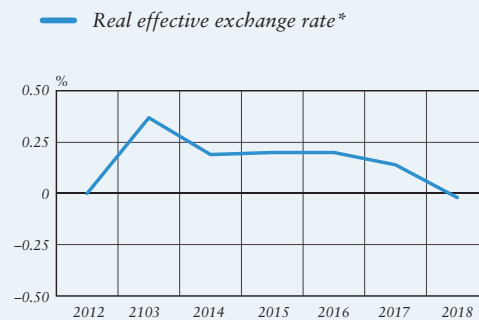

Chart 1d.

— *Real effective exchange rate**

**A positive value of the real exchange rate index
implies depreciation.*

Source: Bank of Finland calculations.

United States and Japan is also relevant for the international transmission of the shock. In the United States, for example, growth falls 0.1% with respect to the baseline and inflation remains near baseline. Overall, the euro area shock has a relatively minor impact on the global economy.

Conclusion

A new global integrated monetary and fiscal (GIMF) model has been adopted at the Bank of Finland. The model covers the entire global economy – viewing it as composed of economic areas – to arrive at a broad analysis of the impact of different shocks and policy changes in the different areas. In particular, the model provides a valuable angle for assessing the domestic and international impacts of monetary and fiscal policy measures.

Keywords: monetary policy, fiscal policy, GIMF

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