

1 Appendix: Long-run comovement of output and prices

In Section 3 it was shown that if country specific supply (u_i) or demand (v_i) shocks are asymmetric across the union then there is a role for greater fiscal management. In order to test the symmetry of such shocks, they must first be empirically identified. Correct identification depends on the dynamic relationship between output and prices. In order to illustrate analytically the changing relationship between monetary and fiscal authorities as a result of join a monetary union, the model in Section 3 was not dynamic. Den Haan (2000), however, shows that a dynamic Keynesian model with supply and demand shocks does capture a negative long-run comovement in prices and output. He then tests this long-run relationship for the United States and finds that the correlation between prices and output is positive in the short run and negative in the long run. This provides empirical evidence that supply shocks dominate in the long run.

Den Haan's estimation technique uses the correlation of VAR forecast errors at different horizons. To find the short- and long-run relationship between prices and output a reduced form VAR is estimated

$$X_t = \mu + \sum_{l=1}^L A_l X_{t-l} + u_t. \quad (1)$$

X_t is a vector containing prices and output, μ is a constant, L is the number of lags, and u_t is a vector of serially uncorrelated innovations that are not necessarily uncorrelated with each other. A time series of K forecast errors for output and prices is then constructed. The correlation coefficient of the k period ahead price and output forecast error is then calculated. Confidence bands around these correlation coefficients are estimated using bootstrapping techniques.

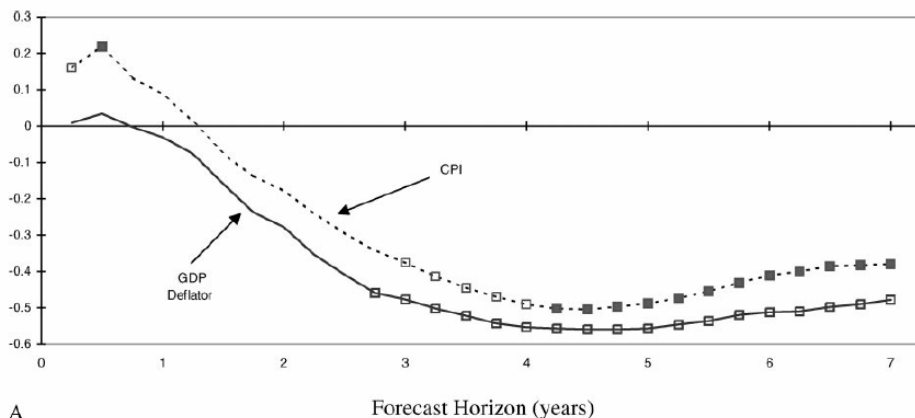
If the forecast error is positively correlated then deviations of output and prices from the forecasted value move in the same direction. This would be consistent with a typical Keynesian demand shock. If, on the other hand, the forecast errors are negatively correlated then deviations of output and prices from the forecasted value move in opposite directions. This is consistent with what would be expected if there were a supply shock. Measuring these correlations across different forecast horizons allows the relationship to change through time. The time dimension makes it possible to find different correlations in the short and long run. The estimated correlations for quarterly measures in

the United States are taken from den Haan (2000) and presented in Figure 1. Den Haan

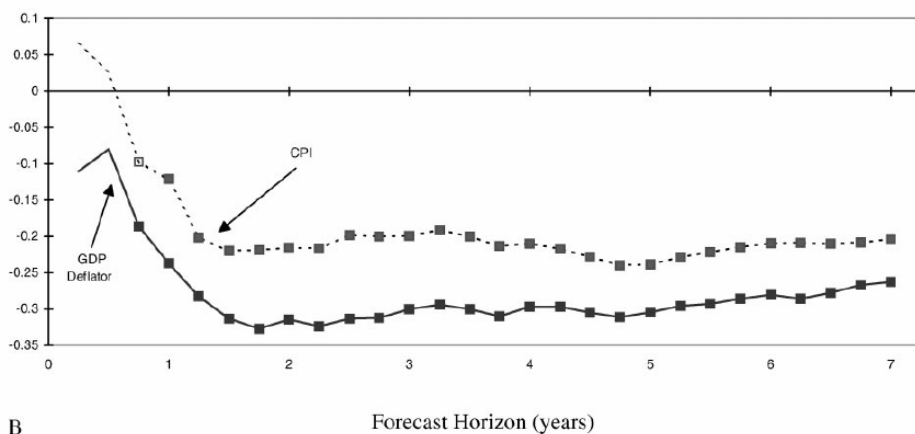
Figure 1:

14

W.J. den Haan / Journal of Monetary Economics 46 (2000) 3–30



A



B

Note: These figures plot the correlation coefficients of the k -period ahead price and output forecast error. The open squares indicate that the estimate is significant at the 10% level and the closed squares indicate that the estimate is significant at the 5% level.

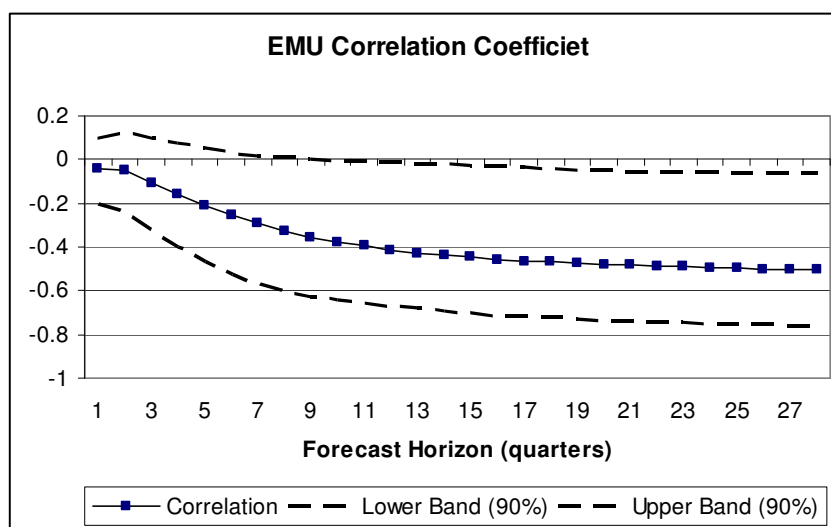
Fig. 3. Correlation coefficients for quarterly price and output data. (A) Unit root imposed in the estimation of the VAR. (B) No unit root imposed in the estimation of the VAR.

used both a CPI measure of prices (dotted line) as well as a the GDP deflator (solid line). Figure A shows the results when the quarterly data is first differenced and Figure B shows when levels are used. In the long run there is a significant negative correlation. This is an indication that supply shocks dominate in the long run for the United States.

To test the relationship in the EMU, quarterly data on EU aggregate data was

taken from the 2007 OECD Economic Outlook. The data covers 1970 quarter 1 to 2006 quarter 4. The log of Euro zone GDP and the GDP deflator are used in first differenced for the VAR, matching the specification used in Section 4. In order to compare correlations to den Haan's results for the United States, a linear trend has also been added to the VAR. Figure 2 illustrates the results for the EMU using den Haan's code (<http://weber.ucsd.edu/~wdenhaan/soft.html>)

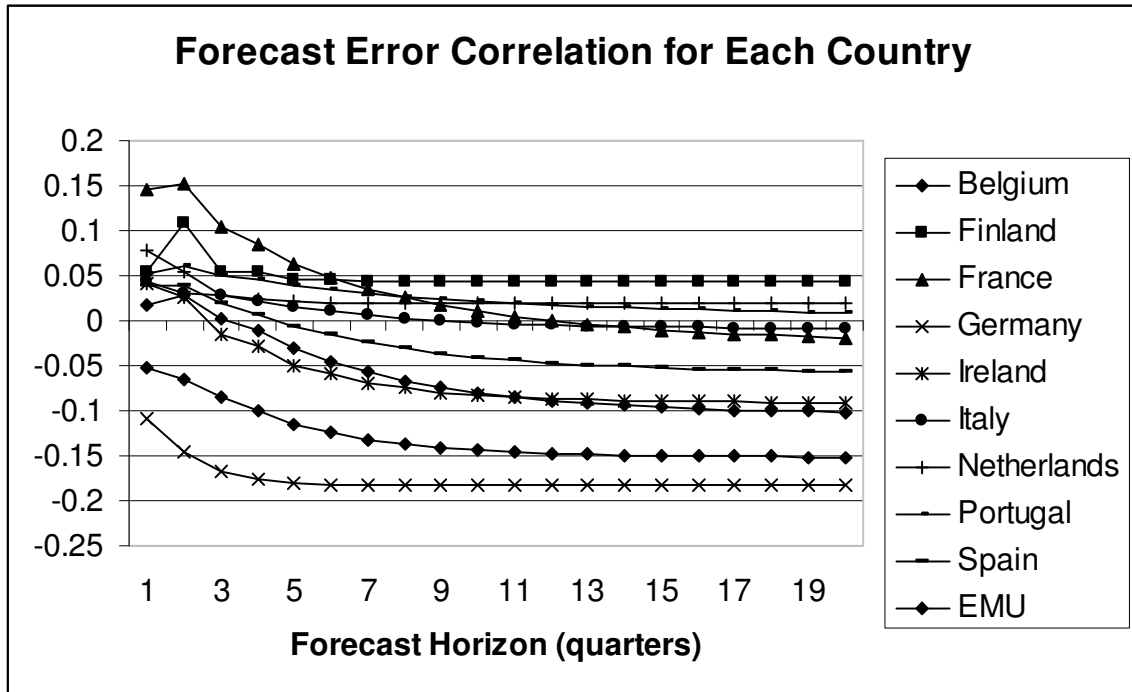
Figure 2:



The results are very similar to that of the United States (Panel A, GDP deflator series in Figure 1). There is a significant negative correlation in the forecast errors of prices and output in the long run.

The SVAR used in Section 4 is estimated for each individual country. Specification tests indicate that the price and output series for each country are stationary once they are first-differenced. Quarterly data are used and a lag length of 2 is selected for each country. As explained in Section 4, Euro zone GDP growth is used with country specific inflation in the VAR. The results for each country and the EMU under this specification are presented in figure 3.

Figure 3:



There is a downward trend in the correlation of forecast errors for each country. The correlation becomes negative (or remains negative) for every country except Finland, Netherlands, and Portugal. This is consistent with the overidentifying restriction in the long-run SVAR specification and Finland, Netherlands, and Portugal are subsequently dropped from the analysis. None of the correlations were significant at the 10 percent level of significance. Den Haan shows that quarterly data was much less significant than monthly so this result was not all together surprising.

This exercise indicates that supply shocks do begin to dominate in the long run. Thus, macroeconomic theory indicates that restricting demand shocks to have no long-run effect on output is a plausible restriction for demand and supply shock identification. This is what will be assumed and used to identify supply and demand shocks for symmetry tests in the remainder of Section 4.