International Linkages of the Korean Macroeconomy: The Global VAR Modelling Approach*

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Abstract

The recent development of global vector autoregressive (GVAR) modelling by Pesaran, Schuermann and Weiner (2004) and Dees, di Mauro, Pesaran and Smith (2007) represents an accessible way of incorporating country–specific models into a global framework which overcomes the typical dimensional problems associated with such large scale models. Using 33 countries (26 regions), we extend the model in a number of significant directions. We explicitly account for the trade balance by including real exports and imports, extend the sample period over 1980Q2-2006Q4, and allow for the presence of structural breaks. Focussing on a number of impulse response functions related to current headline events, we find that the impacts of each shock on six focus economies (Korea, the US, the Eurozone, China, Japan and the UK) are mostly consistent with our prior expectations. Furthermore, by focusing on the single and joint probabilities of achieving an inflation target, maintaining acceptable growth and a number of current account scenarios, we provide a great deal of interesting information of relevance to policy decisions.

Keywords: Global (Cointegrating) VAR Modelling, Structural Breaks, Persistence Profiles, Impulse Response Functions, Probability Forecasts of Inflation, Output Growth and Current Account.
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1 Introduction

The recent development of global vector autoregressive (GVAR) modelling by Pesaran, Schuermann and Weiner (2004, PSW), Dees, di Mauro, Pesaran and Smith (2007, DdPS) and Dees, Holly, Pesaran and Smith (2007, DHPS) represents an accessible way of incorporating country–specific models into a global framework which overcomes the typical dimensional problems associated with such large scale models.[1]

We apply this modelling strategy to the same group of 33 countries (26 regions) as considered by DdPS and DHPS, although we revise and extend their research in a number of directions. Firstly, we extend the sample period from 1979Q1-2003Q4 to 1980Q1-2006Q4 to take account of more recent economic events. Secondly, we explicitly acknowledge the possibility of structural breaks among the governing economic relations of our models, the precise nature and timing of which we investigate empirically.[2] Thirdly, given our interest in export–led Asian economies, our models include current account variables (exports and imports). Fourthly, we extend the range of uses to which the GVAR model is put beyond those of previous applications which have typically focussed on the construction of generalised impulse response functions in the analysis of the effects of various shocks on domestic endogenous variables. We compute a range of forecasts and the associated error variance decompositions and discuss the forecasting performance of the GVAR model in detail, offering some comparisons both to the existing literature and to the equivalent country–specific models where possible. Our final contribution is the construction of qualitative 'events–based' forecasts. We compute the individual and joint probabilities of the central bank achieving an inflation target while maintaining a respectable rate of growth, and also consider a number of scenarios relating to the trade balance and its relative improvement or deterioration. This type of scenario–based forecasting provides a means of presenting forecasts derived from the model in a simple, accessible and easily interpreted manner.

The compact GVAR modelling pursued in this paper represents an alternative to the new open economy macroeconomics (NOEM) paradigm which has been gathering strength in monetary policy circles. The contrast between the ease of estimation and empirical strength of VAR and the benefits of the theoretical microfoundations of DSGE models has been well documented (c.f. Pagan, 2003), although it seems that recent advances in Bayesian DSGE modelling may have narrowed the gap in forecasting performance somewhat (c.f. Smets and Wouters, 2007, and Adolfson, Lindé and Villani, 2007). A number of two country and multi–country DSGE models have emerged in recent years, notably those of de Walque, Smets and Wouters (2005) and Cristadoro, Gerali, Neri and Pisani (2006) and the IMF's Global Economy Model (GEM) and Global Fiscal Model (GFM), which are neatly summarised by Bayoumi (2004) and Botman, Karam, Laxton, and Rose (2007). This sparsity of global DSGE models reflects the complexity of the modelling that is required to deliver the rich microfoundations that are considered the principle advantage of DSGE over more empirically oriented approaches including VAR and VECM. The specification and estimation of a DSGE model where the number of countries exceeds two or three is highly computationally demanding and it is in this arena that the GVAR strategy has a decisive advantage. The principle of parsimony suggests that the relatively more simple GVAR specification should be preferred to the DSGE model in terms of out–of–sample forecasting if it can provide a similar degree of accuracy. Moreover, the relative merits of comparatively unrestricted GVAR models and highly restrictive DSGE models must be carefully considered when discriminating between these two competing approaches. If one follows the logic of Sims (1980), then the preferred strategy is that which imposes fewer restrictions, thereby letting the data 'speak for itself': in this sense, GVAR would be preferred to DSGE[3].

Estimation of the 26 country/region–specific models in isolation yields results which are generally encouraging. We focus our discussion on six economies of particular interest: Korea, the US, the Eurozone,

[1]See also Garratt, Lee, Pesaran and Shin (2006, GLPS) for a general introduction to the global modelling approach.

[2]Following Shin (2007) we account for structural breaks using one–time permanent intercept shifts. Further developments including the modelling of multiple regime shifts in a stochastic manner may prove fruitful, although the scope for pursuit of such strategies is likely to be limited in such dimensionally intensive macroeconometric modelling.

[3]Of course, a number of intermediate cases obtain between the extremes of unrestricted VAR and heavily restricted DSGE, including over identified cointegrating VAR and DSGE–VAR (c.f. Del Negro and Schorfheide, 2004). Such approaches provide many interesting avenues for continuing work in the field.

China, Japan and the UK. Our estimation results for these countries are particularly promising. More specifically, we find that the estimation of the long–run cointegrating relationships, the dynamic impulse response functions and the probability forecasts are generally consistent with our prior expectations. In the case of Korea in particular, we find that our modelling is relatively robust to changes in the model specification and that the model provides qualitatively similar findings for most dynamic forecasting scenarios.

The GVAR model is constructed by combining the 26 country/region–specific models using carefully constructed trade–weight link matrices. Focussing on a small number of impulse responses with respect to an oil price shock, a US monetary policy shock, a positive US stock market shock and a Chinese inflationary shock, we find that the impacts of each shock on our focus economies are largely theory–consistent. Moreover, we believe that the results obtained in this manner are superior to those of country–specific modelling in the sense that they will provide a better description of most global variables. In the Korean case, at least in the short-term, we find that: (i) an oil price shock will be inflationary and will decrease output; (ii) tight monetary policy in the US will reduce both inflation and output; (iii) a positive US stock market shock (i.e. a boom) will stimulate the domestic economy, increasing output and leading to gains in the KOSPI; and (iv) elevated inflationary pressure in China will pass through to Korea relatively quickly. Furthermore, we find that the forecasts derived from the GVAR model are often consistent with recent economic developments, including the building recessionary environment in the US and the growing current account deficit in the UK.

The paper proceeds in five sections as follows. Section 2 outlines the cointegrating GVAR model allowing for presence of deterministic structural breaks. The design and structure of the GVAR model are discussed in detail, and the framework for dynamic analysis is briefly described. Section 3 offers a brief analysis of the dataset and discusses the results of the individual country–specific models for our focus economies. These results provide a benchmark scenario against which the performance of the GVAR model may be evaluated. Section 4 discusses the main empirical results of the GVAR model. Section 5 offers some concluding remarks and identifies a number of interesting avenues for further research. Details of the data construction process are provided in the Data Appendix.

2 Global Vector Autoregressive (GVAR) Modelling Approach

Given the increasing globalisation and integration of economic and financial markets, there is a growing desire to explicitly model the sources of foreign influence on domestic economies and the contributions of individual national economies to conditions in foreign economies and the broader world economy. Our interest is in modelling a small open economy (using the example of Korea) and its interactions with foreign economies, most notably the US, Japan, China and the Eurozone. Such an analysis might be used to establish the impact of shocks to the US or Chinese economies on Korea, and vice–versa. Other applications abound, including the modelling of business cycle linkages within and between countries, the consideration of stock market integration which could inform risk–diversification strategies and the analysis of financial linkages and the risk of contagion (PSW approach this issue).

The issue of how to overcome the dimensional problems associated with a large scale model is pursued by PSW and further developed by DdPS and DHPS.[4] The authors develop a global VAR model to investigate global interactions and to facilitate the analysis of regional shocks on the world economy in general. The problem of modelling many economies in a coherent and consistent manner is solved by the careful construction of country–specific 'foreign' variables for use in each of the separate national models. These country–specific foreign variables are treated as weakly exogenous when estimating the national models[5]. The individual country/region–specific models are then combined in a consistent and cohesive manner to generate forecasts for all of the variables in the world economy simultaneously.

[4]While it is possible to extend the national modelling strategy developed in GLPS to cover the same m core variables in each of $N+1$ separate economies, this would involve the estimation of a p^{th} order cointegrated VAR in $mp(N+1)$ parameters. Such high–dimensional modelling is clearly infeasible even when m is as small as 3 or 4.

[5]Specifically, individual country/region–specific VECM models are estimated using a range of domestic macroeconomic variables and the corresponding foreign variables constructed as a weighted average of the data from the remaining countries. The weighting matrix is derived from the international trade pattern.

2.1 Individual Country–Specific Models

Consider a world consisting of $N+1$ economies, indexed by $i = 0, 1, .., N$, and denote the country–specific variables by an $m_i \times 1$ vector, $\boldsymbol{x}_{it}$ and the associated country–specific foreign variables by an $m_i^* \times 1$ vector $\boldsymbol{x}_{it}^*$ defined as[6]

$$\boldsymbol{x}_{it}^* = \sum_{j=0}^{N} w_{ij} \boldsymbol{x}_{jt},$$

where $w_{ij} \geq 0$ are the weights attached to the foreign variables with $\sum_{j=0}^{N} w_{ij} = 1$, and $w_{ii} = 0$ for all i. The second order country–specific VARX* $(2, 2)$ model can be written as

$$\begin{aligned} \boldsymbol{x}_{it} &= \boldsymbol{h}_{i0} + \boldsymbol{h}_{i1} t + \boldsymbol{\delta}_{i0} d_{it} + \boldsymbol{\delta}_{i1} d_{i,t-1} + \boldsymbol{\delta}_{i2} d_{i,t-2} + \boldsymbol{\Phi}_{i1} \boldsymbol{x}_{i,t-1} \\ &+ \boldsymbol{\Phi}_{i2} \boldsymbol{x}_{i,t-2} + \boldsymbol{\Psi}_{i0} \boldsymbol{x}_{it}^* + \boldsymbol{\Psi}_{i1} \boldsymbol{x}_{i,t-1}^* + \boldsymbol{\Psi}_{i2} \boldsymbol{x}_{i,t-2}^* + \boldsymbol{u}_{it}, \end{aligned} \tag{1}$$

where d_{it} is the country–specific intercept shift variable.[7] The dimensions of $\boldsymbol{h}_{ij}$, $j = 0, 1$ and $\boldsymbol{\delta}_{ij}$, $j = 0, 1, 2$, are $m_i \times 1$ while the dimensions of $\boldsymbol{\Phi}_{ij}$, $j = 1, 2$, and $\boldsymbol{\Psi}_{ij}$, $j = 0, 1, 2$, are $m_i \times m_i$ and $m_i \times m_i^*$, respectively. We assume that the error term $\boldsymbol{u}_{it} \sim iid\,(0, \boldsymbol{\Sigma}_{ii})$ where $\boldsymbol{\Sigma}_{ii}$ is an $m_i \times m_i$ positive definite variance–covariance matrix.

PSW show that careful construction of the global variables as weighted averages of the other regional variables leads to a simultaneous system of regional equations that may be solved to form a global system.[8] Notice that the model (1) extends the basic model considered by PSW and DdPS, taking explicit account of the presence of country–specific structural change. The consideration of structural breaks is expected to improve estimation and forecasting results, especially for those East Asian countries most severely hit by the 1997 currency crisis, and for those South American countries that suffered hyperinflation in the 1980s. Based on careful consideration and analysis of the raw data and consultation of relevant news sources, we include break dummies in the models of Argentina, Brazil, the Eurozone, Japan, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Thailand and the UK (see Table 1 for details).

The individual country–specific models are estimated allowing for unit roots and cointegration assuming that country–specific foreign variables are weakly exogenous (see GLPS and Shin, 2007). Hence, the VECM associated with (1) can be written as

$$\begin{aligned} \Delta \boldsymbol{x}_{it} &= \boldsymbol{c}_{i0} + \boldsymbol{c}_{i0}^* \Delta d_{it} + \boldsymbol{c}_{i1}^* \Delta d_{i,t-1} + \boldsymbol{\Lambda}_i \Delta \boldsymbol{x}_{it}^* + \boldsymbol{\Gamma}_i \Delta \boldsymbol{z}_{i,t-1} \\ &+ \boldsymbol{\alpha}_i \boldsymbol{\beta}_i' \left(\boldsymbol{z}_{i,t-1} - \boldsymbol{\mu}_i d_{i,t-1} - \boldsymbol{\gamma}_i (t-1) \right) + \boldsymbol{u}_{it}, \end{aligned} \tag{2}$$

where $\boldsymbol{z}_{it} = (\boldsymbol{x}_{it}', \boldsymbol{x}_{it}^{*\prime})'$, $\boldsymbol{\alpha}_i$ is an $m_i \times r_i$ adjustment matrix of rank r_i and $\boldsymbol{\beta}_i$ is a $(m_i + m_i^*) \times r_i$ cointegrating matrix of rank r_i.[9] Notice that (1) can be rewritten as

$$\boldsymbol{A}_{i0} \boldsymbol{z}_{it} = \boldsymbol{h}_{i0}^* + \boldsymbol{h}_{i1} t + \boldsymbol{A}_{i1} \boldsymbol{z}_{i,t-1} + \boldsymbol{A}_{i2} \boldsymbol{z}_{i,t-2} + \boldsymbol{u}_{it}, \tag{3}$$

where

$$\underset{m_i \times (m_i + m_i^*)}{\boldsymbol{A}_{i0}} = (\boldsymbol{I}_{m_i}, -\boldsymbol{\Psi}_{i0}); \quad \underset{m_i \times (m_i + m_i^*)}{\boldsymbol{A}_{i1}} = (\boldsymbol{\Phi}_{i1}, \boldsymbol{\Psi}_{i1}); \quad \underset{m_i \times (m_i + m_i^*)}{\boldsymbol{A}_{i2}} = (\boldsymbol{\Phi}_{i2}, \boldsymbol{\Psi}_{i1});$$

$$\boldsymbol{h}_{i0}^* = \boldsymbol{h}_{i0} + \boldsymbol{\delta}_{i0} d_{it} + \boldsymbol{\delta}_{i1} d_{i,t-1} + \boldsymbol{\delta}_{i2} d_{i,t-2}.$$

The parameters of (3) can be obtained from the parameters of (2) by using the following relationship:

$$\boldsymbol{A}_{i0} = (\boldsymbol{I}_{m_i}, -\boldsymbol{\Lambda}_{i0}); \; \boldsymbol{A}_{i1} = \boldsymbol{A}_{i0} + \boldsymbol{\Pi}_i + \boldsymbol{\Gamma}_i; \; \boldsymbol{A}_{i2} = -\boldsymbol{\Gamma}_i; \tag{4}$$

[6] The number of variables in the different country models need not be the same.

[7] It is easily seen that d_{it} is also subject to the same VAR(2) lag order dynamic (see Shin, 2007).

[8] They also provide theoretical arguments as well as empirical evidence in support of the weak exogeneity assumption that allows the country/region–specific models to be estimated consistently.

[9] Noting that

$$\boldsymbol{\beta}_i' (\boldsymbol{z}_{it} - \boldsymbol{\mu} d_{it} - \gamma_i t) = \boldsymbol{\beta}_{ix}' \boldsymbol{x}_{it} + \boldsymbol{\beta}_{ix^*}' \boldsymbol{x}_{it}^* - (\boldsymbol{\beta}_i' \boldsymbol{\mu}_i) \, d_t - (\boldsymbol{\beta}_i' \gamma_i) \, t,$$

it is clearly possible to test the co–trending restrictions, $\boldsymbol{\beta}_i' \gamma_i = 0$, and the co–breaking restrictions, $\boldsymbol{\beta}_i' \boldsymbol{\mu}_i = 0$.

$$\boldsymbol{h}_{i0}^{*} = \boldsymbol{c}_{i0} + \boldsymbol{c}_{i0}^{*}\Delta d_{it} + \boldsymbol{c}_{i1}^{*}\Delta d_{i,t-1} + \left(-\boldsymbol{\Pi}_i\boldsymbol{\mu}_i\right) d_{i,t-1};\ \boldsymbol{h}_{i1} = -\boldsymbol{\Pi}_i\boldsymbol{\gamma}_i. \tag{5}$$

where $\boldsymbol{\Pi}_i = \boldsymbol{\alpha}_i\boldsymbol{\beta}_i'$. An extension to the general VARX* (p, q) form is straightforward.

We follow DdPS in our selection of 26 countries/regions (as defined in Table 1) and select the following core variables for country $i = 1, ..., N$:[10]

$$\boldsymbol{x}_{it} = \left(re_{it}, r_{it}, m_{it}, x_{it}, q_{it}, \Delta p_{it}, y_{it}\right)', \tag{6}$$

$$\boldsymbol{x}_{it}^{*} = \left(p_t^o, r_{it}^{*}, q_{it}^{*}, \Delta p_{it}^{*}, y_{it}^{*}\right)'. \tag{7}$$

The core variables considered are the log of real per capita output (y_{it}), the log of the general price level (p_i), the rate of price inflation (Δp_{it}), the log of exports (x_{it}), the log of imports (m_{it}), the short term interest rate (r_{it}), the log of the nominal exchange rate in terms of the US Dollar (e_{it}), the log of real equity prices (q_{it}), and the log of the nominal spot oil price (p_t^o). The corresponding country–specific foreign variables are defined as follows:

$$y_{it}^{*} = \sum_{j=0}^{N} w_{ij}y_{jt};\ p_{it}^{*} = \sum_{j=0}^{N} w_{ij}p_{jt};\ \Delta p_{it}^{*} = \sum_{j=0}^{N} w_{ij}\Delta p_{jt};\ x_{it}^{*} = \sum_{j=0}^{N} w_{ij}x_{jt};\ m_{it}^{*} = \sum_{j=0}^{N} w_{ij}m_{jt};$$

$$r_{it}^{*} = \sum_{j=0}^{N} w_{ij}r_{jt};\ e_{it}^{*} = \sum_{j=0}^{N} w_{ij}e_{jt};\ q_{it}^{*} = \sum_{j=0}^{N} w_{ij}q_{jt},$$

where w_{ij} is the share of country j in the trade (exports plus imports) of country i such that $w_{ii} = 0$ and $\sum_{j=0}^{N} w_{ij} = 1$. We also follow DHPS and include the log real effective exchange rate, $re_{it} = ee_{it} + p_{it}^{*} - p_{it} = \tilde{e}_{it} - \tilde{e}_{it}^{*}$ (where $ee_{it} = \sum_{j=0}^{N} w_{ij}e_{ijt}$ is the nominal effective exchange rate) amongst the endogenous variables.[11]

In our application, each country–specific model includes 7 endogenous and 5 exogenous variables.[12] However, due to the lack of reliable data, we omit equity prices, q_{it}, from the Chinese, Indonesian, Peruvian, Saudi Arabian and Turkish models. Furthermore, the Saudi Arabian Monetary Agency does not publish a reliable short–term interest rate covering our sample period and so this too is omitted.[13]

Finally, the US, as the reference country, is treated differently. The US model is linked to the outside world through exchange rates themselves being determined in the rest of the country–specific models. Thus we have:

$$\boldsymbol{x}_{0t} = \left(p_t^o, r_{0t}, m_{0t}, x_{0t}, q_{0t}, \Delta p_{0t}, y_{0t}\right)',\ \boldsymbol{x}_{0t}^{*} = \left(\tilde{e}_{0t}^{*}, \Delta p_{0t}^{*}, y_{0t}^{*}\right). \tag{8}$$

The main difference between the US and the rest–of–the–world (ROW) is that re_{0t} is not included and p_t^o is endogenous in the US. In our application, we follow DdPS and DHPS and omit both r^* and q^* from the set of weakly exogenous variables, arguing that they are endogenous to the US economy.[14]

[10] Due to the well–known measurement and comparability issues, we do not consider the inclusion of monetary aggregates in the current paper (see also DdPS). This will be addressed in a separate paper.

[11] This follows because $re_{it} = \sum_{j=0}^{N} w_{ij}e_{ijt} + p_{it}^{*} - p_{it} = e_{it} - e_{it}^{*} + p_{it}^{*} - p_{it} = \tilde{e}_{it} - \tilde{e}_{it}^{*}$. PPP holds if $re_{it} = \tilde{e}_{it} - \tilde{e}_{it}^{*} \sim I(0)$. PSW and DdPS use $\tilde{e}_{it}$ and $\tilde{e}_{it}^{*}$ separately as endogenous and exogenous variables, respectively. An alternative specification adopted by GLPS uses $\boldsymbol{x}_{it} = \left(ee_{it}, r_{it}, m_{it}, x_{it}, q_{it}, pps_{it}, \Delta p_{it}, y_{it}\right)'$ and $\boldsymbol{x}_{it}^{*} = \left(p_t^o, r_{it}^{*}, q_{it}^{*}, y_{it}^{*}\right)'$, where $pps_{it} = p_{it} - p_{it}^{*}$ and Δp_{it}^{*} is dropped to avoid the collinearity problem.

[12] The exogenous variables include the global oil price but omit foreign exports and imports. This omission is motivated by two considerations. Firstly, we prefer a smaller, more parsimonious model to a large and complex model. Secondly, there is a theoretical inconsistency associated with the inclusion of domestic imports and exports as endogenous variables and foreign imports and exports as weakly exogenous variables which derives from the nature of international trade. It follows that whatever is imported by one country must be exported by another country or group of countries. In such a situation, one cannot argue that imports are endogenous without conceding that foreign exports are similarly endogenous. A similar argument may made in the case of domestic exports and foreign imports.

[13] Hence, for China, Indonesia, Peru, and Turkey, we have $\boldsymbol{x}_{it} = \left(re_{it}, r_{it}, m_{it}, x_{it}, \Delta p_{it}, y_{it}\right)'$ and for Saudi Arabia $\boldsymbol{x}_{it} = \left(re_{it}, m_{it}, x_{it}, \Delta p_{it}, y_{it}\right)'$. We use the same foreign variables defined above for these countries.

[14] If either r^* or q^* are endogenous, the results of country–specific modelling will be biased and this will significantly affect the resulting global estimation results. In this regard we may drop either r^* or q^* or both for other financially dominant countries such as the UK, Japan and the Euro Area.

2.2 Long–Run Equilibrium Conditions

We shall consider the following 8 relationships as possible long–run equilibrium conditions linking the core variables of the ith economy to those in all other countries in the global economy:[15]

$$y_{it} - \beta_{11,i}x_{it} = a_{1i} + \zeta_{1,it},\ \beta_{11} > 0, \tag{9}$$

$$r_{it} - \Delta p_{it} = a_{2i} + \zeta_{2,it}, \tag{10}$$

$$r_{it} - r_{it}^* = a_{3i} + \zeta_{3,it}, \tag{11}$$

$$ee_{it} + p_{it}^* - p_{it} - \beta_{41,i}\left(y_{it} - y_{it}^*\right) = a_{4i} + \zeta_{4,it},\ \beta_{41,i} > 0, \tag{12}$$

$$q_{it} - \beta_{51,i}y_{it} + \beta_{52,i}\left(r_{it} - \Delta p_{it}\right) = a_{5i} + \zeta_{5,it},\ \beta_{51,i}, \beta_{52,i} > 0, \tag{13}$$

$$m_{it} - \beta_{61,i}y_{it} = a_{6i} + \zeta_{6,it},\ \beta_{61} > 0, \tag{14}$$

$$y_{it} - y_{it}^* = a_{8i} + \zeta_{8,it}. \tag{15}$$

$$q_{it} - q_{it}^* = a_{9i} + \zeta_{9,it}. \tag{16}$$

The first relationship represents aggregate demand and relates the log of output to the log of exports (additional demand shifting factors could be included as appropriate). This simple specification represents export–led growth in most East Asian countries including China and Korea. The second relationship, the Fisher equation, suggests that the real interest rate is stationary and ergodic. The third relationship is a long–run version of the uncovered interest parity (UIP) condition which omits $E_t\left(\Delta e_{i,t+1}^*\right)$, the expected rate of depreciation of the currency of country i.[16] The fourth relationship represents PPP modified to allow for differential productivity growth rates across countries (the so–called Harrod–Ballassa–Samuelson effect, or, in the terms of Officer (1976), 'productivity–biased' PPP). It relates the log of the nominal effective exchange rate, $ee_{it} = \sum_{j=0}^{N} w_{ij}e_{ijt}$, to the log price ratio, $p_{it}^* - p_{it}$, and the per capita output gap, $y_{it} - y_{it}^*$ [17]. The fifth relationship relates to equity markets and has real equity prices varying procyclically with real output and real interest rates, where the real rate is inversely proportional to the subjective rate of time preference. In the case where the real interest rate is stationary, (13) predicts a long–run relationship between real equity prices and real output only. The sixth relationship posits that the log of imports is positively related to domestic output directly via final demand and indirectly via intermediate demand. The seventh relationship postulates that domestic and foreign output are convergent in the long–run. Although the neoclassical growth model does not explicitly address the issue of cross–country output convergence, it is argued that, in an interrelated global economy, technological progress (taken to be an unobserved I(1) process) is likely to become increasingly common across countries. This may happen for a number of reasons, most notably innovation and imitation of traded goods such that the downstream economy may appropriate some (or potentially all) of the technological advantage of the innovative exporter (an example of the 'conditional convergence' literature is Barro and Sala–i–Martin, 1997). Output convergence will be complete if cross–country technological diffusion is perfect and the Solow–Swan growth process is applied to each country separately. In the case of perfect output convergence, the productivity–biased PPP relation reduces to the classical version, $ee_{it} + p_{it}^* - p_{it} \sim I(0)$. Similarly, the eighth relationship represents long–run convergence between domestic and foreign equity prices, derived from the increasing globalization and liberalization of the financial transactions mechanism.

[15] We allow for different long–run relations in different countries. Notice also that, for simplicity, we do not include deterministic time trends or intercept shift dummies in the above long–run relationships.

[16] We describe this equation as long–run UIP as it is widely acknowledged that $E_t\left(\Delta e_{i,t+1}^*\right)$ follows a stationary I(0) process and, therefore, does not belong in a long–run (cointegrating) relationship. When the exchange rate follows a random walk, the UIP condition reduces to (11).

[17] Note that ee_{it} differs from $e_{it}^* = \sum_{j=0}^{N} w_{ij}e_{jt}$. The latter is defined in terms of the US dollar exchange rates whilst the former is measured in terms of the bilateral exchange rates. Note also that the output gap as defined here differs from the typical concept of the output gap as the difference between actual and potential output. A similar implementation of productivity–biased PPP may be found in GLPS.

2.3 Construction of the GVAR model

This section describes the process of combining the country specific models into GVAR. Define an $(m+1) \times 1$ vector of the intermediate global variables with $m = \sum_{i=0}^{N} m_i$ as

$$\tilde{\boldsymbol{x}}_t = \left(\tilde{\boldsymbol{x}}'_{0t}, \tilde{\boldsymbol{x}}'_{1t}, ..., \tilde{\boldsymbol{x}}'_{Nt}\right)',$$

where[18]

$$\tilde{\boldsymbol{x}}_{0t} = \left(\tilde{e}_{0t}, p_t^o, r_{0t}, m_{0t}, x_{0t}, q_{0t}, \Delta p_{0t}, y_{0t}\right)', \;\; \tilde{\boldsymbol{x}}_{it} = \left(\tilde{e}_{it}, r_{it}, m_{it}, x_{it}, q_{it}, \Delta p_{it}, y_{it}\right)'.$$

Then, $\boldsymbol{z}_{it}$ can be expressed as

$$\boldsymbol{z}_{it} = \boldsymbol{W}_i \tilde{\boldsymbol{x}}_t, \;\; i = 0, 1, ..., N, \tag{17}$$

where $\boldsymbol{W}_i$ are $(m_i + m_i^*) \times (m+1)$ link matrices defined in terms of trade–weights.

Using (17) in (3) and stacking the results we obtain

$$\boldsymbol{H}_0 \tilde{\boldsymbol{x}}_t = \boldsymbol{h}_0^* + \boldsymbol{h}_1 t + \boldsymbol{H}_1 \tilde{\boldsymbol{x}}_{t-1} + \boldsymbol{H}_2 \tilde{\boldsymbol{x}}_{t-2} + \boldsymbol{u}_t, \tag{18}$$

where

$$\underset{m\times(m+1)}{\boldsymbol{H}_0} = \begin{pmatrix} \boldsymbol{A}_{00}\boldsymbol{W}_0 \\ \boldsymbol{A}_{10}\boldsymbol{W}_1 \\ \vdots \\ \boldsymbol{A}_{N0}\boldsymbol{W}_N \end{pmatrix}; \;\; \underset{m\times(m+1)}{\boldsymbol{H}_1} = \begin{pmatrix} \boldsymbol{A}_{01}\boldsymbol{W}_0 \\ \boldsymbol{A}_{11}\boldsymbol{W}_1 \\ \vdots \\ \boldsymbol{A}_{N1}\boldsymbol{W}_N \end{pmatrix}; \;\; \underset{m\times(m+1)}{\boldsymbol{H}_2} = \begin{pmatrix} \boldsymbol{A}_{02}\boldsymbol{W}_0 \\ \boldsymbol{A}_{12}\boldsymbol{W}_1 \\ \vdots \\ \boldsymbol{A}_{N2}\boldsymbol{W}_N \end{pmatrix},$$

$$\boldsymbol{h}_0^* = \begin{pmatrix} \boldsymbol{h}_{00}^* \\ \boldsymbol{h}_{10}^* \\ \vdots \\ \boldsymbol{h}_{N0}^* \end{pmatrix}; \;\; \boldsymbol{h}_1 = \begin{pmatrix} \boldsymbol{h}_{01} \\ \boldsymbol{h}_{11} \\ \vdots \\ \boldsymbol{h}_{N1} \end{pmatrix}; \;\; \boldsymbol{u}_t = \begin{pmatrix} \boldsymbol{u}_{0t} \\ \boldsymbol{u}_{1t} \\ \vdots \\ \boldsymbol{u}_{Nt} \end{pmatrix}.$$

Notice that since $\tilde{e}_{0t}$ is not included among the US variables but is included in $\tilde{\boldsymbol{x}}_t$, the total number of equations in the country–specific models is one less than the number of unknown elements in $\tilde{\boldsymbol{x}}_t$. Without a further restriction, it is not possible to uniquely solve $\tilde{\boldsymbol{x}}_t$ from knowledge of the country–specific models. This final restriction is provided by noting that $e_{0t} = 0$ and hence $\tilde{e}_{0t} = -p_{0t}$. We now set the following $m \times 1$ vector of global economic variables

$$\tilde{\boldsymbol{x}}_t = \left(\mathring{\boldsymbol{x}}'_{0t}, \tilde{\boldsymbol{x}}'_{1t}, ..., \tilde{\boldsymbol{x}}'_{Nt}\right)', \;\; \mathring{\boldsymbol{x}}_{0t} = \left(p_t^o, r_{0t}, m_{0t}, x_{0t}, q_{0t}, p_{0t}, y_{0t}\right)'.$$

where the $\tilde{\boldsymbol{x}}_{it}$'s are defined as above. Note that we are now solving for the US price level as opposed to inflation, though it is inflation that is being solved for in the case of other countries (see also DHPS). It then follows that

$$\tilde{\boldsymbol{x}}_t = \boldsymbol{S}_0 \boldsymbol{x}_t - \boldsymbol{S}_1 \boldsymbol{x}_{t-1}, \tag{19}$$

where $\boldsymbol{S}_0$ and $\boldsymbol{S}_1$ are $(m+1) \times m$ selection matrices defined by

$$\boldsymbol{S}_0 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & -1 & 0 & \mathbf{0} \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \boldsymbol{I}_{m-m_0} \end{pmatrix}, \;\; \boldsymbol{S}_1 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & \mathbf{0} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0}_{m-m_0} \end{pmatrix}$$

[18]As before q is omitted for China, Indonesia, Peru, and Turkey and both q and r are omitted for Saudi Arabia.

Hence we now have

$$\boldsymbol{F}_0\boldsymbol{x}_t = \boldsymbol{h}_0^* + \boldsymbol{h}_1 t + \boldsymbol{F}_1\boldsymbol{x}_{t-1} + \boldsymbol{F}_2\boldsymbol{x}_{t-2} + \boldsymbol{F}_3\boldsymbol{x}_{t-3} + \boldsymbol{u}_t, \tag{20}$$

where $\boldsymbol{F}_0 = \boldsymbol{H}_0\boldsymbol{S}_0$, $\boldsymbol{F}_1 = \boldsymbol{H}_1\boldsymbol{S}_0 + \boldsymbol{H}_0\boldsymbol{S}_1$, $\boldsymbol{F}_2 = \boldsymbol{H}_2\boldsymbol{S}_0 - \boldsymbol{H}_1\boldsymbol{S}_1$, and $\boldsymbol{F}_3 = -\boldsymbol{H}_2\boldsymbol{S}_1$. The reduced–form GVAR is finally obtained as

$$\boldsymbol{x}_t = \boldsymbol{g}_0^* + \boldsymbol{g}_1 t + \boldsymbol{G}_1\boldsymbol{x}_{t-1} + \boldsymbol{G}_2\boldsymbol{x}_{t-2} + \boldsymbol{G}_3\boldsymbol{x}_{t-3} + \boldsymbol{\varepsilon}_t, \tag{21}$$

where $\boldsymbol{G}_j = \boldsymbol{F}_0^{-1}\boldsymbol{F}_j$, $j = 1, 2, 3$, $\boldsymbol{g}_0^* = \boldsymbol{F}_0^{-1}\boldsymbol{h}_0^*$, $\boldsymbol{g}_1 = \boldsymbol{F}_0^{-1}\boldsymbol{h}_1$, and $\boldsymbol{\varepsilon}_t = \boldsymbol{F}_0^{-1}\boldsymbol{u}_t$. Having estimated the separate national models in the form of (1), the global model in (21) can be solved recursively forward to obtain future values of all the endogenous variables in the global model, $\boldsymbol{x}_t$.

Although the model is estimated on a country by country basis, we allow the shocks to be weakly correlated across countries. In particular, it is assumed that $E\left(\boldsymbol{u}_{it}\boldsymbol{u}_{jt}'\right) = \boldsymbol{\Sigma}_{u,ij}$ for $t = t'$ and 0 otherwise. Global interactions take place through three distinct, but interrelated channels: (i) direct dependence of $\boldsymbol{x}_{it}$ on $\boldsymbol{x}_{it}^*$ and its lagged values, (ii) dependence of the region–specific variables on common global exogenous variables such as oil prices, and (iii) non–zero contemporaneous dependence of shocks in region i on shocks in region j, measured via the cross country covariances, $\boldsymbol{\Sigma}_{u,ij}$.

As shown in DdPS, the GVAR model allows for both intra- and inter–country cointegration. The GVAR can also be derived from global factor models where there may exist one or more unobserved common factors with differential effects across countries. Finally, the cointegration properties of the individual country models are preserved in the GVAR model and thus the mean–reverting features of the individual economies carry over to the world economy.

2.4 Link matrices

As discussed above, careful construction of the link matrices used in (17) is critical in the development of the GVAR. In our application, the $\boldsymbol{W}_i$'s are given by[19]

$$\underset{10\times 177}{\boldsymbol{W}_0} = \begin{pmatrix} \boldsymbol{R}_{00} & \boldsymbol{0}_{7\times 7} & \cdots & \boldsymbol{0}_{7\times 7} & \boldsymbol{0}_{7\times 6} & \cdots & \boldsymbol{0}_{7\times 6} & \boldsymbol{0}_{7\times 5} \\ \boldsymbol{0}_{3\times 8} & \boldsymbol{W}_{01} & \cdots & \boldsymbol{W}_{0,20} & \boldsymbol{W}_{0,21} & \cdots & \boldsymbol{W}_{0,24} & \boldsymbol{W}_{0,25} \end{pmatrix},$$

$$\underset{12\times 177}{\boldsymbol{W}_i} = \begin{pmatrix} \boldsymbol{R}_{i0} & \boldsymbol{R}_{i1} & \boldsymbol{R}_{i2} & \cdots & \boldsymbol{R}_{i,25} \\ \boldsymbol{W}_{i0} & \boldsymbol{W}_{i1} & \boldsymbol{W}_{i2} & \cdots & \boldsymbol{W}_{i,25} \end{pmatrix},\ i = 1, ..., 25,$$

where

$$\boldsymbol{R}_{00} = \begin{bmatrix} \boldsymbol{0}_{7\times 1} & \boldsymbol{I}_7 \end{bmatrix},\ \boldsymbol{R}_{i0} = \begin{bmatrix} -w_{i0} & \boldsymbol{0}_{1\times 7} \\ \boldsymbol{0}_{6\times 1} & \boldsymbol{0}_{6\times 7} \end{bmatrix},\ i = 1, ..., 25,$$

$$\{\boldsymbol{R}_{ij}\}_{j=1}^{20} = \left\{ \begin{array}{ll} \begin{bmatrix} -w_{ij} & \boldsymbol{0}_{1\times 6} \\ \boldsymbol{0}_{6\times 1} & \boldsymbol{0}_{6\times 6} \end{bmatrix} & \text{if } j \neq i \\ \boldsymbol{I}_7 & \text{if } j = i \end{array} \right\},\ i = 1, ..., 25,$$

$$\{\boldsymbol{R}_{ij}\}_{j=21}^{24} = \left\{ \begin{array}{ll} \begin{bmatrix} -w_{ij} & \boldsymbol{0}_{1\times 5} \\ \boldsymbol{0}_{6\times 1} & \boldsymbol{0}_{6\times 5} \end{bmatrix} & \text{if } j \neq i \\ \boldsymbol{I}_6 & \text{if } j = i \end{array} \right\},\ i = 1, ..., 25,$$

$$\boldsymbol{R}_{i,25} = \left\{ \begin{array}{ll} \begin{bmatrix} -w_{i,25} & \boldsymbol{0}_{1\times 4} \\ \boldsymbol{0}_{6\times 1} & \boldsymbol{0}_{6\times 4} \end{bmatrix} & \text{if } i \neq 25 \\ \boldsymbol{I}_5 & \text{if } i = 25 \end{array} \right\},$$

$$\{\boldsymbol{W}_{0j}\}_{j=1}^{20} = \begin{bmatrix} w_{0j} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{0j} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & w_{0j} \end{bmatrix},$$

$$\{\boldsymbol{W}_{0j}\}_{j=21}^{24} = \begin{bmatrix} w_{0j} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & w_{0j} & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{0j} \end{bmatrix},\ \boldsymbol{W}_{0,25} = \begin{bmatrix} w_{0,25} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & w_{0,25} & 0 \\ 0 & 0 & 0 & 0 & w_{0,25} \end{bmatrix},$$

[19]See Table 1 for the country order.

and for $i = 1, ..., 25$,

$$\boldsymbol{W}_{i0} = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & w_{i0}^{*} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{i0}^{**} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & w_{i0} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & w_{i0} \end{bmatrix}, \ \{\boldsymbol{W}_{ij}\}_{j=1}^{20} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & w_{ij}^{*} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & w_{ij}^{**} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{ij} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & w_{ij} \end{bmatrix},$$

$$\{\boldsymbol{W}_{ij}\}_{j=21}^{24} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & w_{ij}^{*} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & w_{ij} & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{ij} \end{bmatrix}, \ \boldsymbol{W}_{i,25} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & w_{i,25} & 0 \\ 0 & 0 & 0 & 0 & w_{i,25} \end{bmatrix}.$$

Here w_{ij} is the weight of country i in the trade of country j, w_{ij}^{*} is the ith country's adjusted trade–weight with the jth country after allowing for the lack of Saudi interest rate data, and w_{ij}^{**} is the ith country's trade–weight with the jth country adjusted to accommodate the lack of reliable stock market data for China, Indonesia, Peru and Turkey and Saudi Arabia. Notice that $\sum_{j=0}^{N} w_{ij} = \sum_{j=0}^{N} w_{ij}^{*} = \sum_{j=0}^{N} w_{ij}^{**} = 1$, and $w_{ii} = w_{ii}^{*} = w_{ii}^{*} = 0$ for all i.[20]

2.5 Dynamic analysis of the GVAR model

Here we follow DHPS and provide statistics for analysing the dynamic adjustment process of the variables with respect to shocks. The persistence profiles (PP) refer to the time profiles of the effects of system or variable–specific shocks on the cointegrating relations in the GVAR model. Impulse response functions (IRF) refer to the time profiles of the effects of variable–specific shocks on all variables in the model (see Pesaran and Shin, 1996, 1998, and GLPS). Forecast error variance decomposition (FEVD) of a VAR model has been performed on a set of orthogonalised shocks where the contribution of the jth orthogonalised innovation to the mean squared error of the n–step ahead forecast of the model is calculated. In the case of GVAR, the shocks across countries, u_{it} and u_{st} for $i \neq s$ are not orthogonal. This invalidates the standard application of the orthogonalised FEVD to the GVAR model. An alternative approach invariant to the ordering of the variables is to consider the proportion of the variance of the n–step ahead forecast errors of $\boldsymbol{x}_t$ which is explained by conditioning on non–orthogonalised shocks, u_{jt}, u_{jt+1},..., u_{jt+n} for $j = 1, ..., m$, while explicitly allowing for the contemporaneous correlation between these shocks and shocks to the other equations in the system.[21]

Furthermore, we follow GLPS and provide the estimation and construction of the central forecasts of the m global variables and the associated probability event forecasts in the context of the GVAR model, (21). The compact GVAR modelling described in this paper provides a practical framework for evaluating and measuring probability forecasts of a large variety of empirically important issues in a global context.[22] In empirical application below we focus on the following events of particular interest to national monetary authorities:[23]

[20]Currently, we follow DdPS in our use of the 26 × 26 trade–weighting matrices based on trade averages over the period 1999-2001. Preliminary estimation results based on trade averages over 2001-2003 are qualitatively similar, although the more recent figures are likely to provide sharper forecasts, especially considering the recent rapid Chinese economic growth. We are considering the use of time–varying trade weights, as we believe that this will more fully reflect the changing balance of power among the world economies over the sample period. However, as DdPS note, one must be careful not to introduce an undesirable element of randomness into estimation in this manner.

[21]Detailed derivations and computational techniques of this subsection can be found in the working paper version of the paper.

[22]In order to address the issue of model uncertainty we will provide the forecasting results based on the Bayesian Model Averaging (BMA) framework at a later stage.

[23]See Table 4 for the declared inflation target for each individual country. In some cases, monetary policy does not formally target inflation (e.g. the US). In such cases we use a reasonable figure based on a careful consideration of the targets adopted by similar economies. Where the inflation target is defined in terms of CPI inflation we use this figure. However, in those cases where other measures are used (e.g. the Eurozone which uses HICP and South Africa which uses CPIX) we use an approximately comparable CPI figure. Where countries define a simple target as opposed to an acceptable range, we form an appropriate range centred on this target.

A Achievement of the inflation target, defined as the four–quarterly moving average rate of inflation falling within the acceptable range;

B Achievement of the inflation target, defined as the four–quarterly moving average rate of inflation remaining below the midpoint of the acceptable range;

C Recession, defined as the occurrence of two consecutive quarters of negative output growth;

D Poor growth prospects, identified with the four–quarterly moving average rate of output growth being less than half the historical average;

E Current account deficit, defined as $x - m < 0$; and

F Current account improvement, defined as $\Delta x - \Delta m > 0$.

Furthermore, we consider the following joint events:

- $A \cap \overline{C}$ or $B \cap \overline{C}$ (inflation target is met *and* recession is avoided);
- $A \cap \overline{D}$ or $B \cap \overline{D}$ (inflation target is met *and* growth prospects are reasonable);
- $E \cap F$ (current account deficit *and* improvement - we characterise this as balancing improvement);
- $E \cap \overline{F}$ (current account deficit *and* deterioration - unbalancing deterioration);
- $\overline{E} \cap F$ (current account surplus *and* improvement - unbalancing improvement); and
- $\overline{E} \cap \overline{F}$ (current account surplus *and* deterioration - balancing deterioration).

where $\overline{C}$, $\overline{D}$, $\overline{E}$ and $\overline{F}$ are the complements of C, D, E and F.

3 Data Analysis and Country–Specific Estimation Results

3.1 Data

The dataset consists of 100 quarterly observations between 1982Q1 and 2006Q4 on the variables defined above for 33 countries (26 regions). Detailed data sources and manipulations are described in the data appendix. Due to the extensive nature of the modelling presented in the paper (covering 26 countries/regions, typically with twelve variables) this section provides only a brief summary for a few selected macroeconomic variables of interest.

3.1.1 Real Output Growth

Table 2 provides summary statistics for real output growth. It is immediately apparent that the level and volatility of the average output growth rate varies substantially across countries/regions. The average growth rates of developed countries lie in the range 2-3.5% per annum (e.g. 2.91% for the U.S., 2.14% for the Eurozone, 2.17% for Japan, 2.4% for the UK, 2.98% for Canada and 3.23% for Australia). The emerging economies of Asia have enjoyed considerably faster growth, typically between 5 and 7% (e.g. 6.44% for Korea, 5.89% for India, 6.66% for Singapore and 5.69% for Thailand). The two exceptions are China with the highest growth rate of 9%, and the Philippines which exhibits slow growth at just 2.86%. Among the remaining countries, Turkey and Chile have relatively high growth rates of approximately 4.4% per annum, compared to an average of just 2%.

The growth rates of developed countries are relatively stable, with standard deviations between 2% and 4%, while standard deviations between 6% and 12% typify the emerging and developing countries. Interestingly, China has enjoyed the most rapid growth (9%) in conjunction with volatility comparable to that of a developed economy (just 3.14%).

3.1.2 Inflation

Historical accounts of inflation among the 26 countries/regions are summarised in Table 2. The striking feature is that average rates of inflation in almost all countries are considerably higher than those experienced in recent years. This observation is often attributed to the widespread adoption of inflation–targeting monetary policy regimes in recent years.

The developed economies have the lowest and most stable inflation rates on average, ranging from 2% to 5% (e.g. 3.5% for the US, 3.73% for Eurozone, 1.11% for Japan and 4.34% for the UK). The Japanese figure is somewhat misleading, deriving largely from the post–1990 deflationary era. The emerging Asian economies have experienced slightly higher average inflation rates, mostly of the order of 5-8%. In particular, the figure for China and Korea is approximately 5% and that of India is 7.65%. Singapore and Saudi Arabia are notable for their low inflation rates, at just 1.72% and 0.52%, respectively.

The Latin American countries and Turkey suffered hyperinflation during the sample period which is reflected in the figures which are both high and extremely volatile: 98.9% for Brazil, 71.3% for Argentina, 67.8% for Peru and 41.2% for Turkey. Inflation peaked in Argentina at 759.2% in 1989Q3, 622.61% in Brazil in 1990Q1 and 856.52% in 1990Q3 in Peru.

3.1.3 Real Export and Import Growth

Table 3 summarises the real export and import performance of our sample countries. Similar to the patterns observed for output growth and inflation, the industrialised countries have experienced lower and more stable average export and import growth, typically in the range 1-3%. Emerging and developing economies exhibit higher but more volatile growth rates. For example, the average export and import growth rates are 16.5% and 14.8% for China, 8.87% and 8.88% for India, 7.88% and 6.61% for Korea, 9.1% and 8.13% for Thailand, and 9.44% and 8.41% for Turkey.

Moreover, Table 3 also demonstrates the often large and persistent current account deficits that characterise many of the more developed countries. In particular, the US, UK, Canada, Australia, and New Zealand experience average current account deficits of 1.2%, 0.75%, 0.07%, 0.5% and 0.37%. However, this trend is not universal, with the Eurozone, Japan, Norway, Sweden and Switzerland all experiencing average current account surpluses of 0.57%, 0.98%, 1.61%, 0.93% and 1.15%, respectively. Almost all of the emerging and developing economies enjoy average current account surpluses. China, Korea and Singapore have relatively high surpluses of 1.72%, 1.37% and 1.02%, respectively, reflecting their export–led growth strategies.

3.1.4 Structural Breaks

Given our emphasis on intertemporal effects and our belief that many economies are subject to irregular shocks that fundamentally change the structure of their governing economic relations, we analyse the raw data for individual countries for signs of structural change.[24] When the impacts of structural breaks are considerable (e.g. the 1997 Asian crisis), the choice of whether or not to include break dummies in the individual country models may significantly affect both the cointegrating relationships in the model and its dynamic forecasting performance. But it is also possible that the impacts of breaks will be somewhat attenuated in the global model due to co–breaking.

Table 1 summarises the cause and location of structural breaks. In general, we find substantial support for a break in either 1997Q3 or Q4 for the South–East Asian bloc relating to the financial crisis (in particular inflation and output show a noticeable perturbation). We find that many of the South American economies exhibit striking breaks associated with dollarisation (interest rates, exchange rates and inflation are typically profoundly effected). Our analysis also suggests that the departure of the UK from the ERM had significant repercussions for the domestic economy in 1992Q4 and that the real–estate and stock–market crash in Japan caused a break at 1990Q1. Lastly, we note that our composite

[24]To avoid an arbitrary decision process, we only include breaks when such breakpoints are generally regarded as significantly affecting the macroeconomic performance of individual countries/regions involved over the sample period considered. A more formal, statistical, procedure is clearly desirable but this is currently beyond the scope of the paper.

Eurozone economy reacts noticeably to the introduction of the Euro in 1999Q1, with imports, exports and the exchange rate showing the strongest response.

3.2 Country–Specific Estimation Results

By their nature, global modelling exercises generate a considerable volume of statistical output. In our application, for the typical country there are an average of 3-4 PPs, 38 sheets of assorted IRF output each showing the response of 12 (11 or 10) variables and an average of 3-4 cointegrating vectors to any specific shock, the results of VECM and marginal VAR estimation and 6 different types of central forecast, not to mention the associated event forecasts. In light of this, it is obviously infeasible to discuss all of the estimation results in detail. Hence, we limit our discussion to six focus economies: Korea, the US, the Eurozone, China, Japan and the UK[25].

3.2.1 Korea

Including a structural break at 1997Q4 to account for the (slightly delayed) effects of the Asian financial crisis, the trace statistic selects 5 cointegrating vectors at the 95% level. Figure 1(a) shows that the model estimated on this basis proves stable with well behaved PPs, exhibiting some degree of persistence but no overshooting. In our discussion of the GVAR estimation results in the next section, we note that this persistence is a common trait of most of the South–East Asian economies and is probably caused by some residual effects of the 1997 financial crisis. The VECM and marginal VAR estimation results are promising. In particular, our diagnostic tests detect only minor mis–specifications in some equations, the pattern of significance is generally good and the $\bar{R}^2$s are mostly acceptable.

The SIRFs with respect to the five selected shocks (an oil price shock, a foreign interest rate shock, a foreign equity price shock, a domestic real exchange rate depreciation and a domestic monetary policy shock) are plotted in Figure 2. These SIRFs are well behaved in most cases, the notable exceptions being the large positive equity market response to a foreign interest rate shock, the negative output response to a depreciation and the current account improvement resulting from a domestic interest rate rise.

Comparison of these results with those obtained by Shin (2007) using a slightly different specification in the Korean national CVAR model,[26] reveals that, overall, the patterns of dynamic adjustment are qualitatively similar. For example, in response to an oil price shock, inflation overshoots in the short–run in both models. After four quarters, the current model predicts that inflation stays at a slight positive value whilst it converges to zero in the Korean national model, although this difference is unlikely to be statistically significant. Similarly, the impact of an oil shock on real output is slightly more negative in the Korean national model. One potentially significant discrepancy lies in the impacts of a foreign interest rate shock on domestic inflation. The current model indicates a slight increase in inflation following tight credit conditions overseas, whereas the response of inflation to a US interest rate hike is mildly negative in the Korean national model. This difference derives, of course, from the definitions of r^* employed by each model.

The model forecasts initial low inflation at just 1.2% but which displays a mild upward trend indicating some latent inflationary pressure (see Figure 3). Output is forecast to grow steadily for four quarters before stabilising at approximately 6.4%, which is perhaps a little optimistic but remains consistent with historical experience. These output forecasts are somewhat similar to those of the Korean national model, while the inflation forecasts provide a significantly different profile, especially in the long–term. However, the inflation forecasts of both models remain well below 2% for the first three quarters.

Finally, in terms of probability event forecasting (Table 6), we find that the Bank of Korea has a high probability of maintaining inflation within a range of 2% to 4% while avoiding either recession or low growth in the medium–term. Compared to the results obtained from the Korean national model,

[25]Detailed country–specific estimation results for all countries/regions are available from the authors on request.

[26]Shin defines $\boldsymbol{x}_t = (e_t, r_t, m_t, x_t, q_t, h_t, pps_t, \Delta p_t, y_t)'$ and $\boldsymbol{x}_t^* = (p_t^o, r_t^*, q_t^*, y_t^*)'$, where h_t is the log of the money–output ratio and $pps_t = p_t - p_t^*$ is the relative price. An additional difference lies in the construction of foreign variables. In particular, r_t^* and q_t^* are proxied by the US interest rate and equity price index, while both p^* and y_t^* are constructed using the OECD aggregate measures. Estimation results are based on the finding that $r = 7$.

the probabilities are higher in the short–term but smaller in the medium- and long–term. Indeed, after a year, the probabilities for both joint events drop well below 50%.

3.2.2 USA

The trace statistic supports 5 cointegrating vectors at the 95% level, which yields well–behaved PPs and good VECM results while the marginal VAR results could be improved. In particular, the Δp^* equation shows some mis–specification and has a low $\bar{R}^2$. SIRFs all seem reasonable although our results suggest that a positive world output shock would reduce US output, although this could be attributed to some form of demand–switching behaviour. The model provides respectable inflation and output growth forecasts (Figure 3, panels (a) and (b)), indicating some reasonably strong inflationary pressure in the short–term raising inflation from 2.5% to 3.7%. It seems that inflationary pressure will ease somewhat, and will see inflation converging on a long–run value of 3.25%. Output growth is forecast to increase gradually from approximately 2%, converging at 3%. Table 6 shows that the probability of maintaining inflation between 1-3% while avoiding recession is approximately 40% in the medium- to long–term once the initial inflationary pressure has subsided. Note, however, that the model forecasts a relatively high probability (reaching 31.6%) that the economy will grow at less than half the historical average in the medium–term which tempers the optimistic growth forecasts somewhat.

3.2.3 Eurozone

Subject to a break at 1999Q1, the trace statistic indicates either 3 or 4 long–run relationships. Proceeding on the basis that $r = 3$, we achieve good PPs, and the VECM and marginal VAR estimation results are generally good with the exception of the Δq equation which shows some evidence of misspecification.

SIRFs seem somewhat unreliable, exhibiting strange responses to p^o, r^*, re and r shocks. Growth forecasts are rather low (Figure 3(b)) and inflation forecasts are not encouraging, starting from approximately 1.5% and gradually declining until they are negative (Figure 3(a)). In light of this, the probability forecasts for output and inflation events contained in table 6 are relatively uninformative.

3.2.4 China

The trace statistic indicates 4 cointegrating relationships among the variables. Estimating the model on this basis yields good PPs and marginal VAR results. VECM results are encouraging, showing only a few minor mis–specifications. SIRFs are mostly consistent with our prior expectations. The model forecasts output growth starting at 9%, decreasing to 7% and then recovering and converging around 9-9.5%, consistent with the historical average. Inflation forecasts are reasonable in the short–term but then gradually decrease and become negative after 5 quarters. Given this outcome, the event forecasts indicate a very high probability of maintaining inflation below 2% and avoiding low growth but these results must be interpreted with care.

3.2.5 Japan

Using $r = 5$ results in good PPs and good VECM results in which the break dummy is highly significant.[27] Marginal VAR results are generally good with only the r^* showing evidence of mis–specification . SIRFs are similarly promising, although the p^o, r^*, re and q^* shocks are somewhat disappointing. In terms of forecasting, the model predicts low inflation, starting at 0.35%, dropping to 0.1% at the second quarter and then converging at 0.65% in the long–run, below the historical average of 0.8%. Output forecasts are relatively optimistic, starting from 2.7% and climbing to 3.9% before falling and converging around 2.8%. This compares favourably to the historical average of 2.3%. Based on these results, Table 6 indicates a high probability of maintaining inflation below 2% and an initially low probability of slow growth which rises to non–negligible levels. The joint probability of maintaining inflation below 2% and avoiding low growth remains above 55% for at least 8 quarters.

[27]Cointegration tests indicate either 4 or 5 long–run relationships. We find that there is a trade–off between setting $r = 4$ and $r = 5$. With $r = 4$, the forecasting performance is better, but the SIRFs seem less reliable and vice–versa.

3.2.6 UK

Including a structural break to account for Sterling's departure from the ERM the trace statistic supports 5 long–run relationships, although we find that the modelling is improved by using just 4. Proceeding in this manner, the PPs show a relatively low degree of persistence and are subject to some minor overshooting. Marginal VAR and VECM results are generally good, although some equations fail diagnostic testing. SIRFs are relatively mixed, some behaving well and others substantially at variance with our prior expectations. In particular, responses to y^* and r innovations seem unreliable. Although an exchange rate depreciation does eventually have a positive impact on output there is a substantial lag of 12 quarters.

The forecasting performance of the model is questionable. In particular, we find that the inflation forecast becomes negative within the first year and that this result is robust to changes in the cointegration rank and to the omission of the break dummy. This negativity is, however, short–lived and the forecasts rapidly return to positive values of a sensible magnitude. Output forecasts are relatively optimistic, with persistent growth prospects in excess of 3.4%. In terms of event forecasting, Table 6 reveals that the probability of the Bank of England meeting its declared inflation target (1-3% CPI) is initially relatively high (82%) but then falls rapidly to just 30%, while the probabilities of avoiding recession and low growth are high over all horizons.

4 Main Empirical Results of the GVAR Models

4.1 Persistence profiles

The PPs derived from the GVAR model are generally well–behaved, converging on zero at a decreasing rate. However, we find strong evidence of regionality in the results. In particular, South–East Asian economies typically exhibit some degree of persistence of one cointegrating vector, presumably reflecting some lingering effects of the financial crisis (see Figure 1(b) for the Korean case). Figure 1(c) plots the poorly behaved cointegrating vector from each of the South East Asian countries in our sample and reveals that the overshooting and persistence can be roughly ordered in terms of severity as follows: Thailand (most severe), Korea, Philippines, Indonesia, Singapore and Malaysia (unaffected). This is generally consistent with the fact that the Asian crisis is widely believed to have originated in Thailand and that its effects were mostly concentrated in South–Eastern Asia.

Figure 1(d) presents further evidence of regionality among the Southern American countries, which tend to have one vector which briefly overshoots significantly before dying away rapidly. Brazil is the most severely affected, followed by Argentina and then Peru, with Chile being unaffected. The fact that Chile is the only South American country in our sample which did not suffer an obvious break during the hyperinflation years is unlikely to be coincidental in this regard.

4.2 Impulse Response Analysis

Due to the difficulties in defining an appropriate recursive ordering of variables in the global system, we focus on a small number of GIRFs with respect to a variety of interesting shocks. More specifically, we consider an oil price shock, a US monetary policy shock, a US stock market shock and a Chinese inflationary shock. Where possible we compare our results with those presented by DdPS, in which the GIRFs for the US and Eurozone with respect to the first three of these shocks are discussed.[28]

4.2.1 Oil price shock

Figure 6 shows the effect of an oil price shock on inflation, output, equity prices and the current account. The inflationary impact of the oil shock is generally positive in all countries. The strongest inflationary response is seen in the Eurozone in the longer–term and Korea in the short–run. The effects of the oil

[28]DdPS actually consider a *negative* US stock market shock, so for the purposes of comparison we exploit the linearity of the model which suggests that impulse responses should be symmetrical.

shock on output are generally negative with the exception of the Eurozone. The observation of a positive Eurozone output response in this context is consistent with the results of DdPS, where the response is of a similar magnitude but is found to be insignificant by use of bootstrap critical values. The UK enjoys a substantial current account improvement following the shock, reflecting its position as a net exporter of oil. The remaining focus countries experience some deterioration. Lastly, the effects on the stock markets are generally negative, certainly in the medium–term. Korea shows the strongest negative reaction, reaching a nadir after 3 quarters and then gradually recovering. The GIRFs for EU and US equity prices are again relatively comparable to those contained in DdPS.

In general, these results are qualitatively similar to those derived from country–specific modelling. For example, the impacts on both Korean inflation and output are slightly smaller under GVAR than in the country–specific case, though their adjustment pattern is similar. One notable exception to this, however, is the UK. The national model suggests that output falls sharply following an oil price shock and that economic activity remains depressed. These differences may reflect the additional information used in the GVAR estimation process.

The remaining shocks that we consider are not directly comparable with those derived from the national modelling exercise. Indeed, it is one of the foremost strengths of the GVAR modelling strategy that it permits the analysis of a wider range of shocks than the corresponding national models.

4.2.2 US monetary policy shock

Figure 7 plots the impulse responses with respect to a positive US monetary policy shock. The output effects are mostly plausible, with the notable exception of American output which increases in clear contradiction of the accepted wisdom of monetary policymakers. This effect is also evident in the DdPS results. Japanese output increases in the short–run before falling while British output exhibits the opposite pattern. Interestingly we find that Chinese output is highly sensitive to the US interest rate, an effect which most likely derives from China's increasingly large share in US imports. Korea is initially strongly affected for approximately 6 periods, after which the effect weakens somewhat.

The inflationary consequences of the US monetary policy shock are generally slightly positive but largely negligible. The US response is similar to that reported by DdPS and is a classic example of the price puzzle which is an enduring result in the empirical literature and is, therefore, not unduly troublesome. The Chinese reaction is again strong, with a US interest rate hike causing strong deflationary pressure which does not ease for 10 quarters. The Korean inflationary response to the US interest rate rise is relatively large and positive which could potentially be attributed to cost–push explanations of inflation if Korean firms borrow extensively in dollar–denominated instruments and pass their increased costs on to their customers relatively quickly.

The impact on the US current account position is large and negative, as one would expect. The Eurozone enjoys the most substantial current account improvement, while Asian countries suffer an initial large deterioration which lasts for between 11 and 14 quarters. Stock markets are mostly positively effected, which would tend to suggest that investors move from bonds to equity as the increased interest rate drives bond prices down. The notable exceptions are the Japanese and Korean stock markets which exhibit a negative impact (substantially so in the Korean case).

4.2.3 US (positive) stock market shock

Figure 8 shows the impact of a positive US stock market shock. With the exception of the Eurozone, output responses are positive.[29] The results are relatively similar to those observed in the national models for q^* shocks, reflecting America's position as the world's dominant financial power. The stock price boom is accompanied by universally falling inflation which is an interesting result consistent with the findings of DdPS, and which suggests that the inflationary pressure arising due to the wealth effect

[29]DdPS find a negative impact of a negative US stock market shock on Eurozone output which, due to the linearity of the model, implies a positive response to a positive shock. Hence, our results disagree with those of DdPS in this instance. This could be attributed to our use of a different sample period, our inclusion of additional variables, our consideration of structural breaks or our use of different cointegration ranks in certain country models.

of stock market gains is overpowered by other factors. The responses of national stock markets to the US shock are positive in the short- to medium–term but they tend to die out after approximately 15 quarters (i.e. the impact of the shock is transitory). DdPS find that the Eurozone stock indices react significantly to the US shock for approximately 9-10 quarters before the confidence interval includes zero and in this sense our results are comparable to theirs. The current account picture is mixed with some countries enjoying sustained improvements (most notably the Eurozone and Korea) and others suffering deteriorations (e.g. the UK).

4.2.4 Chinese inflationary shock

Figure 9 plots the impulse responses associated with elevated Chinese inflationary pressure. Given the growing importance of Chinese exports in the world economy, such inflationary pressure has significant inflationary consequences for most of our focus countries (panel (b)). The inflationary pressure is associated with increased output in China and Korea while the US and UK suffer recessionary pressures. China enjoys a significant current account improvement (panel (c)), although the effects on the other countries are mixed. Lastly, the effects on stock markets are positive in the short–run before dying away and becoming negligible.

4.3 Forecast Error Variance Decomposition

Table 5 presents generalised FEVDs of inflation and real output for Korea.[30] The FEVDs are presented in terms of the top 10 determinants of error variance from all 26 countries/regions. The table shows the proportion of forecast error variance of the selected variable by conditioning on contemporaneous and expected future values of the top ten innovations, which are evaluated in terms of their respective contributions for $n = 0, 1, ..., 8$. The last two columns of each table provide the sums across the top ten components and across the total number of innovations (equal by definition to the number of global variables, 176). Notice that these sums may exceed 100% due to the positive correlation across country–specific shocks.

The greater proportion of the forecast variance of the Korean variables is explained by domestic variables, as one might expect. In particular, Table 5(a) reveals that the five most significant determinants of the forecast variance of Korean output are all domestic variables, in the order of real output, nominal interest rate, real exchange rate, real exports and the real equity price. Furthermore, domestic inflation has the seventh largest input. Their total contribution is 185.40% on average over 8 periods. Among the foreign variables, the real equity price in New Zealand is the largest contributor at 9.2%, while Chilean and Thai variables also prove significant. Surprisingly, the contributions of the real outputs of Korea's main trading partners (the US, Eurozone, Japan and China) are negligible at just 0.23%, 0.40%,1.04%, and 3.15%, respectively. The contribution of the oil price is also relatively marginal at 5.41%.

For Korean inflation, five domestic variables (real imports, real output, inflation, the nominal interest rate and real exports) are among the principal contributors, totalling 47.73% on average, see Table 5(b). However, this figure is of a considerably smaller magnitude than that obtained in the real output FEVD. Among the foreign variables, the Brazilian nominal interest rate and rate of inflation dominate, with a combined contribution of 37.84%, which is even larger than the domestic counterpart. This may be a statistical artefact resulting from the high historical and average values of the nominal interest rate and inflation experienced by the hyperinflationary countries in general, and especially Brazil, over the sample period.[31] Another surprising finding is the pattern with respect to a domestic inflation innovation: the

[30]Comprehensive tables of the generalised FEVDs derived from the GVAR model and orthogonalised and generalised FEVDs based on the country–specific models are available upon request.

[31]We find that either Brazilian interest rates or inflation are among the main contributors to the inflation forecast error variances of the majority of countries considered despite the fact that its trade–weight with most countries is rather small (Brazil accounts for less than 1% of Korea's total trade, for example). Such results suggest that an alternative measurement of foreign financial variables (e.g. based on an appropriately constructed financial–transactions–based weighting matrix) may improve the estimation of the GVAR model. In particular, given that the contribution of Latin and South American countries to global financial markets is small if not negligible, the use of trade–weights is likely to overstate their importance in these markets.

impact contribution is the largest at 77.38% and then its contribution in the next quarter drops sharply to just 0.05%. The oil price, US real exports and the US price level also prove to be important foreign factors. Surprisingly, the total combined contribution of all variables of both Japan and China is relatively insignificant at just 17.29%.

4.4 Probability Forecasts of Single and Joint Events

4.4.1 Point and Interval Forecasts

It is worth briefly summarizing the point and interval forecasts to help place the probability forecasts in context. Figure 3 provides the point forecasts for inflation rates, output growth rates and current accounts for the 6 focus countries over a 24 quarter forecast horizon based on both the country–specific and GVAR models. We shall focus mainly on an eight quarter horizon but the additional information is provided to demonstrate the tendency of the forecasts to converge on the historical average value.

The GVAR model predicts that the average annual rate of inflation will stay between 1 and 3% over next two years for the Eurozone and China only (see Figure 3(b)). With the exception of these two countries, the GVAR model predicts inflationary pressure of sufficient magnitude to exceed the upper range of our approximate inflation targets for the remaining central banks. In particular, inflation in the UK is predicted to reach 4.9% within two years while forecasts for the US are slightly worse, starting at 2.5% at 2007q1 and reaching 5.2% at 2008q4. Furthermore, Korean inflation is forecast to start from 3.77% (still within the target range of 2-4%) and then to increase steadily, approaching 10% at the end of the forecast horizon. There results are seemingly spurious as they stand in sharp contrast against the recent experience of low and stable inflation.

The forecasts derived from country–specific modelling summarised in Figure 3(a) seem considerably more promising, indicating a significantly higher probability of the inflation targets being achieved in our focus group of countries. Focussing briefly on the Korean case, it is clear that the forecast is lower than before although some residual inflationary pressure remains. In this case, it seems safe to assume that the GVAR forecasts are erroneous, particularly in light of a comparison with the Korean national CVAR model (Shin, 2007) which indicates inflation of the order of 2.5-3.5% for the benchmark model and 1.5-2.7% for the extended model. This poor performance of the GVAR may be due to the observed excessive persistence of one of the cointegrating vectors for Korea (Figure 1(b)).

The GVAR model predicts that output growth should be reasonably healthy for all countries over the one year period although the picture is clearly dominated by a vibrant Chinese growth forecast of almost 10% (Figure 3(d)). Growth prospects start to decline for all countries except China after 4 or 5 quarters, in some cases dramatically. In particular, the US may suffer a recession toward the end of the 2 year horizon. This result is rather encouraging as, at the time of writing, many commentators are forecasting an imminent American recession. The medium–term growth forecasts are also bleak for Korea, where a sizeable contraction is forecasted. Balancing the cautionary note somewhat is the Chinese forecast which predicts growth in excess of 9% at 2008q4 whilst the economies of the Eurozone, Japan and the UK are likely to grow at a reduced although still healthy pace over 2007-2008.

Comparison with the output forecasts derived from country–specific modelling (Figure 3(c)) reveals a striking difference. The contractionary/recessionary pressures in the GVAR forecasts are largely absent. In general, the output forecasts indicate relatively stable growth at levels mostly consistent with historical experience, after some short–term adjustments at least. Interestingly China is forecast to suffer some non–negligible contractionary pressure in the short- to medium–term where no such pressure existed in the GVAR forecasts.

Figures 3(e) and 3(f) present the forecasted current account movement over next 8 quarters derived from each model. As expected, the US and the UK are notable for their substantial and consistent deficits. Closer inspection reveals that the US current account position should improve in the medium term, rather markedly according to the GVAR forecasts. By contrast, both models agree that the UK's deficit will increase significantly and at a relatively constant rate (the recent experience of the UK suggests that this forecast is being borne out). The models agree that both Korea and China will enjoy sizeable surpluses and improvements over the coming years. The only principle areas of discord between the two models in terms of current account forecasting are Japan and the Eurozone. The GVAR model forecasts a deterioration from surplus to deficit in both cases while the country–specific models indicate a growing surplus.

There are many areas of broad agreement between the country–specific and GVAR forecasts although some significant discrepancies are observed, especially concerning output forecasting in general, and some inflation forecasts.[32] However, it must be borne in mind that point forecasts are subject to a high degree of uncertainty, particularly at longer horizons. Indeed, it is difficult to evaluate the significance of these forecasts for policy analysis without more detailed information. Figure 4 provides interval forecasts for Korean inflation and output growth based on the observed empirical distributions of the variables for both the country–specific and GVAR models. It is immediately apparent that the uncertainty involved is substantial and that the interpretation of such figures is not straightforward. In light of this, a more appropriate approach is to consider probability forecasting as a method of characterising the various uncertainties that are associated with events of interest.

4.4.2 Predictive Distribution Functions

In the case of single events, probability forecasts are best represented by means of probability distribution functions. Here we focus simply on the estimates of the probability distribution functions of the four–quarter moving averages of inflation and output growth over threshold values ranging from -2% to 12% per annum and over 1, 2, 4 and 8 quarter forecast horizons. These estimates are computed using simulation techniques and take account of future uncertainty only. This limited focus is in the interests of brevity, especially given that our main interest lies in joint event forecasting.

Figure 5 plots the estimated predictive distribution functions for inflation and output growth for Korea derived from both the GVAR and country–specific models. In all cases, the gradient of the plots decreases as the forecast horizon increases, reflecting the increasing uncertainty. Moreover, the plots are generally shallower under GVAR than in the country–specific case, indicating that the GVAR model is subject to greater uncertainty in estimation.

In the case of inflation, inspection of the figures for the 6 focus countries (not reported) reveals that the functions at the 1 and 2 quarter horizons are relatively steep, and become flatter as the forecast horizon increases. For the US, Eurozone, Japan, the UK and China, the probability distribution functions of inflation shift further to the right around the 2-4% threshold cutoff values, as longer forecast horizons are considered. This implies that the probability of inflation falling within the target range (about 1-3%) declines with the forecast horizon while uncertainty increases. This rightward shift to a high inflation regime is most apparent in the US, although it is also evident in a number of other countries. Turning to Korea, the predictive distribution function estimated under GVAR is reasonably steep at the 1 and 2 quarter horizons around the 3-4% cutoff threshold (still within the target range) but then shifts considerably to the right at the 4 and 8 quarter horizons, implying medium–term inflationary pressure (Figure 5(b)). A similar pattern emerges in the country–specific case, although the shift is considerably less marked implying more modest inflationary pressure (Figure 5(a)).

Figures 5(c) and 5(d) plot the estimated predictive distribution functions for output growth in Korea under both country–specific and GVAR models. These plots also become increasingly shallow as the forecast horizon increases, demonstrating once again the increased uncertainty associated with longer forecast horizons. In the GVAR case, the plots shift inward markedly, indicating a weakening of the medium–term growth prospects for Korea (a similar pattern is also observed for the US and UK, although not for China which shows robust growth at 9-10%). However, no such pattern is observed in the country–specific case.

[32]It is interesting to note that we found that the point forecast results tend to be lower in those models including carefully considered structural breaks. Hence, it is possible that models taking full account of structural breaks might provide more precise forecasting scenarios for inflation and output growth. We are currently investigating this possibility.

4.4.3 Event Probability Forecasts

There is an increasing recognition among academic econometricians and practitioners alike of the importance of the provision of further information on the uncertainties surrounding forecasts of key macroeconomic variables (c.f. Ericsson, 2001, for an introduction to the issues and Giordani and Söderlind, 2003 for a discussion of inflation forecast uncertainty). Knowledge of the precision of forecasts enables policymakers to motivate and justify actions based on the forecasts, and helps in achieving more balanced evaluation of the forecasts by the public (the issue of the interpretation of inflation forecasts is addressed by Casillas–Olvera and Bessler, 2006). One of the many problems facing economic forecasters and policymakers is conveying to the public the degree of uncertainty associated with point forecasts. Policymakers recognize that their announcements, in addition to providing information on policy objectives, can themselves initiate responses which affect economic outcomes. This means that central bankers are loathed to discuss pessimistic possibilities lest such announcements exert a contractionary influence, and that they are similarly reluctant to make optimistic announcements for fear that they might prove inflationary. A striking example of the strength of the signalling effects of central bank announcements was Alan Greenspan's 'irrational exuberance' speech, in which he warned that caution should be exercised to avoid complacency over stock market overheating (Greespan, 1996), a remark that saw stock markets around the world drop by as much as 2% overnight. Hence there is a clear rationale for policymakers to seek methods of making unambiguous statements regarding the range and likelihood of possible outcomes for any given policy in a manner which avoids these difficulties. GLPS contend that probability forecasts provide just such a method of characterizing the uncertainties surrounding economic forecasts in a superior manner to the use of confidence intervals. The use of probability forecasts has an intuitive appeal, enabling both the forecaster and potentially the end–user to specify 'threshold values' defining an event of interest. This stands in stark contrast to the use of confidence intervals which define threshold values only implicitly through the choice of their width.

The so–called 'river of blood' forecasts produced by the Bank of England in its Inflation Report (see, for example, Bank of England, 2008, pp. 7-8) are an important step toward acknowledging the significance of forecast uncertainties in the decision making process. In the same vein, the Federal Reserve has recently adopted a similar approach to providing transparent forecasts of key macroeconomic variables including inflation and output growth over the short-, medium- and long–term. However, these approaches may suffer from two major shortcomings. Firstly, it seems unlikely that such forecasting scenarios can be replicated by independent researchers. This is largely due to the subjective manner in which uncertainty is taken into account by the central bank. Secondly, separate fan charts are provided for inflation and output growth forecasts and the usefulness of these fan charts in the analysis of uncertainty associated with joint events is thus limited. Here we address both of these issues, and present probability forecasts of the single and joint events defined above estimated using both the country–specific and GVAR models (Table 6).

Inflation Targets: Tables 6(a) and (b) show the estimated probability forecasts of inflation targets A and B defined above estimated from both the country–specific and GVAR models. Considering first the GVAR case, conditional on the information available at 2006q4, the estimated probability of the central bank achieving target A at the 1 quarter–ahead horizon is high for the US, Eurozone and Japan at 92%, 99% and 91%, respectively. The probabilities are reasonable for Korea and China at 63%. Surprisingly, the probability of the Bank of England keeping inflation within a range of 1-3% is quite low at just 13%. With the exception of the UK, the probability of achieving target A falls as the forecast horizon increases. Only for Eurozone and Japan is the probability above 50% over most horizons. For all other countries, the chance that inflation target A will be met after 2007q2 is slim. This may reflect the considerable uncertainty associated with even small–to–medium forecast horizons combined with the (individual country–specific) model uncertainty involved in the construction of the GVAR model. The probabilities of achieving inflation target B are generally lower (the exception is Japan), certainly in the short–run, which suggests that inflation is likely to be in the upper end of the targeted band or exceeding this upper limit in most countries over the forecast horizon.

The country–specific model yields significantly different forecasts. In particular, the probabilities of meeting target A are considerably higher for the UK and lower for Japan and Korea, and the probabilities of achieving target B are very high for the Eurozone, Japan and Korea, and become increasingly large for China in the longer–term. These differences reflect the heterogeneity of the central and interval forecasts discussed above. Of course, such differences have significant implications for joint event forecasting, as will be seen below.

Recession and Poor Growth Prospects: Table 6(c) shows that the probability of recession estimated under GVAR is almost zero for all countries up to 2008q1, after which time the US probability increases, reaching 54% at 2008q4. The likelihood of recession is also relatively high for Korea, at 17%. The model predicts a very slim chance of recession in the Eurozone and Japan and an almost 0% chance of a Chinese recession.

From Table 6(d), a similar pattern is observed for the prospect of poor growth. Once again, the probabilities are almost negligible for all countries up to 2008q1, after which they become more significant for the US and Korea at 2008q4. Interestingly, the probability of low growth in the UK becomes relatively significant at 30% after 8 quarters. Over all forecast horizons considered, the prospect of poor growth is slim for the Eurozone and Japan, and almost nonexistent for China.

The country–specific estimates reported in Tables 6(c) and (d) show a low probability of recession in all countries over all horizons. Similarly, the likelihood of low growth is generally smaller with all of the focus countries having more than a 75% chance of growing at a reasonable rate over the next two years. These figures reflect the greater optimism of the country–specific central forecasts discussed earlier.

Joint Inflation and Output Growth Events: Single events are clearly of interest but policy–makers may often be more concerned with joint events involving both inflation and output growth outcomes. Tables 6(e) and (f) provide the probability estimates of the two joint events, $A_{T+h} \cap \overline{C}_{T+h}$, and $A_{T+h} \cap \overline{D}_{T+h}$ over the forecast horizons $h = 1, ..., 8$.

For the event $A_{T+h} \cap \overline{C}_{T+h}$, the joint probability forecasts from GVAR are similar in magnitude to those for $\Pr(A_{T+h} \mid \Im_T)$ alone at all horizons. This is not surprising, since the probability of recession is estimated to be small at most forecast horizons and, therefore, the probability of avoiding recession is approximately one except for the US and Korea. Nevertheless, these small differences might be important if there are large and/or discontinuous differences in the net benefits of different outcomes. In fact, the probability forecasts for $A_{T+h} \cap \overline{C}_{T+h}$ are slightly less than those for $\Pr(A_{T+h} \mid \Im_T)$ alone. Turning to the probability forecasts of the joint event, $A_{T+h} \cap \overline{D}_{T+h}$, we again observe that the forecast results are somewhat smaller than those for $\Pr(A_{T+h} \mid \Im_T)$ at longer horizons, especially for the US and Korea.

In the country–specific case, the joint probabilities $Pr\left(A_{T+h} \cap \overline{C}_{T+h}\right)$ and $Pr\left(A_{T+h} \cap \overline{D}_{T+h}\right)$ are again similar to the single event probabilities associated with inflation target A owing to the low probability of recession and low growth. The joint probabilities based on inflation target B reported in panels (g) and (h) are considerably lower, reflecting the smaller probability of achieving inflation target B as compared to A.

Current Account Joint Events: In terms of current account probability forecasting, it is possible to classify the countries into a number of groups. Table 6(i) reveals that the USA and UK are persistent deficit countries, Korea and China (and to a lesser extent Japan, at least in the GVAR case) are persistent surplus economies, and the Eurozone occupies an intermediate position, initially in surplus but with an increasing probability of deficit.

Turning now to Tables 6(k)-6(n), we consider the four current account joint events which we interpret as balancing improvement, unbalancing deterioration, unbalancing improvement and balancing deterioration, respectively. We find that the probability of a balancing improvement is high in the US although the probability of further unbalancing deterioration is high in the UK, certainly in the short- to medium–term. Among the surplus countries, the likelihood of a balancing deterioration is high in the Eurozone and also relatively high in Japan, while Korea and China are likely to experience unbalancing improvement.

In the country–specific case the likelihood of unbalancing improvement is also high in the Eurozone and Japan, while the probability of an unbalancing deterioration in the USA is somewhat higher than under GVAR.

5 Concluding Remarks

This paper follows the practical and transparent long–run structural VAR modelling approach advanced by GLPS and its global extension, the GVAR modelling approach pioneered by PSW and DdPS, which develops a framework for the analysis of the dynamic international linkages of a small open economy such as Korea. We apply this modelling strategy to the same group of 33 countries (26 regions) as considered by DdPS but we extend their research by explicitly incorporating the current account, extending the coverage of the data and, most importantly, by explicitly modelling intertemporal structural instability. The inclusion of deterministic structural breaks in the model is shown to be successful in the analysis of the substantial impacts of the 1997 Asian currency crisis on the macroeconomic performance of Korea during and after the crisis period (see also Shin, 2007).

We provide country–specific estimation results for 6 focus economies: Korea, the US, the Eurozone, China, Japan and the UK. Overall, these results are promising although we find a number of nonsensical estimation results even for the developed economies including the Eurozone, Japan and the UK. Based on this initial estimation, we construct the associated GVAR model, combining the country–specific estimation results by means of carefully constructed trade–weights–based link matrices. Focussing on a small number of IRFs with respect to an oil price shock, a US monetary policy shock, a US stock market shock and a Chinese inflationary shock, we find that the performance of the GVAR model is rather encouraging, in the sense that the profiles of the shocks are generally consistent with our prior expectations and with the existing empirical literature.

We consider a range of forecasting exercises which are likely to be of considerable interest in policy-making circles. In general, we find that the GVAR model predicts lower growth prospects and greater inflationary pressures than the equivalent country–specific structural VECMs. In the case of Korea, in particular, the GVAR model predicts rapidly increasing inflation over a fairly wide range of forecast horizons, which stands in contrast to the recent experience of low and stable inflation, and also to the forecasts derived from the country–specific model and the Korean national model (Shin, 2007). This seemingly erroneous forecasting is likely to derive from the excessive persistence of one of the Korean cointegrating vectors, an effect that we attribute to some lingering effects of the 1997 financial crisis. Overcoming such spurious results provides fresh challenges for subsequent revisions of our work.

We present probability forecasts based on a number of single and joint events relating to inflationary pressure, output growth and the current account position which are highly encouraging. In particular, our treatment of joint events allows the monetary authority to evaluate the likelihood of simultaneously meeting its inflation target and maintaining reasonable growth, and to investigate the potential monetary policy trade–offs. Moreover, our analysis of joint events pertaining to the level and change in the current account position allows us to classify various countries in an easily interpretable manner suitable for public reporting.

Two principal areas for further research present themselves. Firstly, the over–identification of a GVAR system is yet to be satisfactorily achieved (see also the limited progress in DHPS). In subsequent work, we hope to impose an over–identified structure based on our tentative long–run theories outlined above. If not rejected by the data, this is likely to significantly improve the performance of the impulse responses and potentially the dynamic forecasts derived from the model. Recently, Pesaran, Schuermann and Smith (2007) have divided the countries into two groups; a focus group of countries of interest, and the remainder. Such an approach allows the imposition of a theory–consistent over–identified long–run structure in the focus countries while the remainder are estimated subject to the exactly identifying restrictions. Alternatively, to further improve model performance, one could impose zero restrictions on those short–run dynamic coefficients (including the loading matrix) which prove to be statistically insignificant. This so–called general–to–specific practice circumvents the Sims critique and, therefore, may be of significant interest in refining the model to sharpen the forecasts.

Secondly, as is clear from the results adduced in this paper, there is a tendency for South American financial variables to spuriously dominate some aspects of the modelling under the current specification. As discussed in section 4.3, we attribute this effect to the use of a trade–based weighting scheme for both real and financial variables. Given that these economies trade largely in primary and low–tech commodities and have only a small presence in the financial markets, such an approach is likely to lend excessive weight to their financial variables in the global model. Hence it is likely that the construction of a more complete (potentially time–varying) weighting system which attaches weights based on financial transactions volumes to financial variables would yield substantial improvements in the performance of the GVAR model. However, the construction of the required financial link matrices and the selection of a window length which balances the improved realism against the level of undesirable randomness introduced into estimation is likely to be non–trivial to say the least, and provides an exciting and challenging avenue for further research.

6 Data Appendix

Variables used in this paper include y (real GDP), p (consumer price index) q (equity price index), e (nominal exchange rate in terms of the US Dollar), r (short–term interest rate), x (exports), m (imports) and p^o (nominal spot oil price).

A1. Real GDP: Real GDP series for 33 countries are taken from the IMF's International Financial Statistics (IFS), Series 90BVRZF (Index, 2000 = 100). Where data were not available, the IFS series were completed by data from other sources: Datastream, OECD, or extrapolated growth rates (using the average growth rate of three previous years).

Where quarterly data were not available, quarterly series were generated from annual series using the interpolation procedure of DdPS (see their Supplement A for details of the interpolation procedure). Specifically, the interpolated series were used throughout the sample period for China and Saudi Arabia and during the following sub-periods: 1980-1989 for Argentina, 1980-1989 for Brazil, 1980-1996 for India, 1980-1982 for Indonesia, 1980-1987 for Malaysia, 1980 for Philippines, 1980-1992 for Thailand, 1980-1986 for Turkey. In these countries, quarterly data were available that covered the remainder of the sample period.

The series for Singapore were completed by Datastream data, while the series for Brazil were completed using OECD data. Extrapolated series were used during: 2006q3 & 2006q4 for India, 2006q4 for Philippines, 2006q4 for Singapore, 2006q3 & 2006q4 for Turkey, and 2006 for China.

The series for Argentina, Austria, Belgium, Brazil, Chile, Finland, India, Indonesia, Korea, Malaysia, Mexico, Norway, Peru, Philippines, Sweden, Thailand, and Turkey were seasonally adjusted using the US Census Bureau's X12 program (as implemented in EViews 5.0).

A2. Consumer Price Indices: The Consumer Price Index for most of the 33 countries were taken from IFS Series 64.ZF (Index, 2000 = 100), except for China, Finland and Germany. The series for China (seasonally adjusted from 1987Q1–2006Q4) and Germany (1980–2006) were provided by the Bank of Korea. The series for China were completed by IFS Series 64.XZF. Meanwhile, the source for Finland's price index was IFS Series 63EY.ZF.

A3. Exchange Rate: IFS Series RF.ZF (National currency per US$) were used for all countries. For the Eurozone, the series for 8 member countries (Austria, Belgium, France, Finland, Germany, Italy, Spain, and Netherlands) were available from 1980 to 1998, after which the Euro/US$ exchange rate was used instead.

A4. Short–Term Interest Rate: The short–term interest rate series (measured in percent per annum) were taken from IFS Series 60B.ZF (money market – interbank – rate) for 16 countries. The data for Argentina, Chile, and Turkey were taken from IFS Series 60L.ZF (deposit rate). For Sweden, IFS Series 60B.ZF was completed by IFS Series 60A.ZF from 2004q4. For Mexico and Philippines, IFS Series 60C.ZF (Treasury bill rate) were used, while IFS Series 60.ZF (discount rate) were used for China, New Zealand and Peru. For India, data covering 1998q2–2006q2 were retrieved from the Reserve Bank of India. No reliable short–term interest rate is published by the Saudi Arabian Monetary Agency.

For the Euro Area, 4 countries (Finland, Germany, Italy, and Spain) had complete short–term interest rate series (1980–2006) while the series for the 4 remaining countries (Austria, Belgium, France, and Netherlands) ended at 1998q4. For these latter countries, the series were completed by the Euro interbank (overnight) rate, IFS Series 60A.ZF.

A5. Exports and Imports: The data sources for exports and imports (millions US$) of 32 countries were available from IFS Series 70.DZF (for exports) and IFS Series 71.DZF (for imports). The data for Belgium are from the World Bank. Extrapolated data were used for China's export and import in 1980, Belgium's export and import in 2006, Saudi Arabia's export in 2006, and South Africa's import in

2006q3 & 2006q4. The quarterly series for Belgium and Saudi Arabia were interpolated from the annual series. All the series were seasonally adjusted using Census X12.

A6. Equity Price Indices: The data source was IFS Series 62.ZF (industrial share prices, index) for 26 countries (Argentina, Australia, Belgium, Brazil, Canada, Chile, Finland, France, Germany, India, Italy, Japan, Korea, Malaysia, Netherlands, New Zealand, Norway, Philippines, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, United Kingdom, and United States). For Belgium, France, Norway, Sweden, and United Kingdom, the IFS series were completed with data from the OECD's Main Economic Indicators. For Argentina, Singapore, Switzerland, and Thailand, the IFS series were completed using Datastream. The data for Austria and Mexico are from the Main Economic Indicators. Reliable equity price indices for China, Indonesia, Peru, Turkey and Saudi Arabia could not be found.

A7. Oil Price: The UK Brent series (US$ per barrel) from IFS Commodity Price was used.

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Order	Country	Code	Case	r	C.I. (%)	n	k	Break point (obs)	Explanation of break
0	USA	USA	4	5	90	7	5		
1	Eurozone*	EUR	6	3	95	7	5	1999Q1 (76)	Introduction of Euro
2	Japan	JAP	4	5	95	7	5	1990Q1 (40)	Real–estate/stock market crash
3	UK	UK	6	4	95	7	5	1992Q4 (51)	Departure from ERM
4	Norway	NOR	4	2	95	7	5		
5	Sweden	SWE	4	3	95	7	5		
6	Switzerland	SWI	4	4	95	7	5		
7	Canada	CAN	4	6	95	7	5		
8	Australia	AUS	4	3	95	7	5		
9	New Zealand	NZ	4	4	90	7	5		
10	South Africa	SAF	4	3	90	7	5		
11	Argentina	ARG	6	4	95	7	5	1991Q3 (46)	First major effects of Convertibility Plan
12	Brazil	BRA	6	2	95	7	5	1994Q4 (58)	First major effects of Real Plan
13	Chile	CHL	4	3	95	7	5		
14	Mexico	MEX	6	4	95	7	5	1988Q2 (33)	End of rising inflation and interest rates
15	India	IND	4	3	90	7	5		
16	Korea	KOR	6	5	95	7	5	1997Q4 (71)	S.E. Asian crisis
17	Malaysia	MAL	6	5	95	7	5	1997Q3 (70)	S.E. Asian crisis
18	Philippines	PHI	6	5	95	7	5	1997Q4 (71)	S.E. Asian crisis
19	Singapore	SNG	4	3	95	7	5		
20	Thailand	THA	6	5	90	7	5	1997Q3 (70)	S.E. Asian crisis
21	China	CHN	4	4	90	6	5		
22	Indonesia	INS	6	4	95	6	5	1997Q3 (70)	S.E. Asian crisis
23	Peru	PER	6	4	95	6	5	1991Q4 (47)	Dollarisation following 'Washington consensus'
24	Turkey	TUR	4	3	95	6	5		
25	Saudi Arabia	SAR	4	3	95	5	5		

* For our purposes, the Eurozone includes Austria, Belgium, Finland, France, Germany, Italy, the Netherlands and Spain only. Eurozone data are constructed by aggregating the contributions of these member states using a PPP–GDP weighting scheme. See the data appendix for details.

Table 1: Countries/Regions Included in the GVAR

Country	Inflation (% per annum)				Output Growth (% per annum)			
	Mean	St. Dev.	Maximum	Minimum	Mean	St. Dev.	Maximum	Minimum
USA	3.51	2.49	14.18	-3.42	2.92	2.86	8.92	-8.15
EUR	3.73	2.77	13.12	0.06	2.14	2.25	13.65	-2.72
JAP	1.11	2.76	12.52	-4.00	2.17	3.50	10.71	-8.90
UK	4.34	4.08	22.60	-2.68	2.41	2.43	8.72	-7.27
NOR	4.23	3.96	18.48	-6.71	2.82	7.15	30.29	-11.74
SWE	4.07	4.28	17.27	-4.33	2.12	4.90	15.00	-20.11
SWI	2.23	2.62	9.56	-2.62	1.54	2.64	9.04	-4.64
CAN	3.55	3.23	12.83	-3.67	2.99	4.14	31.91	-6.08
AUS	4.58	3.73	16.34	-1.67	3.24	3.25	11.49	-6.61
NZ	5.26	5.75	34.17	-3.18	2.32	3.97	13.89	-10.88
SAF	9.70	5.24	22.93	-4.81	2.29	3.42	10.02	-8.55
ARG	71.32	119.03	759.22	-4.20	1.76	9.27	21.30	-25.42
BRA	98.85	120.73	622.61	-1.42	2.35	7.47	28.47	-29.00
CHL	11.30	9.93	46.19	-1.43	4.42	8.36	33.19	-25.83
MEX	26.47	26.63	131.44	0.06	2.60	6.17	15.14	-24.73
IND	7.66	6.76	24.19	-16.01	5.89	5.36	20.52	-12.93
KOR	5.20	5.48	29.63	-2.72	6.44	6.39	26.20	-34.88
MAL	3.05	2.78	14.92	-2.43	5.89	6.17	19.94	-27.66
PHI	9.13	10.09	63.56	-14.02	2.87	6.04	17.99	-25.01
SNG	1.73	2.67	13.68	-4.63	6.66	6.84	23.78	-11.46
THA	4.11	4.10	24.39	-4.98	5.69	6.33	25.23	-20.48
CHN	5.36	7.12	33.94	-2.68	9.29	3.14	17.31	0.69
INS	10.19	12.03	73.14	-9.08	4.67	9.15	48.55	-31.51
PER	67.83	122.03	856.53	-2.38	2.40	12.94	28.01	-55.04
TUR	41.15	22.88	136.12	3.07	4.45	9.87	24.71	-47.17
SAR	0.52	3.60	17.64	-18.43	1.68	9.06	20.10	-23.03

Table 2: Historical Inflation and Output Growth by Country/Region

	Import Growth (% per annum)				Export Growth (% per anum)				
Country	Mean	St. Dev.	Maximum	Minimum	Mean	St. Dev.	Maximum	Minimum	Current acc.
USA	3.85	12.62	50.08	-36.23	2.64	11.57	27.55	-29.30	-1.21
EUR	0.36	16.74	31.00	-97.14	0.93	16.19	35.53	-95.08	0.57
JAP	1.84	21.11	48.09	-60.94	2.83	15.79	38.97	-52.53	0.98
UK	1.95	16.83	66.17	-49.31	1.20	19.02	43.21	-86.98	-0.75
NOR	2.01	21.01	53.71	-44.72	3.63	26.25	62.19	-92.97	1.62
SWE	2.96	17.00	45.97	-57.91	3.89	18.66	66.40	-67.72	0.93
SWI	1.58	16.30	80.16	-36.70	2.74	13.40	34.50	-30.71	1.15
CAN	2.91	17.87	58.12	-50.07	2.84	18.45	101.78	-47.54	-0.07
AUS	3.81	17.61	38.86	-72.53	3.31	21.15	80.84	-50.66	-0.50
NZ	2.03	27.69	82.47	-80.16	1.65	20.87	55.45	-52.60	-0.37
SAF	5.03	32.41	83.51	-106.40	1.81	30.59	61.32	-85.16	-3.22
ARG	4.63	62.16	338.22	-178.51	6.70	70.67	391.39	-166.57	2.07
BRA	2.06	37.36	104.04	-84.20	4.62	49.71	191.46	-174.51	2.56
CHL	5.60	27.43	57.40	-92.02	7.45	32.98	114.09	-93.09	1.85
MEX	6.74	30.23	119.77	-175.89	6.81	44.78	229.15	-139.59	0.07
IND	8.89	29.84	88.39	-127.61	8.87	24.26	78.80	-58.86	-0.02
KOR	6.51	22.90	87.27	-65.47	7.89	27.49	120.76	-68.05	1.38
MAL	8.39	22.39	63.15	-65.11	8.20	21.04	71.15	-64.07	-0.19
PHI	5.38	35.48	80.41	-143.41	6.02	51.57	305.24	-150.66	0.64
SNG	6.13	17.75	40.45	-41.31	7.16	17.85	65.63	-34.38	1.03
THA	8.14	25.83	79.58	-92.76	9.10	25.86	87.53	-99.07	0.96
CHN	14.79	35.97	149.50	-139.87	16.52	26.83	119.13	-43.55	1.72
INS	8.95	54.09	163.76	-226.52	6.18	52.91	255.38	-258.03	-2.77
PER	2.43	48.80	163.08	-168.95	-0.03	54.63	218.26	-153.70	-2.45
TUR	8.41	37.37	150.38	-75.31	9.44	41.26	129.87	-119.81	1.03
SAR	3.07	18.53	34.66	-47.97	4.00	36.52	91.09	-72.13	0.93

Table 3: Historical Import and Export Growth and Current Account Position by Country/Region

Country	Official inflation target	Inflation Target 1 (% CPI)	Inflation Target 2 (% CPI)	Low Growth (%p.a.)
USA	None	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	1.46%
EUR	HICP <2% and ≈2%	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	1.07%
JAP	None	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	1.09%
UK	2% CPI ±1%	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	1.20%
NOR	2.5% CPI	$1.5\% \leq \Delta p \leq 3.5\%$	$\Delta p < 2.5\%$	1.41%
SWE	2% CPI ±1%	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	1.06%
SWI	<2% CPI	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	0.77%
CAN	2% CPI ±1%	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	1.49%
AUS	2-3% CPI	$1.5\% \leq \Delta p \leq 3.5\%$	$\Delta p < 2.5\%$	1.62%
NZ	1-3% CPI	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	1.16%
SAF	3-6% CPIX	$3\% \leq \Delta p \leq 6\%$	$\Delta p < 4.5\%$	1.14%
ARG	None	$2.5\% \leq \Delta p \leq 6.5\%$	$\Delta p < 4.5\%$	0.88%
BRA	4.5% CPI ± 2%	$2.5\% \leq \Delta p \leq 6.5\%$	$\Delta p < 4.5\%$	1.17%
CHL	3% CPI ±1%	$2\% \leq \Delta p \leq 4\%$	$\Delta p < 3\%$	2.21%
MEX	3% CPI	$2\% \leq \Delta p \leq 4\%$	$\Delta p < 3\%$	1.30%
IND	None	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	2.95%
KOR	3% CPI ± of 0.5%	$2\% \leq \Delta p \leq 4\%$	$\Delta p < 3\%$	3.22%
MAL	None	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	2.95%
PHI	4-5% CPI	$3.5\% \leq \Delta p \leq 5.5\%$	$\Delta p < 4.5\%$	1.43%
SNG	None	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	3.33%
THA	0-3.5% CPIX	$2.5\% \leq \Delta p \leq 4.5\%$	$\Delta p < 3.5\%$	2.85%
CHN	None	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	4.65%
INS	5% CPI ± 1%.	$4\% \leq \Delta p \leq 6\%$	$\Delta p < 5\%$	2.34%
PER	1-3% CPI	$1.5\% \leq \Delta p \leq 3.5\%$	$\Delta p < 2.5\%$	1.20%
TUR	5% CPI ± 2%	$4\% \leq \Delta p \leq 6\%$	$\Delta p < 5\%$	2.23%
SAR	None	$1\% \leq \Delta p \leq 3\%$	$\Delta p < 2\%$	0.84%

† Low growth is defined as half of the historical average growth rate. Where event definitions are common to all countries they are defined in the text.

Table 4: Definition of Forecasting Events Specific to Various Countries

Horizon	KOR y	KOR r	KOR $e-p$	KOR x	KOR q	NZ q	KOR Δp	CHL m	CHL q	THA Δp	Sum of top 10	Sum of total
0	74.13	12.54	7.09	4.30	4.07	6.49	1.72	1.22	5.12	1.25	117.94	324.11
1	37.65	46.38	35.62	27.86	30.64	8.49	7.98	7.79	8.36	6.46	217.23	396.71
2	37.43	42.00	35.58	33.20	31.30	9.30	8.44	8.55	8.21	7.52	221.54	404.18
3	36.17	42.25	36.42	34.41	33.29	9.53	9.03	8.76	7.82	8.15	225.83	409.01
4	35.53	42.80	37.78	35.84	33.96	9.82	9.34	8.88	7.36	8.41	229.73	416.57
5	35.29	43.48	39.18	36.57	34.26	9.92	9.87	8.80	6.88	8.20	232.46	422.53
6	35.08	43.82	40.34	37.13	34.42	9.96	10.23	8.61	6.46	7.83	233.88	426.61
7	35.14	43.80	41.04	37.27	34.48	9.86	10.42	8.35	6.20	7.35	233.90	427.82
8	35.22	43.46	41.38	37.20	34.35	9.68	10.40	8.08	6.08	6.85	232.68	426.65
Mean	40.18	40.06	34.94	31.53	30.09	9.23	8.60	7.67	6.94	6.89		

(a) GFEVD of Korean Real Output

Horizon	BRA r	BRA Δp	KOR m	KOR y	US p^o	KOR Δp	US x	KOR r	KOR x	US p	Sum of top 10	Sum of total
0	0.14	0.01	9.99	2.99	3.25	77.38	0.05	21.50	10.69	4.28	130.26	395.66
1	19.68	17.98	23.68	16.91	6.56	0.07	6.35	0.00	10.07	4.06	105.35	321.20
2	29.47	25.88	15.39	10.57	13.04	0.14	11.59	3.05	5.94	3.80	118.89	336.69
3	24.68	21.43	14.59	11.62	12.59	0.12	11.98	4.67	5.03	5.03	111.74	329.73
4	21.09	18.22	13.90	12.51	10.97	0.10	10.96	5.82	4.83	6.34	104.73	328.82
5	20.52	18.05	13.78	13.00	10.91	0.12	10.28	6.73	4.59	6.60	104.57	330.37
6	21.34	19.16	13.91	12.81	9.98	0.13	9.53	7.19	4.17	6.02	104.23	329.07
7	21.88	19.70	13.32	12.21	8.88	0.12	8.57	7.09	3.83	5.46	101.07	329.74
8	21.74	19.62	12.91	11.65	8.36	0.12	7.85	6.88	3.49	5.27	97.89	331.68
Mean	20.06	17.78	14.61	11.58	9.39	8.70	8.57	6.99	5.85	5.21		

(b) GFEVD of Korean Inflation

Table 5: Generalised FEVDs of Inflation and Real Output for Korea

	US		EUR		JAP		UK		KOR		CHN	
2007q1	0.96	*0.92*	0.95	*0.99*	0.11	*0.91*	0.82	*0.13*	0.19	*0.63*	0.57	*0.63*
2007q2	0.84	*0.58*	0.40	*0.90*	0.02	*0.82*	0.47	*0.14*	0.34	*0.13*	0.39	*0.36*
2007q3	0.73	*0.22*	0.44	*0.76*	0.06	*0.26*	0.27	*0.12*	0.34	*0.15*	0.26	*0.28*
2007q4	0.20	*0.00*	0.44	*0.60*	0.24	*0.02*	0.20	*0.20*	0.35	*0.03*	0.19	*0.22*
2008q1	0.27	*0.00*	0.38	*0.51*	0.36	*0.16*	0.33	*0.14*	0.32	*0.06*	0.12	*0.19*
2008q2	0.50	*0.01*	0.31	*0.44*	0.44	*0.56*	0.34	*0.26*	0.29	*0.03*	0.09	*0.15*
2008q3	0.48	*0.01*	0.28	*0.39*	0.44	*0.69*	0.30	*0.28*	0.27	*0.02*	0.08	*0.14*
2008q4	0.36	*0.01*	0.25	*0.31*	0.43	*0.65*	0.30	*0.26*	0.27	*0.02*	0.10	*0.12*

(a) Inflation Target 1 (Event A)

2007q1	0.14	*0.04*	0.92	*0.79*	1.00	*0.97*	0.17	*0.00*	0.99	*0.12*	0.22	*0.28*
2007q2	0.26	*0.04*	0.97	*0.65*	1.00	*0.07*	0.87	*0.01*	0.89	*0.01*	0.36	*0.28*
2007q3	0.22	*0.01*	0.89	*0.51*	1.00	*0.00*	0.92	*0.03*	0.82	*0.04*	0.48	*0.35*
2007q4	0.02	*0.00*	0.79	*0.42*	0.98	*0.00*	0.90	*0.07*	0.60	*0.01*	0.62	*0.48*
2008q1	0.04	*0.00*	0.79	*0.43*	0.94	*0.01*	0.64	*0.08*	0.54	*0.04*	0.71	*0.53*
2008q2	0.18	*0.00*	0.79	*0.57*	0.85	*0.14*	0.57	*0.22*	0.52	*0.03*	0.75	*0.59*
2008q3	0.18	*0.00*	0.80	*0.56*	0.82	*0.30*	0.53	*0.34*	0.53	*0.01*	0.75	*0.61*
2008q4	0.12	*0.00*	0.79	*0.51*	0.78	*0.31*	0.55	*0.42*	0.51	*0.01*	0.75	*0.62*

(b) Inflation Target 2 (Event B)

2007q1	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*
2007q2	0.01	*0.00*	0.07	*0.00*	0.02	*0.02*	0.00	*0.00*	0.01	*0.00*	0.00	*0.00*
2007q3	0.04	*0.00*	0.07	*0.00*	0.03	*0.00*	0.00	*0.00*	0.04	*0.00*	0.00	*0.00*
2007q4	0.06	*0.01*	0.06	*0.00*	0.04	*0.00*	0.00	*0.00*	0.05	*0.02*	0.00	*0.00*
2008q1	0.02	*0.05*	0.05	*0.01*	0.05	*0.00*	0.00	*0.01*	0.06	*0.09*	0.00	*0.00*
2008q2	0.01	*0.39*	0.05	*0.03*	0.06	*0.01*	0.00	*0.02*	0.05	*0.19*	0.01	*0.00*
2008q3	0.02	*0.58*	0.05	*0.05*	0.06	*0.06*	0.01	*0.05*	0.05	*0.25*	0.00	*0.00*
2008q4	0.03	*0.54*	0.05	*0.08*	0.06	*0.06*	0.01	*0.06*	0.05	*0.17*	0.00	*0.00*

(c) Recession (Event C)

Note: italicised text refers to the GVAR model while normal text refers to country–specific forecasts.

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	US		EUR		JAP		UK		KOR		CHN	
2007q1	0.12	*0.04*	0.00	*0.00*	0.02	*0.05*	0.00	*0.00*	0.22	*0.03*	0.00	*0.00*
2007q2	0.24	*0.07*	0.10	*0.00*	0.04	*0.03*	0.00	*0.00*	0.15	*0.01*	0.00	*0.00*
2007q3	0.27	*0.04*	0.20	*0.01*	0.02	*0.01*	0.00	*0.00*	0.22	*0.02*	0.01	*0.00*
2007q4	0.32	*0.06*	0.30	*0.02*	0.09	*0.01*	0.00	*0.00*	0.19	*0.02*	0.09	*0.01*
2008q1	0.30	*0.25*	0.28	*0.03*	0.13	*0.00*	0.00	*0.01*	0.25	*0.15*	0.16	*0.01*
2008q2	0.28	*0.65*	0.25	*0.05*	0.17	*0.01*	0.01	*0.09*	0.27	*0.38*	0.18	*0.01*
2008q3	0.19	*0.89*	0.23	*0.13*	0.19	*0.03*	0.02	*0.20*	0.25	*0.60*	0.16	*0.02*
2008q4	0.17	*0.96*	0.23	*0.22*	0.22	*0.13*	0.04	*0.30*	0.25	*0.65*	0.13	*0.03*

(d) Slow Growth (Event D)

2007q1	0.96	*0.92*	0.95	*0.99*	0.11	*0.91*	0.82	*0.13*	0.19	*0.63*	0.57	*0.63*
2007q2	0.84	*0.58*	0.38	*0.90*	0.02	*0.81*	0.47	*0.14*	0.34	*0.13*	0.39	*0.36*
2007q3	0.71	*0.22*	0.42	*0.76*	0.06	*0.26*	0.27	*0.12*	0.32	*0.15*	0.26	*0.28*
2007q4	0.19	*0.00*	0.42	*0.60*	0.24	*0.02*	0.20	*0.20*	0.34	*0.03*	0.19	*0.22*
2008q1	0.27	*0.00*	0.37	*0.51*	0.35	*0.16*	0.33	*0.14*	0.30	*0.06*	0.12	*0.19*
2008q2	0.50	*0.01*	0.30	*0.43*	0.42	*0.55*	0.34	*0.26*	0.27	*0.03*	0.09	*0.15*
2008q3	0.48	*0.01*	0.27	*0.38*	0.41	*0.65*	0.30	*0.27*	0.25	*0.02*	0.08	*0.14*
2008q4	0.36	*0.01*	0.24	*0.29*	0.41	*0.60*	0.30	*0.25*	0.25	*0.02*	0.10	*0.12*

(e) Inflation Target 1 *and* No Recession (Events $A \cap \overline{C}$)

2007q1	0.84	*0.88*	0.95	*0.99*	0.10	*0.87*	0.82	*0.13*	0.13	*0.62*	0.57	*0.63*
2007q2	0.65	*0.55*	0.37	*0.90*	0.02	*0.80*	0.47	*0.14*	0.26	*0.13*	0.39	*0.36*
2007q3	0.53	*0.21*	0.39	*0.75*	0.06	*0.26*	0.27	*0.12*	0.24	*0.14*	0.26	*0.28*
2007q4	0.14	*0.00*	0.35	*0.59*	0.23	*0.02*	0.20	*0.20*	0.28	*0.03*	0.18	*0.22*
2008q1	0.20	*0.00*	0.32	*0.50*	0.33	*0.16*	0.33	*0.14*	0.24	*0.05*	0.10	*0.19*
2008q2	0.36	*0.00*	0.27	*0.44*	0.40	*0.56*	0.33	*0.25*	0.20	*0.02*	0.08	*0.15*
2008q3	0.40	*0.00*	0.24	*0.37*	0.38	*0.67*	0.30	*0.24*	0.20	*0.02*	0.06	*0.14*
2008q4	0.32	*0.00*	0.22	*0.26*	0.35	*0.55*	0.29	*0.19*	0.20	*0.01*	0.09	*0.12*

(f) Inflation Target 1 *and* No Slow Growth (Events $A \cap \overline{D}$)

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	US		EUR		JAP		UK		KOR		CHN	
2007q1	0.14	*0.04*	0.92	*0.79*	1.00	*0.97*	0.17	*0.00*	0.99	*0.12*	0.22	*0.28*
2007q2	0.26	*0.04*	0.90	*0.64*	0.98	*0.06*	0.87	*0.01*	0.89	*0.01*	0.36	*0.28*
2007q3	0.22	*0.01*	0.82	*0.51*	0.97	*0.00*	0.92	*0.03*	0.79	*0.04*	0.48	*0.35*
2007q4	0.02	*0.00*	0.74	*0.42*	0.94	*0.00*	0.90	*0.07*	0.58	*0.01*	0.62	*0.48*
2008q1	0.04	*0.00*	0.74	*0.42*	0.89	*0.01*	0.64	*0.08*	0.52	*0.04*	0.71	*0.53*
2008q2	0.18	*0.00*	0.74	*0.55*	0.79	*0.13*	0.57	*0.22*	0.50	*0.03*	0.74	*0.59*
2008q3	0.18	*0.00*	0.75	*0.52*	0.77	*0.28*	0.53	*0.34*	0.51	*0.01*	0.75	*0.61*
2008q4	0.12	*0.00*	0.74	*0.45*	0.73	*0.28*	0.55	*0.41*	0.48	*0.01*	0.75	*0.62*

(g) Inflation Target 2 *and* No Recession (Events $B \cap \overline{C}$)

2007q1	0.12	*0.04*	0.92	*0.79*	0.98	*0.93*	0.17	*0.00*	0.78	*0.12*	0.22	*0.28*
2007q2	0.21	*0.04*	0.87	*0.65*	0.96	*0.06*	0.87	*0.01*	0.77	*0.01*	0.36	*0.28*
2007q3	0.17	*0.01*	0.70	*0.50*	0.98	*0.00*	0.92	*0.03*	0.66	*0.04*	0.47	*0.35*
2007q4	0.02	*0.00*	0.52	*0.40*	0.89	*0.00*	0.90	*0.07*	0.51	*0.01*	0.56	*0.48*
2008q1	0.03	*0.00*	0.52	*0.41*	0.81	*0.01*	0.64	*0.08*	0.43	*0.04*	0.59	*0.53*
2008q2	0.13	*0.00*	0.55	*0.53*	0.69	*0.14*	0.57	*0.21*	0.40	*0.02*	0.60	*0.58*
2008q3	0.15	*0.00*	0.58	*0.45*	0.65	*0.29*	0.52	*0.31*	0.41	*0.01*	0.62	*0.60*
2008q4	0.10	*0.00*	0.57	*0.33*	0.58	*0.26*	0.54	*0.34*	0.40	*0.01*	0.65	*0.59*

(h) Inflation Target 2 *and* No Slow Growth (Events $B \cap \overline{D}$)

2007q1	1.00	*1.00*	0.00	*0.00*	0.00	*0.00*	1.00	*1.00*	0.00	*0.00*	0.00	*0.00*
2007q2	1.00	*1.00*	0.00	*0.00*	0.00	*0.00*	1.00	*1.00*	0.01	*0.00*	0.00	*0.00*
2007q3	1.00	*1.00*	0.00	*0.04*	0.00	*0.00*	1.00	*1.00*	0.03	*0.00*	0.00	*0.00*
2007q4	1.00	*1.00*	0.00	*0.47*	0.00	*0.09*	1.00	*1.00*	0.09	*0.03*	0.00	*0.00*
2008q1	1.00	*1.00*	0.00	*0.63*	0.01	*0.18*	1.00	*1.00*	0.16	*0.11*	0.00	*0.00*
2008q2	1.00	*1.00*	0.00	*0.74*	0.03	*0.27*	1.00	*1.00*	0.18	*0.11*	0.01	*0.00*
2008q3	1.00	*1.00*	0.01	*0.80*	0.04	*0.34*	1.00	*1.00*	0.20	*0.10*	0.02	*0.00*
2008q4	1.00	*1.00*	0.02	*0.82*	0.05	*0.40*	1.00	*1.00*	0.22	*0.09*	0.03	*0.00*

(i) Current Account Deficit (Event E)

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	US		EUR		JAP		UK		KOR		CHN	
2007q1	1.00	*1.00*	0.81	*0.03*	0.96	*0.11*	0.00	*0.00*	0.90	*1.00*	0.75	*0.89*
2007q2	0.97	*1.00*	0.97	*0.05*	0.84	*0.20*	0.00	*0.00*	0.71	*0.73*	0.63	*0.92*
2007q3	0.95	*1.00*	0.96	*0.10*	0.75	*0.25*	0.22	*0.00*	0.77	*0.77*	0.58	*0.93*
2007q4	0.70	*1.00*	0.81	*0.00*	0.61	*0.15*	0.47	*0.05*	0.59	*0.57*	0.54	*0.93*
2008q1	0.64	*1.00*	0.92	*0.18*	0.57	*0.34*	0.63	*0.40*	0.54	*0.29*	0.66	*0.92*
2008q2	0.60	*1.00*	0.77	*0.11*	0.62	*0.33*	0.52	*0.33*	0.60	*0.67*	0.68	*0.82*
2008q3	0.52	*1.00*	0.74	*0.15*	0.64	*0.29*	0.48	*0.48*	0.58	*0.72*	0.71	*0.73*
2008q4	0.45	*0.99*	0.63	*0.15*	0.65	*0.30*	0.31	*0.42*	0.53	*0.74*	0.66	*0.55*

(j) Current Account Improvement (Event F)

2007q1	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	1.00	*1.00*	0.00	*0.00*	0.00	*0.00*
2007q2	0.04	*0.00*	0.00	*0.00*	0.00	*0.00*	1.00	*1.00*	0.01	*0.00*	0.00	*0.00*
2007q3	0.05	*0.00*	0.00	*0.04*	0.00	*0.00*	0.78	*1.00*	0.03	*0.00*	0.00	*0.00*
2007q4	0.30	*0.00*	0.00	*0.47*	0.00	*0.09*	0.53	*0.95*	0.09	*0.03*	0.00	*0.00*
2008q1	0.36	*0.00*	0.00	*0.61*	0.01	*0.18*	0.37	*0.60*	0.15	*0.11*	0.00	*0.00*
2008q2	0.40	*0.00*	0.00	*0.72*	0.03	*0.25*	0.48	*0.67*	0.14	*0.08*	0.01	*0.00*
2008q3	0.48	*0.00*	0.01	*0.75*	0.04	*0.30*	0.52	*0.52*	0.16	*0.06*	0.02	*0.00*
2008q4	0.55	*0.01*	0.02	*0.77*	0.04	*0.35*	0.69	*0.58*	0.16	*0.06*	0.03	*0.00*

(k) Current Account Deficit *and* Deterioration (Events $E \cap \overline{F}$)

2007q1	1.00	*1.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*
2007q2	0.97	*1.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*	0.00	*0.00*
2007q3	0.95	*1.00*	0.00	*0.00*	0.00	*0.00*	0.22	*0.00*	0.00	*0.00*	0.00	*0.00*
2007q4	0.70	*1.00*	0.00	*0.00*	0.00	*0.00*	0.47	*0.05*	0.00	*0.00*	0.00	*0.00*
2008q1	0.64	*1.00*	0.00	*0.01*	0.00	*0.00*	0.63	*0.40*	0.01	*0.00*	0.00	*0.00*
2008q2	0.60	*1.00*	0.00	*0.01*	0.00	*0.02*	0.52	*0.33*	0.04	*0.03*	0.00	*0.00*
2008q3	0.52	*1.00*	0.00	*0.04*	0.00	*0.03*	0.48	*0.48*	0.04	*0.04*	0.00	*0.00*
2008q4	0.45	*0.99*	0.00	*0.05*	0.01	*0.05*	0.31	*0.42*	0.05	*0.04*	0.00	*0.00*

(l) Current Account Deficit *and* Improvement (Events $E \cap F$)

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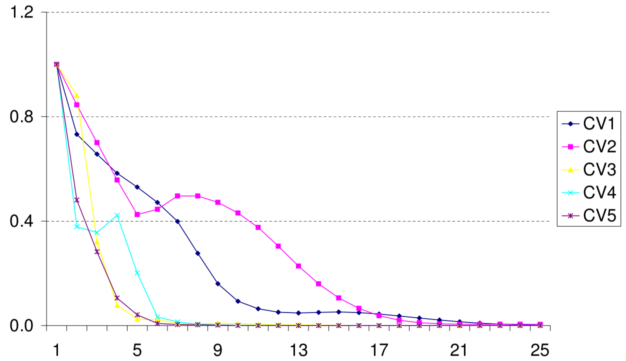
	US		EUR		JAP		UK		KOR		CHN	
2007q1	0.00	*0.00*	0.19	*0.97*	0.04	*0.89*	0.00	*0.00*	0.10	*0.00*	0.25	*0.11*
2007q2	0.00	*0.00*	0.03	*0.95*	0.16	*0.80*	0.00	*0.00*	0.29	*0.27*	0.37	*0.08*
2007q3	0.00	*0.00*	0.04	*0.87*	0.25	*0.75*	0.00	*0.00*	0.19	*0.23*	0.42	*0.07*
2007q4	0.00	*0.00*	0.19	*0.53*	0.39	*0.77*	0.00	*0.00*	0.32	*0.40*	0.46	*0.07*
2008q1	0.00	*0.00*	0.08	*0.21*	0.42	*0.48*	0.00	*0.00*	0.32	*0.60*	0.34	*0.08*
2008q2	0.00	*0.00*	0.23	*0.16*	0.35	*0.42*	0.00	*0.00*	0.26	*0.25*	0.31	*0.18*
2008q3	0.00	*0.00*	0.25	*0.10*	0.32	*0.41*	0.00	*0.00*	0.27	*0.22*	0.28	*0.27*
2008q4	0.00	*0.00*	0.35	*0.08*	0.31	*0.35*	0.00	*0.00*	0.30	*0.21*	0.32	*0.45*

(m) Current Account Surplus *and* Deterioration (Events $\overline{E} \cap \overline{F}$)

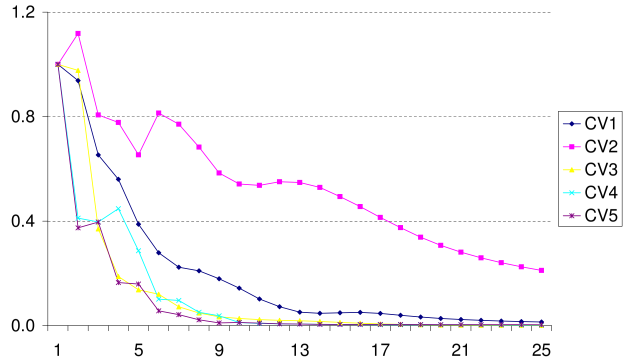
2007q1	0.00	*0.00*	0.81	*0.03*	0.96	*0.11*	0.00	*0.00*	0.90	*1.00*	0.75	*0.89*
2007q2	0.00	*0.00*	0.97	*0.05*	0.84	*0.20*	0.00	*0.00*	0.71	*0.73*	0.63	*0.92*
2007q3	0.00	*0.00*	0.96	*0.10*	0.75	*0.25*	0.00	*0.00*	0.77	*0.77*	0.58	*0.93*
2007q4	0.00	*0.00*	0.81	*0.00*	0.61	*0.15*	0.00	*0.00*	0.59	*0.57*	0.54	*0.93*
2008q1	0.00	*0.00*	0.92	*0.17*	0.57	*0.34*	0.00	*0.00*	0.53	*0.29*	0.66	*0.92*
2008q2	0.00	*0.00*	0.77	*0.10*	0.62	*0.32*	0.00	*0.00*	0.56	*0.64*	0.68	*0.82*
2008q3	0.00	*0.00*	0.74	*0.10*	0.63	*0.26*	0.00	*0.00*	0.53	*0.68*	0.71	*0.73*
2008q4	0.00	*0.00*	0.63	*0.10*	0.64	*0.25*	0.00	*0.00*	0.48	*0.70*	0.66	*0.55*

(n) Current Account Surplus *and* Improvement (Events $\overline{E} \cap F$)

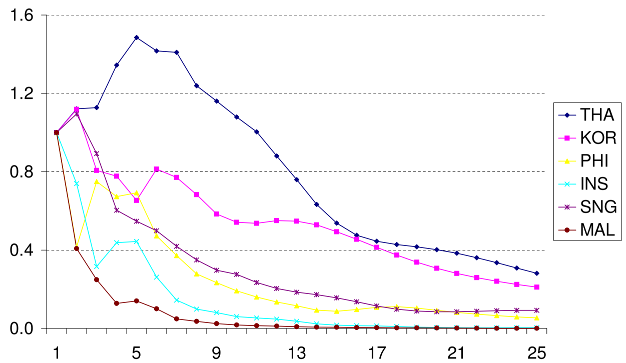
Table 6: Probability Event Forecasts Based on Country–Specific and GVAR Models (GVAR in Italics)



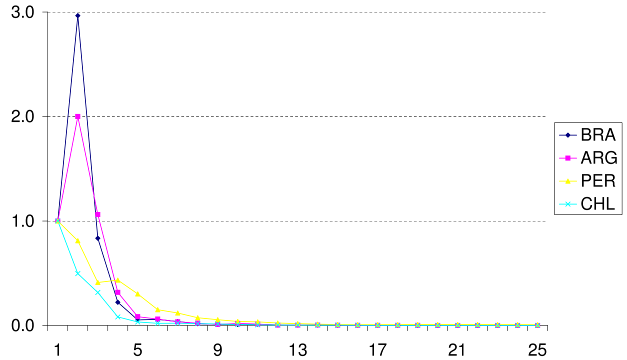
(a) Korea (Country–Specific)



(b) Korea (GVAR)

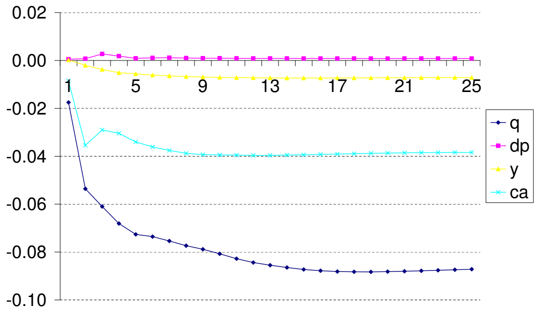


(c) Excess Persistence in South–East Asian PPs

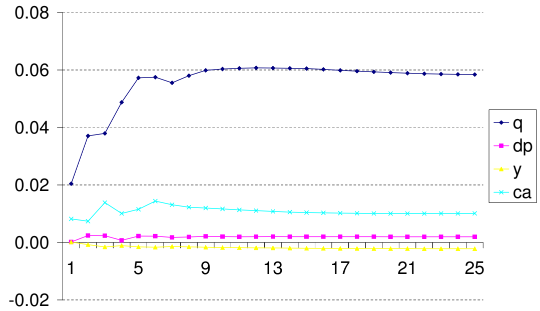


(d) Overshooting in South American PPs

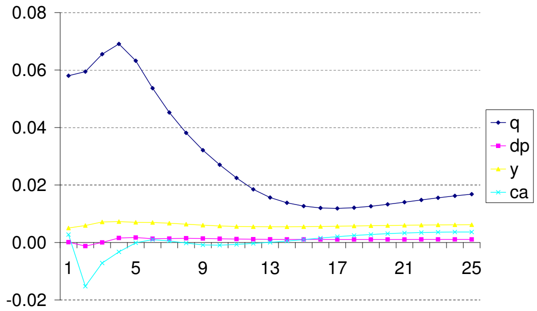
Figure 1: Persistence Profiles



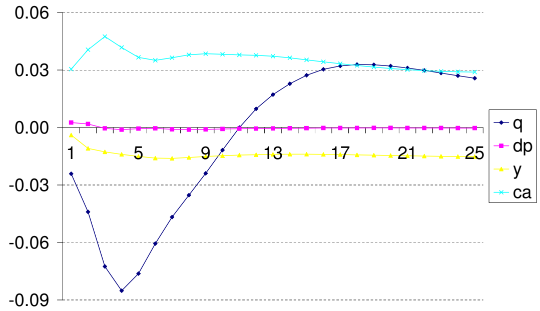
(a) Oil Price Shock



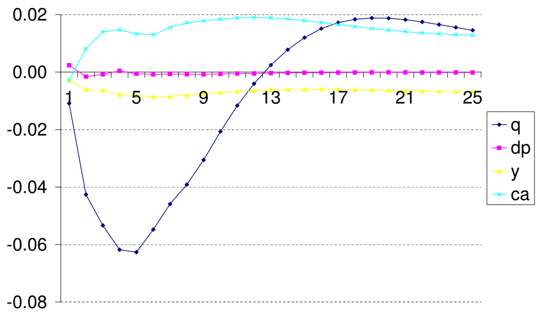
(b) Foreign Monetary Policy Shock



(c) Foreign Equity Shock

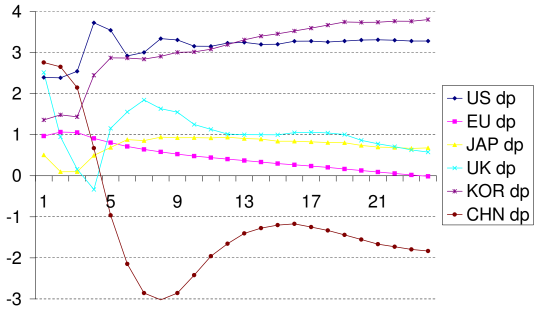


(d) Real Depreciation of the Won

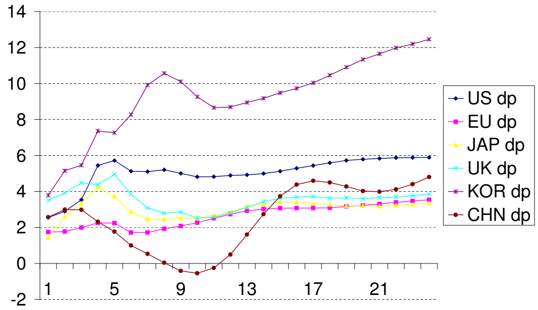


(e) Domestic Monetary Policy Shock

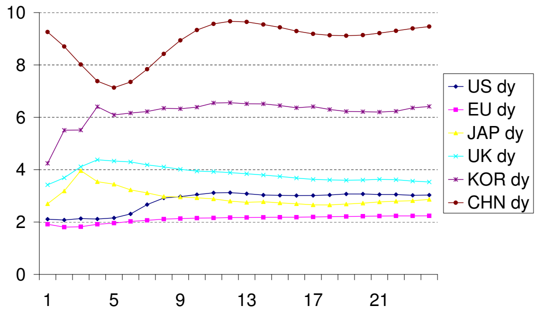
Figure 2: Various SIRs from the Korean Country–Specific Model



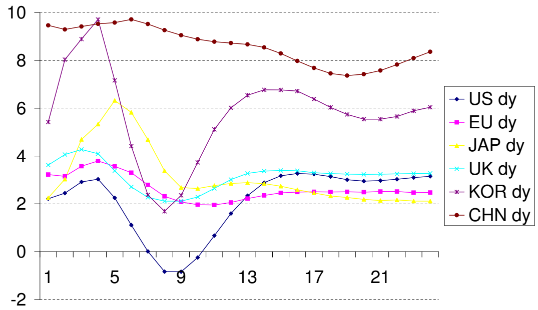
(a) Inflation (Country–Specific)



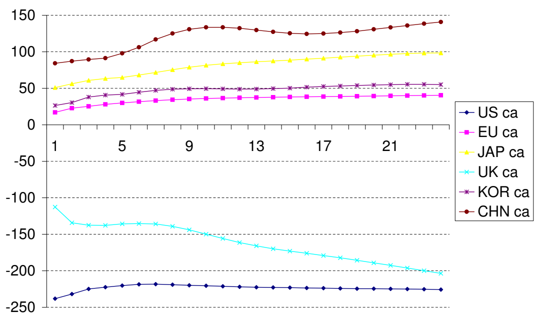
(b) Inflation (GVAR)



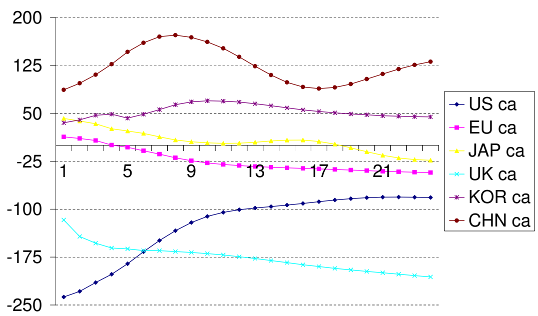
(c) Output Growth (Country–Specific)



(d) Output Growth (GVAR)

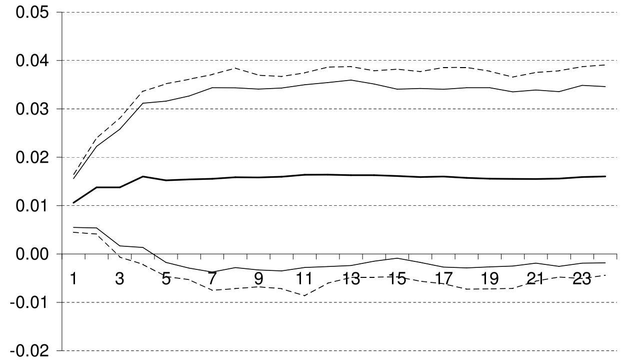


(e) Current Account (Country–Specific)

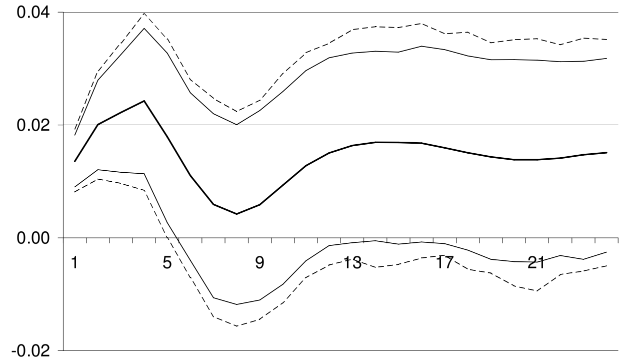


(f) Current Account (GVAR)

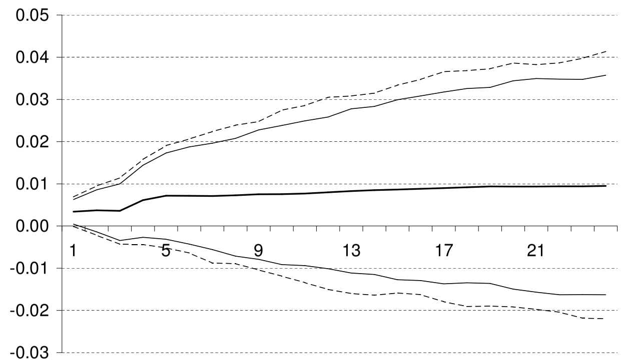
Figure 3: Four–Quarter Moving Average Central Forecasts



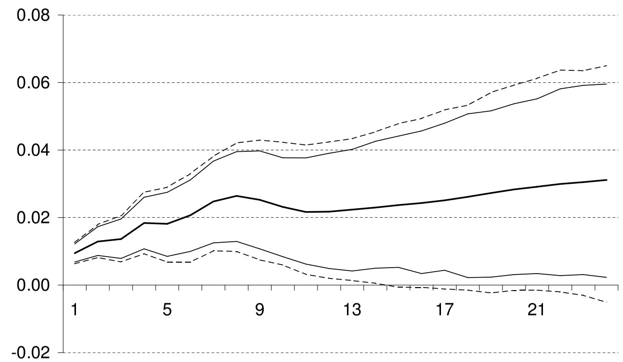
(a) Output Growth (Country–Specific)



(b) Output Growth (GVAR)

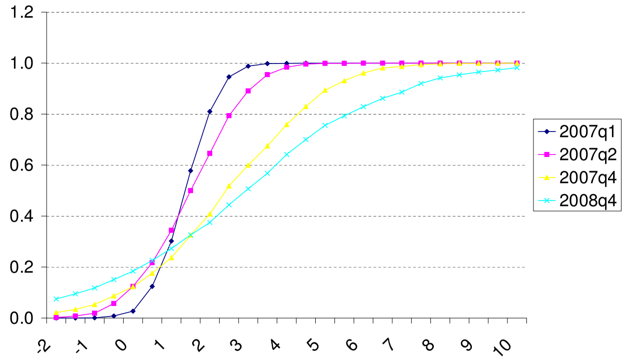


(c) Inflation (Country–Specific)

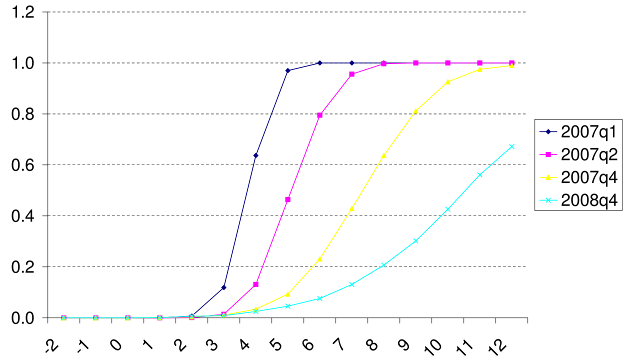


(d) Inflation (GVAR)

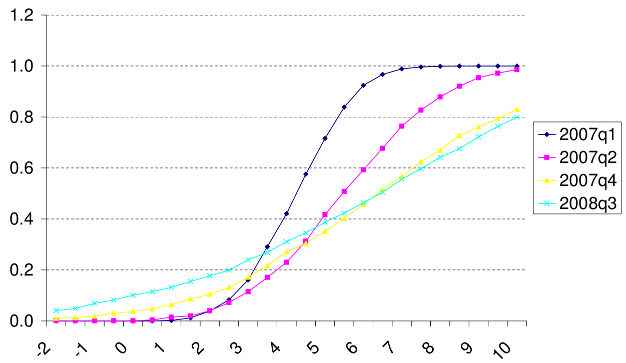
Figure 4: Korean Interval Forecasts



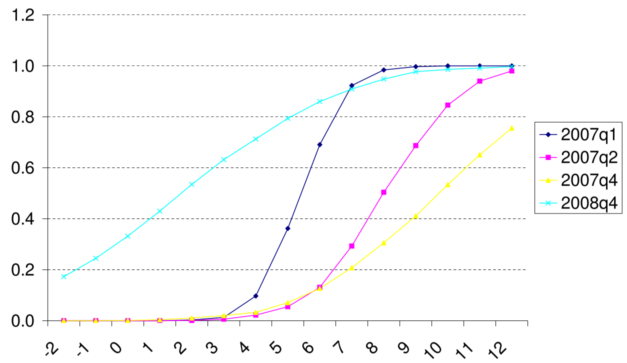
(a) Inflation (Country–Specific)



(b) Inflation (GVAR)

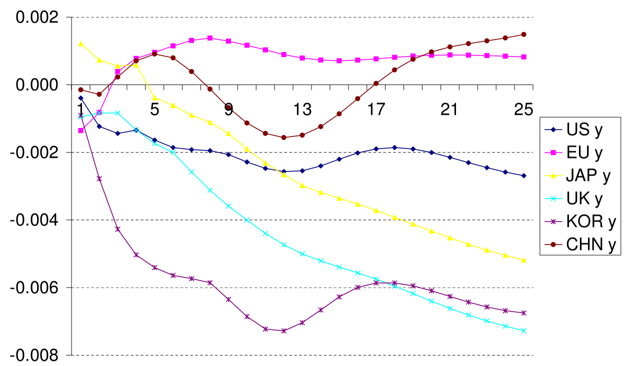


(c) Output Growth (Country–Specific)

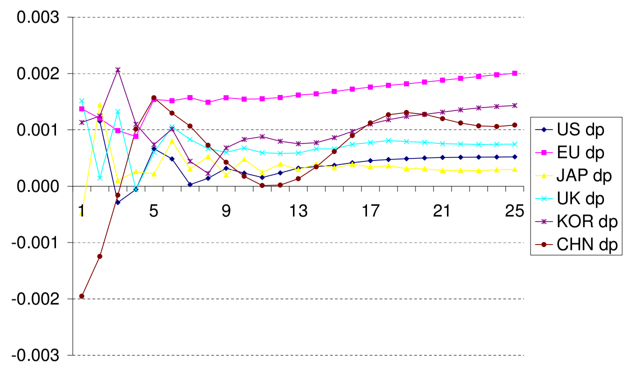


(d) Output Growth (GVAR)

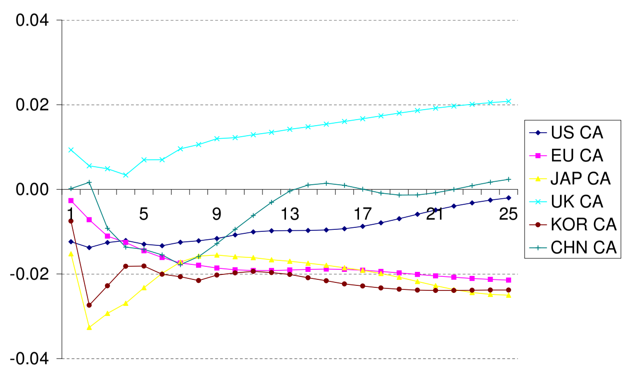
Figure 5: Predictive Distribution Functions for Korea



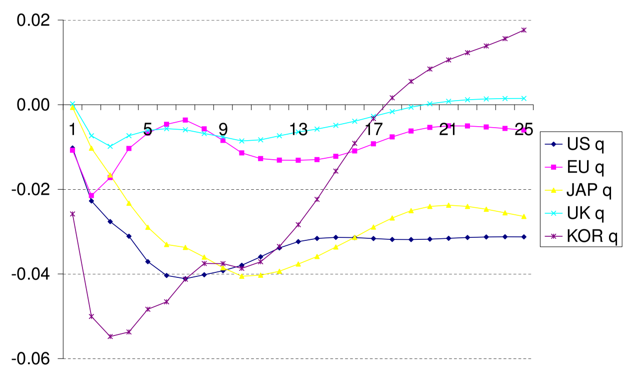
(a) Output



(b) Inflation (Price level)

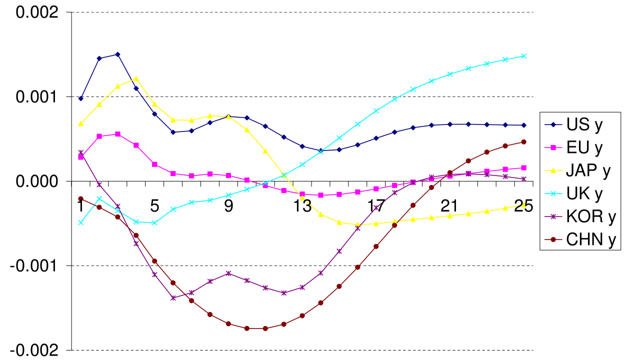


(c) Current Account

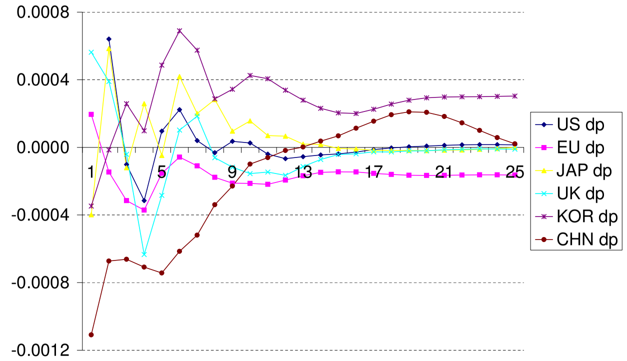


(d) Stock Market

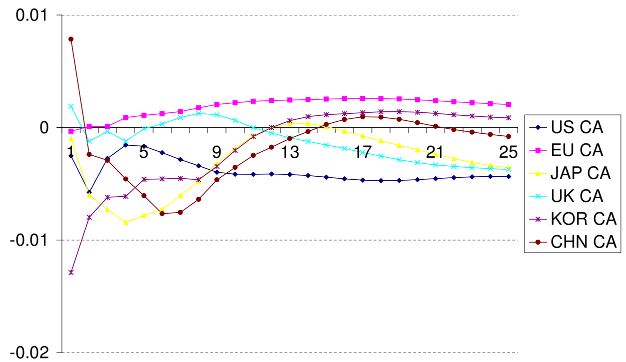
Figure 6: Various GIRs with respect to an Oil Price Shock



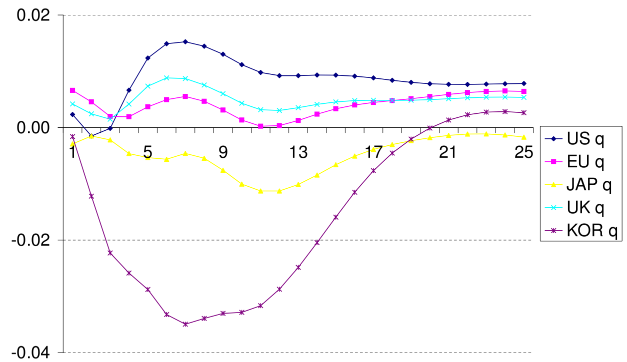
(a) Output



(b) Inflation (Price level)

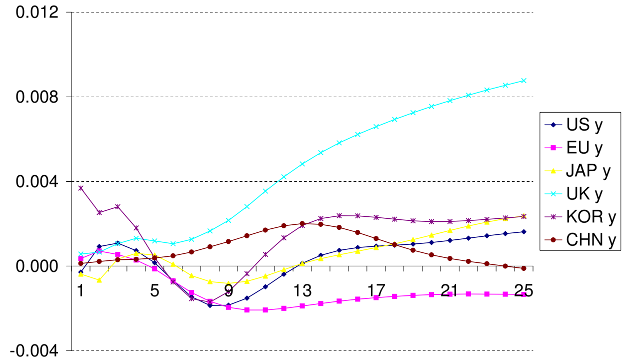


(c) Current Account

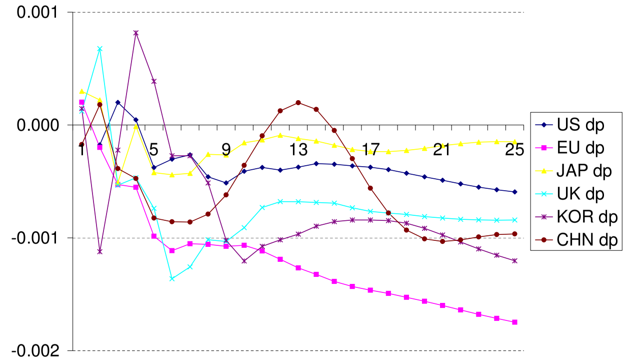


(d) Stock Market

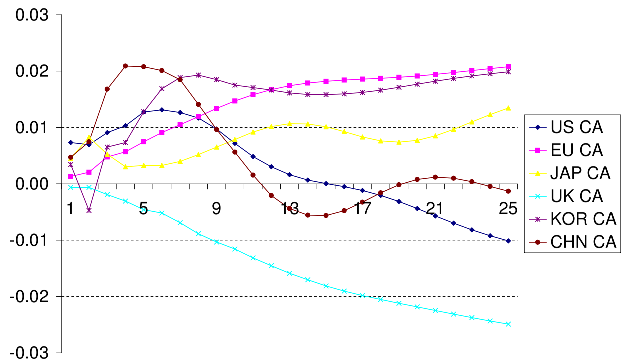
Figure 7: Various GIRs with respect to a US Monetary Policy Shock



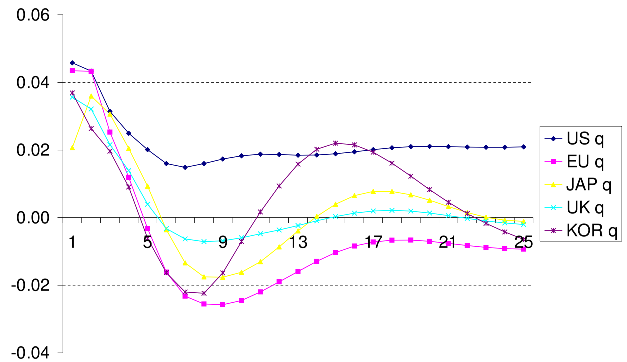
(a) Output



(b) Inflation (Price level)

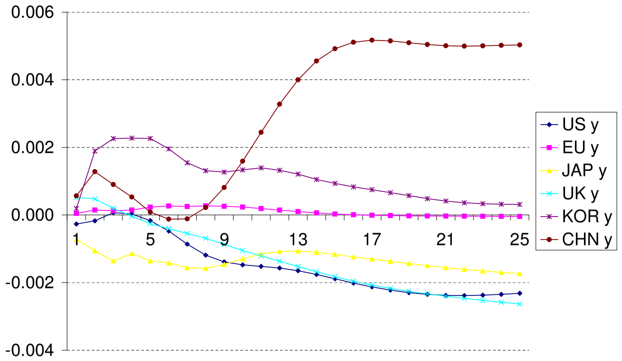


(c) Current Account

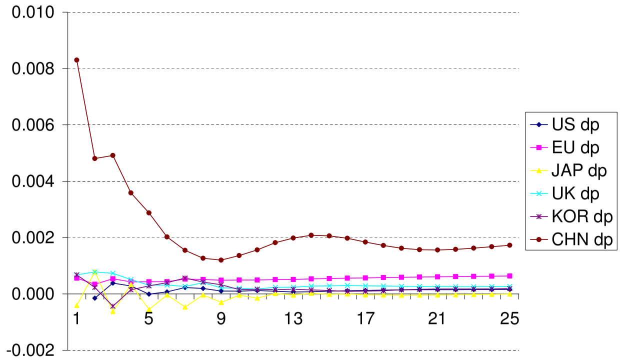


(d) Stock Market

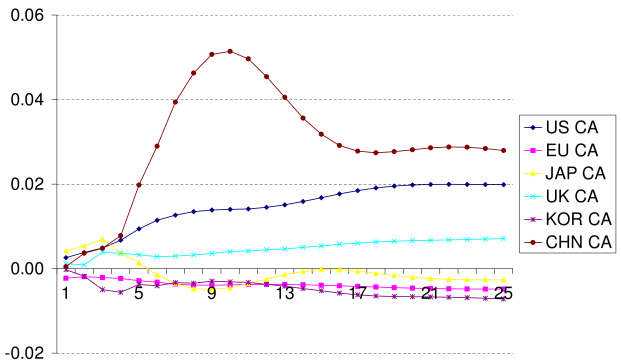
Figure 8: Various GIRs with respect to a Positive US Stock Market Shock



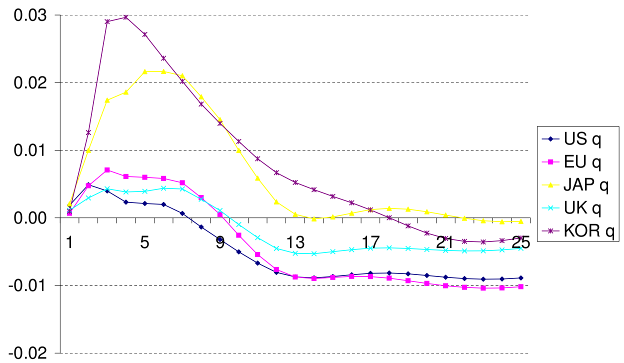
(a) Output



(b) Inflation (Price level)



(c) Current Account



(d) Stock Market

Figure 9: Various GIRs with respect to Elevated Chinese Inflationary Pressure