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Policy Applications of a Global Macroeconomic Model

Central banks and other policy institutions have a long history of using macroeconomic models to help prepare forecasts and to quantify the economic consequences of various policies. Likewise, private sector firms have long depended on models to summarize these complex interactions succinctly and to evaluate the likelihood of specific macroeconomic outcomes; this is especially true for financial institutions, where such models can help with capital investment and asset allocation decisions.

Typically, such macroeconomic models focus on a single country and treat outcomes in the rest of the world as an input that is not explicitly modeled. As international trade has burgeoned, however, interest in models that formally account for global developments has emerged. Although such "multi-country" models have existed for some time, they are often large and complex and can be cumbersome and unwieldy to employ, which limits their usefulness in many situations.

Recognizing both the advantages that models can provide the private sector and the difficulties with many existing multi-country models, Pesaran et al. (2003) constructed a global macroeconomic model that is both compact and relatively straightforward to implement. Their global vector autoregression (GVAR) model combines national and international variables using standard statistical methods to forecast a core set of variables for multiple countries. The authors motivate their model as a tool for valuing banks' global asset portfolios and for quantifying the impact of global macroeconomic shocks on the value of these portfolios.

In this *Economic Letter*, we summarize the key components of the GVAR model and discuss its usefulness for monetary policy applications and for credit risk management issues faced by financial institutions and their government supervisors. We argue that while the GVAR model is probably useful for credit risk management and could potentially have some use for bank supervision, it is unlikely to be as useful for monetary policy applications.

An overview of the GVAR model

The GVAR model that Pesaran et al. (2003) develop begins with individual models of eleven countries and regions—the U.S., Germany, Japan, China, France, the UK, Italy, Western Europe, Southeast Asia, Latin America, and the Middle East—which collectively make up about 80% of world GDP. The model for each country or region seeks to explain six core macroeconomic variables: GDP, consumer prices, nominal money supply, nominal equity prices, the nominal exchange rate, and the nominal long-term interest rate. Focusing on these broad aggregates rather than on disaggregate data, such as personal consumption and business investment, keeps the model small and manageable and helps make it easy to operate. The cost of this broad aggregate focus, of course, is the inability to assess the sectoral impact of shocks or to examine the aggregate effect of sectoral shocks.

The GVAR model is pieced together by connecting these eleven models, each of which is designed to mesh with the others, much like the pieces of a jigsaw puzzle. Specifically, the six domestic variables in each country/region are modeled, and their parameters are estimated, using a particular form of vector autoregressive model commonly used in macroeconomics. This form specifies that the domestic variables depend on their lagged values and on current and lagged values of "rest-of-the-world" measures of the six variables. For example, in the Italian model, Italy's trade weights with the other countries and regions are used to construct the Italian measures of the six variables for the rest of the world; the domestic variables in the Italian model then are taken to depend on the current and lagged values of these trade-weighted aggregates in addition to the lagged values of the domestic Italian variables.

To operate the aggregate model, one simply connects each of the individual models by feeding into each the trade-weighted predictions from the other ten models. The result is a system describing more than 60 variables in terms of the lagged values of these

variables, which can be analyzed and used for forecasting without specialized modeling software.

The GVAR model puts more emphasis on the time-series properties of the macroeconomic data than on economic theory. In particular, the model takes advantage of empirical estimates of the long-term comovements between macroeconomic variables, known as cointegrating relationships, to produce statistical summaries of the relationships among the variables. Economic theory does guide the model's structure to the extent that the "rest-of-the-world" variables entering each country/region model are treated very differently during estimation than the domestic variables, a version of the small country assumption that makes sense from an economic standpoint. More generally, though, the estimation is free to determine the number and nature of any cointegrating relationships, and these cointegrating relationships are not given an economic interpretation.

In order to use what is essentially a dynamic macroeconomic forecasting model for credit risk analysis, a link is created by assuming that the stock market value of a firm with outstanding debt is a function of the regional and global macroeconomic environment in which it operates. The link is a regression of firm stock returns on the relevant domestic and international macroeconomic variables in the GVAR model. If the value of the firm falls below a predefined threshold, based on historical bond ratings, the firm is said to default, and its debt is then worth a fraction of its face value. By linking the GVAR model's macroeconomic output to the financial health of firms in a bank's loan portfolio, the value of the portfolio can be calculated for a specific set of macroeconomic outcomes, or it can be simulated for a variety of outcomes.

Applications for macroeconomic and monetary policy

Most central banks, including those in small open economies that are highly exposed to external shocks, tend not to use global models for policy formulation. The central banks in New Zealand, Australia, and Canada all use models to some degree, but their models focus on describing domestic variables, taking external factors as given. By and large, central banks tend to concentrate their efforts on using models for macroeconomic forecasting, and rather than forecasting foreign GDP or foreign inflation themselves, they might use U.S. Blue Chip macroeconomic forecasts as proxies. However, it is clear that for policy simulations and scenario analyses, quantifying and understanding the effects of global shocks requires a global model.

Would the GVAR model be useful for policy formulation? Unfortunately, the answer is likely to be no, partly because the model is not sufficiently theoretical for policy analysis, and partly because the limited dynamic structure used to describe each country or region makes it difficult for the model to capture the mechanisms at play in actual economies.

The importance of the latter point is made clear in Pagan (2003), who used the Forecasting and Policy System (FPS) model, a small open economy model of New Zealand operated by the Reserve Bank of New Zealand, to show that simple time-series processes, such as vector autoregressions, cannot easily represent accurately the complex interactions at work in structural macroeconomic models. Pagan's simulations indicate that higher-order lags of the macroeconomic variables (on the order of ten) are needed to approximate the dynamics of the FPS model, suggesting that the GVAR's simple dynamic structure is likely to be insufficient.

The GVAR model has other drawbacks that make it less useful for two kinds of analysis that are of particular significance to monetary policymakers. The first kind of analysis involves issues related to inflation stabilization. A model for this analysis must have the property that inflation is not self-stabilizing, that policy interventions are required to keep inflation low and stable. This property is usually achieved by imposing restrictions on the dynamics of inflation in the model, restrictions that are generally imposed on models but are not imposed on the GVAR model.

The second kind of analysis is policy simulations. For policy simulations, it is desirable to model the relationships between the stocks and the flows of wealth, indebtedness, and capital stocks, for example, in order to account for their effects on current outcomes and in order to respect intertemporal budget constraints. This matters particularly for policy simulations involving optimal policy decisions where the absence of stock/flow relationships and intertemporal budget constraints can appear to offer policymakers a free lunch. The GVAR model does not allow for stock/flow relationships, which limits its ability to address and answer many important policy issues.

Applications for bank supervisory policy

As the world has become more financially integrated, banks have pursued loan opportunities outside of their home countries. Consequently, the balance sheets of large banks typically contain assets that span several countries.

To help ensure that banks hold sufficient capital reserves across countries, the Basel Committee on Banking Supervision (BCBS) was formed and, in 1988, it proposed an international standard of minimum regulatory

capital requirements that was set at 8% of risk-weighted assets. More recently, the BCBS proposed the Basel II Accord to make these capital requirements more sensitive to the underlying credit risks in bank asset portfolios. The new Accord, which should be completed by mid-year 2004 and fully implemented by year-end 2007, should hasten the efforts of banks and their supervisors to examine credit risk and its underlying drivers, both macroeconomic and others, more closely.

The GVAR modeling framework could be of use for banking supervision in two ways. First, supervisors might use the GVAR model's ability to examine several relevant macroeconomic series within and across countries to detect increases in macroeconomic risks that could affect bank portfolios. For example, a consistent forecast of the consequences of a cyclical downturn could warn that the probabilities of corporate defaults are increasing and hence that weaknesses in the financial system are emerging.

However, several major implementation issues regarding the GVAR model, as well as any related models, would need to be addressed first. For example, the forecasting accuracy of the GVAR model over time and with respect to different borrowers would need to be tested thoroughly. It is interesting to note that in one empirical example in Pesaran et al. (2003), the model is able to explain only about a third of firm stock returns. Other important limitations of the GVAR model are its emphasis on publicly traded firms (considering that many bank borrowers do not have publicly traded equity), the stability of the model's estimated coefficients over long time periods, and the robustness of the model to structural shifts in national and international economies. Finally, the benefits of using an international model would be limited to banks that have international lending exposures, which are typically an important but relatively small subset of a national banking system. Also, specific to U.S. supervisors, since the U.S. is essentially considered a closed economy within the GVAR model, its usefulness for U.S.-based institutions is further limited.

Regarding the Basel II process specifically, the GVAR model could provide a convenient framework for approaching credit-risk stress-testing. In Basel II, stress-testing refers to a bank's methodology for analyzing the magnitude of credit losses that could arise under "stress" scenarios, such as broad-based recessions, downturns in specific industries, or large financial market movements. To date, the process banks use to establish their stress-test scenarios and the methods they use for stress testing contain more art than science. The GVAR modeling framework could help credit managers improve these procedures by providing a more coherent structure for considering the global impact of shocks.

Supervisors could potentially benefit from the framework as well. For example, supervisors might be able to use a GVAR model in fashioning guidelines on how bank stress scenarios could be designed and in reviewing the stress scenarios and testing procedures of specific banks.

Conclusion

Macroeconometric models have been used historically by central banks and other policy institutions. The work of Pesaran et al. (2003) has extended these models to incorporate global macroeconomic factors and introduced these models to the field of credit risk management. In this *Economic Letter*, we focus on the GVAR model and consider its possible application to public policy questions. Regarding monetary policy, it is not clear that the GVAR model would be useful for policy analysis. Aside from the fact that most central banks do not typically model global economic factors, their emphasis on policy simulations limits the GVAR model's usefulness. Regarding credit risk applications, while the model's limited dynamic structure is a concern, its ability to link specific firms' credit quality to macroeconomic factors could make the GVAR model an interesting alternative to the extant models. With respect to policy applications, this characteristic could make it an attractive tool for supervisory concerns regarding credit risk stress-testing.

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