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A review of the New Zealand Structural Inflation Model (NZSIM) structural forecasting model used by the Reserve Bank in their quarterly forecasting exercise[1]

1. Introduction

I was asked to review NZSIM from the perspective of its practical usefulness in the forecasting process that precedes monetary policy decisions. I visited the Reserve Bank during February, observed meetings at which the forecasts were presented to the Governor and others and had separate meetings with the model builders and the forecasting team. Economists of the RBNZ also responded helpfully to questions I raised after my return to the BIS. Their professionalism is praiseworthy.

The model is well described in Kamber et al (2013). BIS colleagues, who are more knowledgeable about Dynamic Stochastic General Equilibrium (DSGE) models than me, reviewed the model on the basis of the description contained in this article. Although each had some questions to raise, their overall judgement was that this model does a very good job of focusing on tweaking the standard DSGE model to fit NZ experience. On technical matters, my colleagues were impressed with the quality of this work. The model builders have dealt well with the trade-offs, such as simplicity (for ease of interpretation) versus complexity (good statistical fit). The version of the model used for forecasting is based on changes (with trends treated as exogenous) and that is less sensitive to national accounts data revisions.

The methodology employed lends itself to aiding an empirical assessment of different elements of the model to ensure parsimony. As discussed in Kamber et al, the improvement in the statistical fit associated with the addition (or subtraction) of individual blocks of the model can be calculated. Given that the model is intended to evolve over time, one can imagine this methodology being employed extensively to ensure that the model fit improves without increasing the complexity of the model unduly.

2. Evolution of the use of models

The invitation to do this review prompted me to reflect on my own experience with forecasting models. When I was last involved in forecasting (at the OECD in the 1980s), the models typically used for forecasts and policy simulations contained a very large number of reduced form equations. Often the person responsible for one bit of the model had had a hand in estimating the equations directly relevant to his or her own work. The trade forecaster would often have built the import and export blocks, the fiscal forecaster the tax revenue equations and so on. In the forecast round, judgments were then applied through successive layers – often in a non-transparent way. Such a decentralised approach ensured "buy-in" of those responsible for the various elements of the forecasts. But it had two major drawbacks. The first was that it was open to manipulation, and sometimes mirrored the prejudices of policymakers. The second was that too little attention was paid to the economic

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[1] This note reflects my own views, not those of the BIS. I am grateful for helpful discussions on this subject with Ryan Banerjee, Marco Lombardi and James Yetman, all of the BIS.

logic of the aggregate response of the model to shocks. One example from my OECD days illustrates this. A central issue at that time concerned the impact of fiscal expansion in current account surplus countries (eg Germany) on global growth. The Keynesian income-expenditure models of the type developed by Lawrence Klein and adopted by the OECD gave some plausible answers to this. But the Germans objected that this model was too Keynesian. One specific argument they advanced was that the German household saving rate rose whenever inflation expectations increased. Fiscal expansion would lift inflation expectations. So the OECD econometricians got to work to estimate a consumption function with the strongest real wealth effect they could find ... so that they could say their model incorporates this effect. The new equation was duly put in the model and – hey presto! – fiscal expansion in Germany no longer stimulated German GDP or global growth. But a very simple investigation that I carried out revealed that, in this new model, no exogenous shock to demand (eg a rise in exports or fixed capital formation) raised GDP. Real GDP in Germany had become invariant to all demand shocks.

These shortcomings of large-scale econometric models containing a huge number of reduced form equations led to a search for alternatives. A general equilibrium model – in which aggregate outcomes are the plausible consequence of rational individual decisions ("microfounded") – was an obvious alternative. If they are to be readily grasped by users, models with such microeconomic logic have to be small. But early small-scale models were often found too simplistic, and unable to reproduce stylized facts. In addition, some policymakers still hankered after the great detail of the econometric models they were replacing. So, over the years, DSGE models used by central banks became very large. Detail came at the price of ease of interpretation: models became too complex and, very often, proved too sensitive to small changes in inputs or assumptions. Even so, experience gained with the early versions of such models had a durable influence on central banks' modelling capacities.

Use of DSGE models at the RBNZ seems to have mirrored this evolution. An earlier large-scale DSGE model (KITT) could not be made into a practical tool for forecasters. NZSIM was developed in order to provide a forecasting tool that would be used. Equally important, NZSIM is a tool that can be used to analyse what happened in the past and to consider policy options. One advantage of trying to use the same model for all three purposes – analysis of the past, forecasting and the assessment of policy options – is that it favours objectivity/impartiality. When there is a proliferation of different models on offer, there is the danger that a particular model is selected à la carte to fit prejudices.

3. Usefulness of a general equilibrium model for forecasting

There are at least three criteria for judging the effectiveness of any model used as an aid to the preparation of forecasts for a monetary policy committee: *intellectual coherence* concerning how monetary policy actually works; *tractability* for the forecasters (many of whom will not be model boffins) who must turn round very quickly (and with a high degree of accuracy) the successive iterations of the projections; *comprehensibility* so that members of the monetary policy committee can think in terms of the model as they consider successive iterations.

(i) *Intellectual coherence*. General equilibrium models normally impose coherence. The policy framework is standard for a small open economy. The policy rule is a Taylor rule (ie the policy rate responds to the deviation of expected inflation from target and to the output gap) with the addition of the deviation of the exchange rate from equilibrium. NZSIM follows the mainstream version as to how monetary policy operates. It incorporates many ways in which changes to the 90-day rate feed through to the real economy and so affect financial variables.

(ii) *Tractability.* This proved to the main shortcoming of KITT. I was told that neither its developers nor the forecasters really understood how to use it. Successive iterations proved too cumbersome. NZSIM has proved much easier to use and forecasters were at ease "tweaking" the model to incorporate both their special knowledge (see below) and the judgement of MPC members whilst respecting the model's underlying logic.

(iii) *Comprehensibility.* Within their own world, academic model-builders can sometimes thrive by displaying greater virtuosity than their peers. But a model that becomes too complex to be understood by MPC members will be ignored. It was quite clear from the discussions I observed that MPC members grasp the logic of the model-based projections presented them, and that this helps to shape their debate.

Not all DSGE models have been subjected to the tests of their usefulness for forecasting. Therefore the effort the authors made to carry out a forecasting evaluation exercise is commendable. Their results show the model is suitable for forecasting purposes especially in the medium term.

A model should also help to ensure that policy discussions take place with "eyes wide open" to the complexity of macroeconomic interactions. The user friendly design of the Graphic User Interface (GUI) supports this objective. It aims to help economists explore the impact of shocks on the model forecast. It does so by prompting reflection on the sources of, and transmission mechanisms behind, various shocks. The demonstration of GUI arranged for me addressed a question I had asked before coming about the impact of an exchange rate shock. The GUI system gave me a prompt that invited me to specify the source of the shock: what is assumed to cause the rise in the exchange rate? This seems to be a useful mechanism to counter the tendency to fall back of misleading rules of thumb.

The model is suitable for the input of judgement. The Reserve Bank is very transparent in its published forecasts, which include forecasts of a future path for short-term interest rates (the RBNZ was a pioneer here). A speech last year by Assistant Governor McDermott (2013) provided a useful explanation of the forecasting process, underlying some inescapable uncertainties forecasts must grapple with. The use of alternative scenarios is a useful practice to bring home to the public that different assumptions can produce a different outlook.

4. Pragmatic treatment of non-structural variables

An inevitable consequence of keeping the main model simple is that forecasters (and others in the Bank) will know more about economic relationships than what has been built into the model. Hence the model will need to be supported by other research.

It was very clear from the meetings I attended that both the special knowledge of forecasters and empirical research were taken into account in a very open-minded way. Such pragmatism improves the forecast process. I was very impressed by the seriousness with which such research is used. One example was the relationship between migration and house prices. Foreigners coming to New Zealand have a different effect than the return of New Zealanders. What happens in Australia influences migration. And so on. Such effects need to be quantified. The uncertainty about such qualification can also be assessed. All this can influence the forecast – even it would be unwise to build them in to the main model.

Extensive use is also made of small satellite variables. The use of off-model estimates from satellite variables to generate projections of other variables is straightforward *where such estimates do not themselves feedback to other structural variables.*

Matters are less straightforward when satellite variables feedback onto the structural variables – the semi-structural block. Consider, for instance, house prices: there is a very strong correlation between house prices and private consumption in New Zealand. House

prices cannot be taken as exogenous because they depend on interest rates and debt, which are endogenous structural variables. The difficulty with adding a reduced form equation semi-structural variable is that it could result in unexpected and hard-to-rationalise dynamics elsewhere in the model – because of the general equilibrium nature of the model. The model builders therefore apply a double-check – comparing the impulse responses in the model with and without the semi-structural variable. Decisions on certain occasions to exclude some variables that at first sight appear plausible on the ground that their inclusion because such would result in odd dynamics elsewhere in the model seem wise. The bar to introducing such variables should be high to preserve the qualities of a structural model.

5. What is missing?

The bar to the addition of new structural variables in DSGE models is rightly set high – quite unlike the old large-scale econometric models when equations were added à la carte. Therefore researchers who want to add a new variable need to show the pay-off would exceed costs that would arise from compromising intellectual coherence, tractability and comprehensibility.

So I gave some thought to the question of what variables or areas might be missing. Three candidates for inclusion came to mind: fiscal policy; business capital formation; and the long-term interest debt.

(a) *Fiscal policy.* The lack of a fuller fiscal block is one question. On reflection, however, it is not clear that incorporating anything more detailed in the fiscal block would be justified. Fiscal policy changes are just too sui generis. In addition, New Zealand has a tradition of avoiding fiscal deficits – which makes it easier to separate monetary policy from fiscal policy.

(b) *Business capital formation.* Microeconomic effects related to the central bank policies are, in principle, important drivers of fixed investment. Changes to interest rates should have an impact on business investment. In addition, attempts to hold back residential investment – now of greater interest because of new macroprudential policies? – should release funds for increased business investment. But it has to be recognised that economists have not been good at incorporating such microeconomic effects in business investment equations. It has proved difficult to improve in a simple way on the classic accelerator relationship. In addition, business equipment goods are typically imported: so "shocks" to business investment affect primarily the current account rather than real GDP.

(c) *The long-term interest rate.* My own view is that changes in the term premium is a key – but much-neglected – element of the transmission of monetary policy. There is a lot of evidence that the term premium in US Treasuries dominates term premia in other bond markets – even if local central banks can keep short-rates some distance from US levels. Movements in bond markets have significant effects for private sector wealth, especially that held via institutions. However, changes in long-term rates may not have the large effects on aggregate demand seen in other countries because New Zealand mortgage rates are not linked to the long-term rate.

My conclusion is there is no obvious missing structural variable. Nevertheless, it is important for the model builders to keep an open mind on this question. The model itself should stimulate other researchers to make a good case for additional variables or for the replacement of certain variables.

Conclusion

The strategic choice to keep NZSIM small has been vindicated by the use I saw it put to during the forecasting round in February 2014. It not only produced the central projection but also helped shape the answers to "what if you assumed x" questions during this round. This is an achievement as many central banks have failed to operationalise their general equilibrium models. The use of a model disciplines the policy debate, and can expose thinking that is partial or incomplete. The use of many, alternative forms of supplementary analysis supported the forecast process very well.

Philip Turner
Deputy Head
Monetary and Economic Department
Bank for International Settlements

References

Kamber, G, C McDonald, N Sander and K Theodoridis (2013): "A structural forecasting model for New Zealand: NZSIM". 22 November.

McDermott, J (2013): "The role of forecasting in monetary policy". Speech delivered to FINSIA in Wellington. 15 March.