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China's 'New Normal': Is the growth slowdown demand- or supply-driven?

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China's 'New Normal': Is the growth slowdown demand- or supply-driven?

Abstract

China's 'New Normal' has been much discussed in recent years. An important aspect of the New Normal is the growth slowdown from levels of around 10% per annum to a more modest 6 or 7%. Not surprisingly, there has been widespread discussion of whether the slowdown is permanent or not and, in either case, what the sources of the slowdown are. However, much of this discussion has been based on informal analysis of the data rather than formal econometric results. We make a move in the direction of formal empirical analysis of this issue by estimating and simulating a vector autoregressive (VAR) model which distinguishes between demand, supply and foreign shocks as possible drivers of changes in economic growth. We analyse both two-variable (growth and inflation) and three-variable (foreign growth, domestic growth and inflation) VAR models and identify demand, supply and foreign shocks, using a modification of the Blanchard-Quah identification procedure. In the two-variable model we identify two shocks (demand and supply) and find that the slowdown since the GFC has been mainly supply-driven. This conclusion is not changed when a foreign growth variable is added to the model and a foreign shock is allowed for – we find that demand continues to be of relatively little importance, that the foreign shock also makes little contribution to explaining the long-run growth decline in China which continues to be driven by long-term supply factors. This conclusion is robust to a number of alternative formulations of the model. Thus, the growth slowdown may, indeed, be characterised as the 'New Normal'. (257 words)

Keywords: China, slowdown, New Normal, growth, supply shocks, demand shocks
JEL Codes: O47, O53, E17, F47

1. Introduction

The term “New Normal” has cropped up frequently in the discussion of China’s macroeconomic performance in recent years. It did not originate in the discussion of the Chinese economy, however. In the Per Jacobsson Lecture of 2010, Mohamed A. El-Erian of investment management company PIMCO explained that the term had been coined at PIMCO in the aftermath of the Global Financial Crisis (GFC). The purpose was to caution “against the prevailing (and dominant) market and policy view that postcrisis industrial economies would revert to their most recent means” (El-Erian, 2010, p.12). Slower post-GFC growth was not a temporary aberration which would be righted once industrial economies got back on track but the new normal.¹

It was in 2014 that Chinese President Xi Jinping applied the term to China’s slowing growth. It has since been used not just to describe slowing growth but more generally for a range of observed and planned changes in the Chinese economy, from industrial restructuring (increases in the shares of services and high-tech industries in total output and a reduction in energy consumption per capita) to a change in the balance between the components of GDP (greater reliance on domestic demand at the cost of exports and investment), to change in the sources of growth (from factor inputs to greater innovation).

Nevertheless, in this paper, we focus on the growth slowdown aspect of the New Normal. In particular, we ask whether the slowdown is demand- or supply-driven or, equivalently, whether it is temporary or permanent. We do so within the framework of a multivariate time-series model of the vector-autoregressive (VAR) family and begin with a two-variable variant originally due to Blanchard and Quah (1989). They estimated and simulated a bivariate VAR model in real output and the unemployment rate and used a long-run restriction to identify the supply shock which they assumed could have a permanent

¹ El-Erian also noted that the term had been used for this concept earlier by analysts at Boomborg in 2008—see El-Erian (2010, footnote 8). Interestingly, it was subsequently also used as a title of a US sitcom which ran in 2012-13.

effect on output as distinct from the demand shock which had only a temporary effect on output. In their model, therefore, the supply-demand distinction corresponds to the temporary-permanent distinction, a feature attractive to our application since it allows us to answer the question of whether the slowdown is temporary or permanent and the question as to whether it is supply- or demand-driven at the same time.

We apply the BQ procedure to a model in real GDP and the (CPI) inflation rate, following similar applications in the recent literature (see, e.g., Gong and Li, 2010, Bashar, 2012, and Keating and Valcarcel, 2015). In the BQ approach it is assumed that the demand and supply shocks are uncorrelated and we extend the analysis to take into account the possibility of the correlation of demand and supply shocks following the work of Cover, Enders and Hueng (CEH) (2006), before extending the model to accommodate a foreign variable (we use the growth of OECD GDP) in the manner of Ahmad and Pentecost (2012), using the extension of the CEH procedure to a three-variable model in Enders and Hurn (EH) (2007).

We find that the slowdown since the GFC has been mainly supply-driven, suggesting a permanent change in the growth rate. Demand has some negative influence during the GFC but little thereafter. When foreign growth is added to the model and a foreign shock is allowed for, we find that demand loses some of its early influence which is partly absorbed by the effects of the foreign shock which plays no role in explain the slowdown after about 2011. The slowdown in growth therefore seems to be driven by long-run forces and may rightly be characterised as the New Normal.

The structure of the paper is as follows. In the next section we provide some background information on the New Normal, including evidence for the slowdown in growth and a brief discussion of the growing literature on the sources of the slowdown. In section 3 we discuss the empirical literature concerned with the distinction between demand and supply

shocks or permanent and temporary shocks in multivariate time-series models. In the following section we present the data to be used and discuss some of its characteristics. The method to be used is set out in section 5 and the results are presented in section 6.

Conclusions are drawn and discussed in the final section.

2. The New Normal

As explained in the previous section, we focus on the growth slowdown aspects of the New Normal and we begin by presenting some evidence on the slowdown. From a longer-term perspective, Figure 1 shows the annual growth rate of real GDP in the post-reform period (1978 to 2016).

Figure 1 about here

While economic growth has fluctuated considerably over the period, it is clear that growth has slowed considerably since the pre-GFC highs in the early 2000s to a level of around 6-7% at the end of the period. There have been earlier substantial slowdowns in growth, the most recent being that beginning from a remarkable level of 14% in 1992 and falling to below 8% less than a decade later. The recovery from this to the level of 1992 by 2007 was equally remarkable and it is reasonable to ask whether the economy will recover in like manner from the current slowdown or whether this is a new phase in the history of Chinese economic growth. There has been much discussion of this question and the balance of the argument seems to favour a permanent shift in growth, driven by supply-side factors.

Arguments with a supply-side flavour include the following. First, the drying up of excess labour from agriculture which is forcing the urban wage up and so reducing the marginal product of capital compared to what it would have been with continued flows of cheap labour from agriculture (see, for example, Li *et al.*, 2012). It should be recognised, though, that the proportion of the labour force employed in agriculture is still much higher

than agriculture's share of output and is also much higher than in developed countries, suggesting that agriculture might still be able to shed a considerable amount of labour. Golley and Meng (2011), Meng (2012) and Lou (2016), for example, all recognise that labour markets have tightened but argue that further reforms of agriculture and continuing relaxation of *hukou* constraints will contribute to a continuation of the supply of rural labour to the cities.

The second supply-side argument concerns the depletion of the “demographic dividend”. Cai and various co-authors have been a strong proponent of this view – see Huang *et al.* (2013), Garnaut *et al.* (2013), Cai and Lu (2013), Cai and Roberts (2015) and Cai (2016). This is related to the previous point but concerns the effect of the age-structure of China's population on the labour force for a given population growth rate. Previously, the structure was such that the working-age population was increasing more quickly than the overall population, providing more labour at a given population growth rate. But this has run out as the “dent” that the one-child policy put in the age structure has moved from the dependent groups (younger than labour-force age) to the working-age groups and so reduced the proportion of the population which can support non-workers (mainly the aged). Hence, in future the labour force growth rate will be slower than the (already low) population growth rate.

A third aspect affecting supply is that it is increasingly urgent to address the negative consequences of China's long period of high growth: pollution, inequality, urban sprawl and so on which will require resources which will no longer be available for production of output (see Tyers, 2014, for some discussion of these issues).

Finally, it is argued that China is catching up to the rest of the world as far as technology is concerned and as it reaches the frontier it will need to be pushed out, rather than simply move up to an existing frontier based on developments in the rest of the world.

Wu (2014) shows that China's GDP growth and TFP growth are overestimated using official data. Lee and Hong (2010) indicate that the slowdown comes mainly from a decline in TFP growth.

A notable exception to the supply-side focus of much of the literature is the paper by Lin *et al.* (2016) who attribute "the recent slowdown mainly to cyclical and external factors" (p.843). But they also argue for the necessity of structural reforms to sustain New-Normal-level growth rates. Demand-side arguments are inter-related with the claimed need for "re-balancing" of the components of aggregate demand. Thus, for example, it is argued that investment is too high a proportion of GDP and consumption (particularly private consumption) is too low or, alternatively, that private saving is too high. Some argue that the level of investment is unsustainable because the return to capital is falling so that the capital stock (i.e., investment) will grow more slowly, thus slowing the growth of aggregate demand and, hence, of output.

A further demand-side argument is that export growth cannot be sustained. This is perhaps partly because of the weak global economy after the GFC. Another possible reason for the slower export growth is China's gradual loss of competitive position in the market for low-tech labour-intensive manufacturing, with other low-cost countries such as India, Bangladesh and Vietnam undercutting China as its real wage rises.

In all, many alternative explanations of this slowdown have been offered, both ones which operate through demand channels and ones which affect output via aggregate supply factors. There has, however, been little empirical work trying to disentangle possible causes and it is the purpose of this paper to make a contribution to this issue by focussing on broad supply and demand forces.

3. Literature

In this section we briefly review the literature on the modelling of demand and supply or temporary and permanent components of output in a VAR framework. The seminal paper is the one by Blanchard and Quah (1989) (BQ hereafter) in which they use a two-variable VAR model in real output and the unemployment rate. Two structural shocks are identified (aggregate demand and aggregate supply) on the assumptions that (i) the demand shock has no long-run effect on either the level of output or the rate of unemployment. (ii) the supply shock may have a long-run effect on output but not on the unemployment rate and (iii) the two shocks are independent. These two shocks can therefore also be characterised as temporary and permanent. The model identified in this way can be used to simulate the effect of the two shocks on the endogenous variable (using the impulse response functions, IRFs) as well as decomposing the historical behaviour of the endogenous variables into the accumulated effects of the past values of the two structural shocks – their demand and supply components.

This framework is particularly well-suited to our application since an alternative to the demand/supply interpretation is a temporary/permanent interpretation and this distinction goes to the heart of the New Normal hypothesis which is based on the argument that the recent downturn in economic growth is permanent.

The BQ procedure has been widely used in a variety of applications. Examples include Fackler and McMillin (1998) who use the long-run restriction of the BQ type to decompose real US output into demand and supply components. Both Zhang and Wan (2005) and Gong and Li (2010) use the BQ scheme in a two-variable VAR model for China to distinguish the effects of demand and supply shocks on the two endogenous variables – output and inflation. Zhang and Wan go on to regress the demand and supply shock series on a variety of aggregate variables like investment, retail sales and exports to discover the

possible sources of the demand shocks. Ahmad and Pentecost (2012) also distinguish demand from supply forces using a three-variable model (adding foreign output as the third variable) and apply it to a number of countries in Africa. A recent paper by Keating and Valcarcel (2015) extends the BQ analysis of the two-variable (output, inflation) model by introducing time-varying parameters and estimating the model over a long time-period going back to 1870. They find substantial changes in the sources of output and inflation variability over long periods of time.

Another innovation in the BQ procedure which has been adopted in various applications recently is associated with the paper by Cover, Enders and Hueng (2006) (CEH, hereafter). They argue that one of the identifying assumptions of the BQ approach, that of the independence of the demand and supply shocks, is not tenable but that these shocks are likely to be correlated in practice. They allow for such correlation in a two-variable (output and inflation) model and show that there is significant and substantial correlation between the shocks. In order to be able to generate IRFs and compute an historical decomposition of output, they do need, however, to assume either the priority of the supply shock or the priority of the demand shock, an arbitrary assumption which undermines their generalisation to some extent. The CEH analysis was applied to a number of ASEAN countries by Bashar (2012) also using a two-variable framework. The CEH model was extended to three variables (adding foreign output to the previous model) by Enders and Hurn (2007) (EH hereafter) and applied to Australian data to identify demand and supply components of output and inflation in an open economy and to assess the effects of inflation-targeting on output and inflation.

We propose to use the BQ approach, experimenting both with the CEH modification and the (EH) extension of the model to include a foreign variable. The closest paper to ours (apart from CEH and EH) is the application of the BQ decomposition to China by Gong and

Li (2010) (and the earlier paper by Zhang and Wan, 2005). Ours adds to their analysis in various ways. First, our data are more recent – Zhang and Wan end their sample period in 2000 while Gong and Li’s data runs to 2005 while ours extends to 2016; this allows us to analyse the slowdown in growth since 2008 which is a central aspect of the New Normal. Second, we relax the stringent BQ assumption by applying the CEH extension which accommodates the possibility that the shocks may be correlated. Finally, we extend the model to three variables; this has the double advantage of allowing us to test the sensitivity of our two-variable results to the inclusion of a third variable as well as to assess the importance foreign influences on domestic output and inflation.

4. The data

Quarterly real GDP and inflation data for the period 1992Q1 to 2016Q3 were used to estimate the two-variable models. The data were obtained from the website of the National Bureau of Statistics (NBS) and from the CEInet Statistics Database. The starting date of 1992 is determined by the availability of quarterly GDP data. While real GDP (RGDP) data are available after 2010, before this date only an index of RGDP growth is available and this has been linked to later data to compute the level of RGDP for earlier years. The NBS publishes only monthly data for the CPI and we used the average of the CPI over the three months within the quarter to compute the quarterly CPI. A number of variables were experimented with to capture foreign shocks on the Chinese economy: real exports, real OECD GDP and real G7 GDP. Exports are measured in RMB; we converted exports in US dollars to RMB using the official exchange rate and then use the GDP deflator to compute real exports (REXP). All data for China are not seasonally adjusted and were seasonally adjusted using X12 with a multiplicative factor. The data for real GDP for the OECD and the G7 group of countries were obtained from the OECD.stat website; the data are in USD, real and

seasonally adjusted. Where growth rates were used, we computed them using the difference between logs of the variables four quarters apart (four-quarter growth rates); we also experimented with one-quarter growth rates as part of the sensitivity tests reported at the end of the results section.

Before specifying the model, we tested the series for stationarity using the ADF test. The results are in Table 1.

Table 1 about here

The results for the data for China are somewhat mixed but using lags appropriate for removing autocorrelation in the residuals of the DF equations produces strong evidence that the levels of the variables are non-stationary but the four-quarter growth rates are stationary. Additional evidence of the stationarity of the growth rates is provided by the IRFs for a standard VAR in the three variables, all of which converge to zero by about 20 to 25 quarters with the exception of the response of inflation to a growth shock which takes somewhat longer. The OECD and G7 real GDP data are clearly stationary in the growth rates but not in the (log) levels. We proceed, therefore to analyse the growth rates in a stationary VAR.

5 Method

We carry out our analysis within the framework of a VAR model. Consider a (structural) VAR:

$$\mathbf{A}\mathbf{Z}_t = \mathbf{B}(\mathbf{L})\mathbf{Z}_{t-1} + \mathbf{e}_t \quad (1)$$

where $\mathbf{Z}$ is an n -vector, $\mathbf{A}$ is a matrix of coefficients, $\mathbf{B}(\mathbf{L})$ is a matrix polynomial in the lag operator, $\mathbf{L}$, and $\mathbf{e}$ is a vector of independent error terms. We will analyse the dynamics of the model primarily by using impulse response functions (IRFs) which show the effects over time on the endogenous variables in $\mathbf{Z}$ of a shock to one of the elements of the error vector, $\mathbf{e}$. To enable the errors in $\mathbf{e}$ to be shocked, the model in (1) must be estimated in such a way as

to enable the retrieval of estimates of the elements of $\mathbf{e}$. However, since all equations in (1) are identical, from the point of view of estimation, the structural shocks cannot be identified and the system must be restricted to achieve identification.

The model can be written (and estimated) as a reduced form:

$$\mathbf{Z}_t = \mathbf{A}^{-1}\mathbf{B}(\mathbf{L})\mathbf{Z}_{t-1} + \mathbf{A}^{-1}\mathbf{e}_t \equiv \mathbf{C}(\mathbf{L})\mathbf{Z}_{t-1} + \mathbf{u}_t \quad (2)$$

which can be validly estimated with OLS and estimates of the residuals, $\mathbf{u}$, retrieved.

However, the reduced-form VAR errors, $\mathbf{u}$, are linear combinations of the structural shocks, since $\mathbf{u} = \mathbf{A}^{-1}\mathbf{e} \equiv \mathbf{D}\mathbf{e}$, and estimates of the structural shocks can be derived from the estimated model only with restrictions which allow identification of the $\mathbf{A}$ matrix that relates the structural and reduced-form errors. The way in which we proceed to this identification follows the seminal paper by Blanchard and Quah (1989). They analyse a two-variable model (in real output and the unemployment rate) with two shocks which they interpret as demand and supply shocks. To achieve identification they use two normalisation restrictions, impose orthogonality on the shocks and assume that the long-run effect of the demand shock on the level of output is zero.

To see the implications of the long-run assumption, note that for their data set the log of real output is non-stationary but stationary in its first difference. The unemployment rate is also stationary so that they specify a stationary VAR in the first difference of output and the level of the unemployment rate. The demand shock is assumed to be the second shock and output is modelled as the first variable so that the long-run effect of demand on the level of output is given by the sum of the IRFs for the first variable with respect to a unit shock to the second structural error. The IRFs are derived from the vector-moving-average (VMA) form of the model:

$$\mathbf{Z}_t = (\mathbf{I} - \mathbf{C}(\mathbf{L})\mathbf{L})^{-1}\mathbf{u}_t = (\mathbf{I} - \mathbf{C}(\mathbf{L})\mathbf{L})^{-1}\mathbf{D}\mathbf{e}_t \equiv \mathbf{E}(\mathbf{L})\mathbf{D}\mathbf{e}_t \quad (3)$$

so that the long-run effects of a unit shock to e_t are given by the sum of the coefficients of the e_{t-1} terms, i.e., $E(1)D$. In the two-variable BQ model the long-run effect of a demand shock on output is given by the (1,2) element of $E(1)D$. Setting this element to zero results, after a little manipulation, in the following:

$$d_{12}(1-\Sigma c_{22k}) + d_{22}\Sigma c_{12k} = 0 \quad (4)$$

where c_{ijk} is the effect of a shock to error j on variable i at lag k so that the Σc_{ijk} are the sums of the lag coefficients in the reduced-form VAR, equation (2), and the d_{ij} are the elements of the matrix D .

Cover, Enders and Hueng (2006) apply the BQ scheme to identify demand and supply components of real output in a two-variable VAR model with real output and the inflation rate where it is assumed that the supply shock may have a long-run effect on both variables but the demand shock has no long-run effect on real output. They find, in common with earlier literature, that the demand shock accounts for most of the historical variation in inflation while supply accounts for most of the variation in output and argue that this may be due to the violation in practice of the identifying assumptions that the two structural shocks are uncorrelated. They argue that for a variety of reasons the supply shock may respond directly to the demand shock or *vice versa* and proceed to adjust the model to allow for these possibilities. They impose extra identification restrictions on D , based on a macro model and find that, indeed, there is substantial correlation between the two error terms.

While the model can be estimated under the correlated-errors assumption, uncorrelated errors are needed in order to compute the IRFs and the related forecast-error-variance decompositions (FEVDs). This requires the specification of the nature of the correlation between the errors and they consider two polar cases – the first where a pure supply shock drives the demand shock and the second where a pure demand shock drives the supply shock (the supply-prior and demand-prior cases, respectively). They show that the

supply-prior case produces the same IRFs as the BQ model but that the demand-prior assumption has quite different implications for the IRFs and the FEVDs.

In an extension of the CEH paper, Enders and Hurn (2007) apply the CEH procedure to a three-variable model for an open economy (Australia) by adding a world output variable (proxied by US output) to the VAR. They assume that there is no feedback from the two domestic variables to world output and so estimate a near-VAR. Again, the demand-prior case produces quite different IRFs and associated FEDVs to those obtained from the supply-prior (which is again the BQ case), underlining the importance of the particular identification assumptions made.

We propose to address our question of the nature of the forces driving China's growth slowdown within the BQ framework – it seems ideally suited to questions of the permanence and source of the shocks underlying the observed changes. We will start with a two-variable model in output and inflation which we will analyse under both the BQ and the CEH assumptions. Since the Chinese economy is importantly influenced by international events, we also extend our model in the EH direction by adding a real foreign variable as a third variable. This will allow us both to assess the sensitivity of the two-variable results as well as to consider the possible effects of international economic forces on the slowdown in growth.

6. Results

In this section we discuss the two-variable and three-variable models in turn and finally present a brief account of our tests of the robustness of the results under a series of reasonable alternative modelling assumptions.

6.1 *The two-variable model: BQ identification*

We begin with the two-variable model in four-quarter overlapping growth rates in seasonally adjusted real GDP and the seasonally adjusted CPI. These variables were found to be stationary in section 4 so that we can specify a stationary VAR model. Lag choice was difficult with different criteria indicating different numbers of lags, some indicating two lags and others six lags. A check of the autocorrelation of the residuals at various lags indicated that there was residual autocorrelation even with six lags; we chose four lags (given the quarterly data) at which there was less widespread autocorrelation than at either two or six lags. We report sensitivity-analysis for alternative lag lengths at the end of this section.

We begin by presenting results based on the BQ identification, with the usual assumption that the demand shock has no long-run effect on either the inflation rate or the level of output but that the supply shock may affect output permanently although it can have no permanent effect on inflation which is stationary. The IRFs are presented in Figure 2.

Figure 2 about here

In Figure 2 the two panels for output are accumulated IRFs which represent the effects on the (log) level of output of the two shocks. The supply shock has a permanent effect on output but the demand shock does not (by construction); neither shock has a permanent effect on inflation. The effects of both shocks on both variables are predominantly positive. In three cases (demand on both variables and supply on output) this is as expected. The effect of the supply shock on inflation is initially negative as expected but becomes positive after one period and remains positive thereafter which is rather counter-intuitive but not unlike that reported in CEH for the US, for many countries in Ahmad and Pentecost (2012) and for some Asian countries in Bashar (2012).

The FEVDs show the proportion of the variance of the forecast error at various horizons accounted for by each of the shocks. For this model they are reported in Table 2:

Table 2 about here

The FEVDs show, like earlier literature using the BQ decomposition (see, .e.g., CEH) that most of the variance in the output forecast is accounted for by the supply shock while demand explains most of inflation, although this wanes a little in the long run.

Finally, we compute the historical decomposition (HDs) of the two variables. The VMA form of the model, equation (3), shows that each of the endogenous variables is simply an accumulation of the effects of present and past structural errors. The HD shows the contribution to this accumulated value for each error at each period. The HDs for the two-variable model estimated using the BQ identification scheme are pictured in Figure 3. The HDs were computed for both variables for the whole sample but we report the decomposition only for the variable of interest – growth – for the period from 2007 onwards which corresponds, more or less, with the period of the growth slowdown in China. The underlying numbers for both variables are reported in the Appendix.

Figure 3 about here

It is clear from Figure 3 that both demand and supply shocks contribute substantially to the fall in growth in the immediate aftermath of the GFC in 2008. Both recover quickly, after that demand has had little to do with the growth slowdown which has been mainly supply-driven. While our model does not allow us to identify the aspects of the supply side which are mainly responsible for the downward trend, the results do suggest that looking at supply influences would be a good place to start. An alternative explanation, which is more strictly in accordance with the model assumptions, is that the slowdown was caused mainly by permanent factors, supporting the interpretation of the observed fall-off in growth as a permanent phenomenon and so supporting the “New Normal” characterisation. This provides support for the dominant view discussed in section 2.

We can summarise the results from the two-variable BQ analysis by pointing out that they confirm those of other authors such as CEH and EH: the supply (permanent) shock has its main effect on output while the demand (temporary) shock has its main effect on inflation. The growth slowdown since 2008 has been mainly the result of (permanent) supply-side factors and is either here to stay or must be reversed by policy which addresses the supply-side forces in the Chinese economy.

6.2 The two-variable model: CEH identification

We turn now to the CEH modification of the BQ model. As pointed out in the previous section, CEH allow for contemporaneous correlation between the demand and supply shocks, thus removing one of the identifying restrictions. They overcome the resulting identification problem by imposing restrictions based on a macroeconomic model of the simple AS-AD type:

$$y_t^s = {}_{t-1}y_t + \alpha(p_t - {}_{t-1}p_t) + \varepsilon_t, \quad \alpha > 0 \quad (5)$$

$$(y_t + p_t)^d = {}_{t-1}(y_t + p_t)^d + \eta_t \quad (6)$$

$$y_t^d = y_t^s \quad (7)$$

where y and p are the logs of real output and the price level, a preceding subscript indicates expectation conditional on the information corresponding to the subscript and the superscripts d and s indicate demand and supply respectively. The two variables ε and η are supply and demand shocks respectively. CEH assume that the expectations terms are generated by a univariate auto-regressive process for each variable. If these are substituted in and the system is solved for the two endogenous variables y and p , the model may be written as a general VAR model of the form of equation (2) with the relationship between the reduced-form and structural errors given by the matrix $\mathbf{D}$ which has the form:

$$\mathbf{D} = \begin{bmatrix} \frac{1}{1+\alpha} & \frac{\alpha}{1+\alpha} \\ \frac{-1}{1+\alpha} & \frac{1}{1+\alpha} \end{bmatrix} \quad (8)$$

In this model there are four structural parameters to be estimated: α and the variances and covariance of the errors ε and η . The estimated reduced-form and structural-form variance-covariance matrices contain three pieces of information and the final restriction is imposed by the long-run constraint that the demand shock has no long-run effect on real output. We saw previously that the long-run restriction implies $d_{12}(1-\Sigma c_{22k}) + d_{22}\Sigma c_{12k} = 0$. Substituting for the d_{ij} coefficients from equation (8), implies $\alpha = -\Sigma c_{12k}/(1-\Sigma c_{22k})$ which can be used to compute α from the coefficients of the estimated VAR and, for the present model, gives a value of 0.3172 which is positive, as expected, but less than CEH's estimate for the US of 1.5590; this difference seems plausible since aggregate supply might well be less sensitive to price in the Chinese economy with its large share of output produced by SOEs which might be argued to be less subject to market discipline than their private US counterparts. The remaining parameters can be estimated from the equivalence of the covariance matrices derived from the relationship between the reduced-form and the structural errors: $\mathbf{u} = \mathbf{D}\mathbf{e}$.

We wish to use the model for the computation of IRFs, FEVDs and HDs; CEH point out that in order to do this we need orthogonal shocks. They achieve this by explicitly modelling the relationship between the demand and supply shocks in one of two polar opposite ways: supply-prior and demand-prior. In the former the supply shock is assumed to contemporaneously affect the demand shock but not *vice versa* and in the second the opposite is the case. They show that the IRFs etc. for the supply-prior case are identical to those of the BQ model and we will, therefore, not deal with this model explicitly, using, instead, the results we have already generated from the BQ model. The demand-prior characterisation of the shocks makes the assumptions:

$$\varepsilon_t = c_1\eta_t + \delta_{1t} \quad (9)$$

$$\eta_t = \delta_{2t} \quad (10)$$

where the δ_i s are orthogonal, δ_{1t} and δ_{2t} being the “pure” supply and demand shocks respectively. We can use these equations and the $\mathbf{D}$ matrix to express the reduced-form errors in terms of the δ_i s and in this case compute α as before from the long-run restriction (which still holds with respect to the original structural shocks) and use the relationship between the reduced-form and “pure” shocks to compute c_1 and the variances of the δ_i s, noting that their covariance is now zero. The estimated value of c_1 is 0.1942 (p-value = 0.0003). This seems a plausible value which is statistically precisely estimated. It implies that a demand shock will elicit an immediate supply response of the same sign but about 20% of the magnitude. This implies less responsiveness than CEH found for the US – their estimate was 0.8040. This lower sensitivity in the Chinese case might be rationalised along the lines of the difference in the estimated value of α discussed above.

The IRFs for the “pure” shocks are pictured in Figure 4:

Figure 4 about here

The effects of the demand and supply shocks on inflation and output respectively are similar to the BQ/supply-prior case. The accumulated IRF for output with respect to a demand shock now no longer tends to zero in the long-run since the long-run restriction ignores the effects of the pure demand shock on the supply shock which imparts positive changes to output. The effect of supply on inflation is now more reasonable in that it is initially a larger negative value and it remains negative for longer. This lends added plausibility to this case relative to BQ. The implications of the new assumptions for the FEVDs are given in Table 3:

Table 3 about here

The results in the table show that it is still the case that output variations are driven mainly by supply errors and that inflation variation by demand. However, demand now has a greater influence on output in both the short and long runs although the results for inflation

are not so clear – supply now has a larger influence on inflation in the short run but less in the long run.

The HD for growth are in Figure 5 and, for both variables, in Appendix Table 2.

Figure 5 about here

Focussing on the decomposition of output, there is not a great deal of difference at the end of the period between the results in Figure 5 and those derived from the BQ model although there are interesting differences in 2008 and 2009 where it appears that the initial slowdown was more demand-determined in the current model. From then on, however, the influence of supply on growth has been persistently declining and, after 2011, persistently negative while the effect of demand was roughly constant after 2009.

Our conclusion from the two-variable model may be stated as follows. It is clear from both models analysed above that the contribution of supply factors to growth in China has fallen steadily over the period since 2008 and become negative around 2011. If the BQ identification is used, the sharp fall in growth in 2008 is associated with both demand and supply factors. But when the possible correlation of the shocks is allowed for most of this early fall in growth is largely demand-determined and may plausibly be associated with the general sharp contraction in world economic activity associated with the GFC. Demand recovered relatively quickly (by about 2010) but supply forces continually declined from then to the end of the sample period, consistent with the widely discussed tightening of supply determinants such as labour supply (with the reduction of internal migration and the depletion of the demographic dividend) and slowing productivity growth (as China approached the technological frontier). It seems clear, therefore, that the long-term contraction in the growth rate is largely driven by supply factors and is permanent. Thus China's policy-makers are on the right track when they move towards adjustment to this lower growth rate rather than

treating it as a temporary aberration before a return to “business as usual”. A return to earlier growth rates will be possible only if supply issues are addressed and reversed.

6.3 *The three-variable model*

Enders and Hurn (2007) extend the two-variable VAR model in Cover, Enders and Hueng (2006) by adding an exogenous autoregressive process for world output growth.² This allows them to add a further shock to the system which they label a foreign supply shock. We follow their general approach in this section by adding real OECD GDP growth to our model of the previous sub-section and identifying a foreign shock; we also experiment with G7 real GDP and Chinese exports as an alternative to OECD GDP. There are at least two reasons for adding this variable. First, it allows us to test the robustness of our earlier findings to the addition of a further variable and, second, it allows us to investigate the extent to which foreign shocks bear some of the responsibility for the growth slowdown in China since 2008.

While EH specify and estimate a near-VAR, we use a standard (“full”) VAR which assumes that the foreign variable is endogenous to the model. The restrictions incorporated in the near-VAR were tested using a likelihood ratio test; the restrictions could be rejected at the 5% level for all three alternative foreign variables (exports, OECD GDP and G7 GDP) but not at the 1% level for OECD GDP and G7 GDP, suggesting that exports may be endogenous but that the near-VAR specification is adequate when OECD GDP and G7 GDP are used.³ Nevertheless, we specified a full VAR as our base case and report results for alternative specifications (different foreign variables and the near-VAR model) later in this section.

² They also unaccountably include the current value of world growth in both the growth and inflation equations. This could be substituted out using the AR process for world growth, leaving only lagged values of all three variables in the growth and inflation equations. We follow this specification.

³ The LR test statistics (with p-values) were 27.2300 (0.0006), 16.3732 (0.0373) and 16.3591 (0.0375) for exports, OECD GDP and G7 GDP.

As part of the identification strategy, EH make a only slight modification to the CEH AD-AS model by simply adding a foreign shock to the AS equation, (5), which now becomes:

$$y_t^s = {}_{t-1}y_t + \alpha(p_t - {}_{t-1}p_t) + \varepsilon_t + \gamma v_t, \quad \alpha > 0 \quad (5')$$

where v is the foreign shock. Assuming, again, that expectations are autoregressive, allows them to derive the following implications for the (expanded) $\mathbf{D}$ matrix:

$$\mathbf{D} = \begin{bmatrix} 1 & 0 & 0 \\ \frac{\gamma}{1+\alpha} & \frac{1}{1+\alpha} & \frac{\alpha}{1+\alpha} \\ -\frac{\gamma}{1+\alpha} & \frac{-1}{1+\alpha} & \frac{1}{1+\alpha} \end{bmatrix} \quad (8')$$

The long-run restriction is as in the two-variable model: the demand shock has no permanent effect on real output so that the accumulated IRF for output with respect to the demand shock is zero in the long run. We follow their specification of the $\mathbf{D}$ matrix and proceed to the estimation of the structural parameters as follows. In the three-variable model the long-run restriction may be solved for α :

$$\alpha = [(1-\Sigma a_{11k})(-\Sigma a_{23k}) - (\Sigma a_{13k})(\Sigma a_{21k})] / [(1-\Sigma a_{11k})(1-\Sigma a_{33k}) - (\Sigma a_{31k})(\Sigma a_{13k})] \quad (11)$$

To identify the remaining parameters (γ and the variances and covariances of the structural errors) the equivalence between the variance-covariance matrices of $\mathbf{u}_t$ and $\mathbf{D}\mathbf{e}_t$ is used, together with the assumption of the independence of the foreign shocks and the supply shock. The model allows for the correlation of the demand shock to both the supply and the foreign shocks.

As in the CEH analysis, the nature of the relationship between the shocks needs to be modelled explicitly in order to be able to generate the IRFs, HDs and FEVDs and, as in the earlier paper, they consider two alternatives: supply-prior and demand-prior, the former being equivalent to the BQ case for their model. We therefore do not report the BQ results separately but begin with the supply-prior model in which the relationship between the structural shocks is assumed to be:

$$v_t = \delta_{1t} \quad (12)$$

$$\varepsilon_t = \delta_{2t} \quad (13)$$

$$\eta_t = c_1\delta_{1t} + c_2\delta_{2t} + \delta_{3t} \quad (14)$$

where the δ_{it} s are orthogonal “pure” shocks. The third equation captures the possible correlation between the demand shock and the other two while the first two equations imply that the foreign and supply shocks are uncorrelated.

The value of α computed from equation (11) and the estimated VAR lag coefficients is 0.3021 which is slightly lower than that estimated in the two-variable model (0.3712). The resulting IRFs for the pure shocks are in Figure 6.

Figure 6 about here

The signs of the IRFs are largely as expected: both demand and supply shocks increase domestic growth, at least in the short to medium run; demand increases inflation and supply reduces it although only in the very short term after which the sign is persistently positive and counter-intuitive; the effects of the domestic shocks on foreign growth are mixed. The FEVDs are reported in Table 4:

Table 4 about here

Focussing on growth, it is clear that the foreign shock accounts for only a modest proportion of the variation in the forecast error for growth with the bulk accounted for by the supply shock and this strengthens as the forecast horizon increases.

Finally, the HD for domestic growth is reported in Figure 7 and, for all variables, in Appendix Table 3.

Figure 7 about here

It is clear from Figure 7 that the supply shocks play a dominant role in the determination of domestic growth, as they did in the two-variable model: the contribution of supply declines persistently after the GFC and, after 2011, is consistently negative. The initial negative effect

of the demand shock in the two-variable model is greatly reduced and replaced by the effect of the foreign shock which has a negative effect during the GFC and is only slightly negative thereafter. It appears, therefore, that the demand effect in the two-variable model erroneously captures some of the effects of omitted foreign shocks. However, it remains the case that most of the responsibility for the growth slowdown after the GFC must be placed at the feet of supply forces as we concluded in the two-variable analysis.

We turn, finally, to the demand-prior case where the relationship between the shocks is assumed to be

$$v_t = \delta_{1t} \tag{15}$$

$$\varepsilon_t = c_3\delta_{3t} + \delta_{2t} \tag{16}$$

$$\eta_t = c_1\delta_{1t} + \delta_{3t} \tag{17}$$

The IRFs for this case are in Figure 8.

Figure 8 about here

They are not very different to those generated by the supply-prior model; the counter-intuitive sign of the effect of the supply shock on inflation is not as pronounced but is still positive after the first few periods. The corresponding FEVDs are in Table 5.

Table 5 about here

Here the forecast errors for foreign growth are largely explained by the foreign shock. The proportion of the forecast errors for domestic growth accounted for by the supply shock is now closer to that in the two-variable model, with the share previously held by the demand shock now shared with the foreign shock. The influences of the demand and supply shocks are more or less reversed for inflation. In line with these results, it is not surprising that the supply shock once again provides the main explanation for the slowdown as evidenced in the HD for domestic growth pictured in Figure 9 (and reported in Appendix Table 4 for all three variables).

Figure 9 about here

It is clear from Figure 9 that the supply shock continues to be an important factor in the slowdown since 2008 with demand a fairly stable influence apart from early in the period when it reduced growth at a time of the GFC contraction, as did the foreign shock. From 2010 onwards neither demand nor foreign influences accounted for much of the decline in domestic growth.

The conclusions we can draw from the three-variable model is that the importance of the supply contribution to the growth slowdown in the last decade generated by the two-variable model survives the addition of foreign output growth and the foreign shock to the model. This is true for both the demand-prior and supply-prior versions of the model. The addition of the foreign shock also allowed us to assess the importance of foreign influences for the slowdown and the results show that they made a substantial negative contribution to growth in China at around the time of the GFC but had little impact since 2010.

6.4 Robustness-testing

It remains to briefly discuss the sensitivity-analysis which we carried out. In addition to the various models reported above, we also experimented with the following variations on the base model:

1. Foreign variables as alternative to OECD real GDP: G7 real GDP, Chinese real exports.
2. A near-VAR model in which the foreign variable was generated by a univariate autoregressive process for both OECD real GDP and G7 real GDP.
3. Alternative lags in the VAR model: lags of 2 and 6.
4. One-quarter growth rates instead of four-quarter growth rates.
5. An alternative assumption regarding the relationship between the pure shocks: no direct effect of the foreign shock on demand in both the supply-prior and demand-prior cases.

6. An alternative macro model in which the foreign shock appeared in the AD equation rather than in the AS equation.

While space precludes our discussing the effects of all these alternatives in detail, we could conclude that only the use of exports as the variable through which foreign influences are measured produces substantially different results. When we use exports the basic conclusion that the supply factor declines persistently after the first couple of years and it is negative after about 2011 still holds but there is the added effect that the foreign shock has a general negative effect on growth over the whole period which is not the case when real GDP for the OECD or for G7 are the foreign variable. This negative contribution of the foreign factor seems to be offset both by a slightly more positive effect of demand and a slight less negative effect of supply. Thus, it is likely that exports capture some of the effect attributed to demand when the foreign variable is OECD or G7 real GDP. Similarly, compared to the exports case, the model with OECD or G7 real GDP attributes some of the exports effect to supply.

7. Conclusions

This paper started by pointing out that an important aspect of China's 'New Normal' is the slowdown in real output growth which has occurred in the decade since the onset of the GFC. The focus of the empirical work reported in this paper has been to assess the importance of supply and demand as well as foreign shocks in causing this slowdown.

We analysed this issue within a VAR model framework, starting with a two-variable model in growth and inflation before adding a further variable, real foreign growth to capture foreign influences on China's growth. We identified supply and demand shocks using the approach of Blanchard and Quah (1989) with modifications by Cover, Enders and Hueng (2006) and Enders and Hurn (2007) which allow for correlation between demand and supply

shocks. In all cases the supply shock was identified as one which has a long-run effect on real output, whereas demand shocks have only a temporary effect on output.

The predominant finding is that supply has made by far the greatest contribution to the growth slowdown since the GFC – the influence of the supply shock has persistently declined over the period and has become negative after about 2011. This is true in both the two- and three-variable models. In the two-variable model the supply factor declined persistently after the GFC and became negative from about 2011 onwards while demand had a substantial negative effect only during the GFC. In the three-variable model the foreign shock absorbs some of the influence of demand and has a strong negative effect on growth during the GFC but little effect after that. Thus supply influences dominate the post-GFC slowdown or, alternatively, the forces driving China's slowdown are permanent rather than temporary and in this sense the situation since 2008 can be rightly characterised as the 'New Normal'.

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Figure 1. The annual growth rate of real GDP (1978 to 2016)

Figure 2: Impulse responses, two-variable model, BQ identification

Figure 3: Supply and demand contributions to domestic growth, two-variable model, BQ identification

Figure 4: Impulse responses, two-variable model, CEH, demand-prior identification

Figure 5: Supply and demand contributions to domestic growth, two-variable model, CEH, demand-prior identification

Figure 6: Impulse responses, three-variable model, EH, supply-prior identification

Figure 7: Foreign, supply and demand contributions to domestic growth, three-variable model, EH, supply-prior identification

Figure 8: Impulse responses, three-variable model, EH, demand-prior identification

Figure 9: Foreign, supply and demand contributions to domestic growth, three-variable model, EH, demand-prior identification

Table 1. ADF tests for stationarity

Variable	Lags	Levels		Lags	Growth rates ^a	
		intercept	intercept+trend		no intercept	intercept
RGDP	1	1.0000	0.9995	1	0.2403	0.1301 ^b
CPI	1	0.3013	0.0565	1	0.0216	0.0915
REXP	1	0.8646	0.5318	8	0.0668	0.1242 ^c
OECDGDP	1	0.5602	0.6447	4	0.2054	0.0000
G7GDP	1	0.4870	0.6967	0	0.0014	0.0003

Notes: The numbers in the table are p-values for the unit root null.

Lags chosen using the SIC with a maximum number of lags of 11.

The variables are the following: RGDP = real gross domestic product, CPI = Consumer Price Index, REXP = real exports, OECD GDP = real GDP for the OECD, G7GDP = real GDP for the G7 countries.

^a the growth rates are four-quarter overlapping changes in the logs.

^b autocorrelation in the DF equation at lags 1 and 2 but not at lag 3; at lag 3 the ADF p-value is 0.0873.

^c lags of 4 are sufficient to remove autocorrelation in the residuals of the DF equation; with 4 lags the ADF p-value is 0.0060.

Table 2: FEVDs, two-variable model, BQ identification

Growth		
Step	Supply	Demand
1	83.29	16.71
5	89.70	10.30
20	91.40	8.60
Inflation		
Step	Supply	Demand
1	4.30	95.70
5	6.92	93.08
20	22.50	77.50

Table 3: FEVDs, two-variable model, CEH, demand-prior identification

Growth		
Step	Supply	Demand
1	50.40	49.60
5	60.89	39.11
20	72.19	27.81
Inflation		
Step	Supply	Demand
1	29.04	70.96
5	3.95	96.05
20	8.84	91.16

Table 4: FEVDs, three-variable model, EH, supply-prior identification

Foreign growth			
Step	Foreign	Supply	Demand
1	100.00	0.00	0.00
5	86.90	6.82	6.29
20	73.55	18.81	7.65
Domestic growth			
Step			
1	15.11	51.09	33.80
5	11.77	59.20	29.03
20	8.39	72.36	19.25
Inflation			
Step			
1	6.08	28.42	65.49
5	13.16	4.28	82.56
20	10.42	12.50	77.08

Table 5: FEVDs, three-variable model, EH, demand-prior identification

Foreign growth			
Step	Foreign	Supply	Demand
1	100.00	0.00	0.00
5	70.58	11.28	18.14
20	64.27	12.29	23.44
Domestic growth			
Step			
1	7.96	75.74	16.30
5	9.30	80.52	10.18
20	12.11	80.71	7.18
Inflation			
Step			
1	15.06	4.79	80.14
5	7.46	5.11	87.43
20	7.29	19.20	73.50

Appendix Table 1: Supply and demand contributions, two-variable model, BQ identification

Date	Growth		Inflation	
	Supply	Demand	Supply	Demand
2008Q1	2.63	-0.01	6.40	-0.94
2008Q2	1.50	0.14	5.83	-0.68
2008Q3	1.02	-0.51	5.55	-2.70
2008Q4	-0.76	-0.81	5.04	-4.77
2009Q1	-1.04	-1.05	3.23	-6.16
2009Q2	-0.16	-0.50	2.21	-6.09
2009Q3	1.28	0.20	1.04	-4.59
2009Q4	2.01	0.78	0.96	-2.72
2010Q1	2.20	0.91	0.96	-1.21
2010Q2	1.40	0.40	1.65	-1.26
2010Q3	0.64	0.29	1.73	-0.81
2010Q4	0.60	0.35	1.73	0.51
2011Q1	0.82	0.40	1.60	1.16
2011Q2	0.59	0.54	1.58	1.86
2011Q3	0.08	0.48	1.39	2.55
2011Q4	0.03	-0.15	1.05	1.19
2012Q1	-0.47	-0.22	1.05	0.42
2012Q2	-0.66	-0.37	0.48	0.07
2012Q3	-0.80	-0.33	0.29	-0.75
2012Q4	-0.87	0.09	-0.15	-0.21
2013Q1	-1.11	0.22	-0.36	0.41
2013Q2	-1.45	0.33	-0.68	0.69
2013Q3	-1.23	0.43	-1.12	1.51
2013Q4	-1.37	0.22	-1.14	1.69
2014Q1	-1.42	0.12	-1.53	1.51
2014Q2	-1.26	0.04	-1.64	1.58
2014Q3	-1.53	-0.03	-1.63	1.42
2014Q4	-1.53	-0.03	-1.90	1.22
2015Q1	-1.56	-0.07	-1.85	0.97
2015Q2	-1.73	0.07	-1.98	1.21
2015Q3	-1.94	0.12	-2.05	1.50
2015Q4	-2.04	0.10	-2.22	1.42
2016Q1	-2.29	0.33	-2.29	2.23
2016Q2	-2.17	0.19	-2.63	2.49
2016Q3	-2.09	0.11	-2.68	2.20

Appendix Table 2: Supply and demand contributions, two-variable model, CEH, demand-prior identification

Date	Growth		Inflation	
	Supply	Demand	Supply	Demand
2008Q1	2.69	-0.08	3.30	2.16
2008Q2	1.79	-0.15	3.69	1.46
2008Q3	1.93	-1.42	3.78	-0.94
2008Q4	0.89	-2.45	4.68	-4.41
2009Q1	0.58	-2.66	3.81	-6.75
2009Q2	0.97	-1.64	3.36	-7.24
2009Q3	1.52	-0.04	2.23	-5.77
2009Q4	1.76	1.03	1.85	-3.62
2010Q1	1.78	1.34	1.37	-1.62
2010Q2	1.48	0.33	1.62	-1.23
2010Q3	0.94	-0.01	1.85	-0.93
2010Q4	0.69	0.26	1.92	0.31
2011Q1	0.77	0.45	1.73	1.03
2011Q2	0.51	0.61	1.90	1.54
2011Q3	0.02	0.53	1.93	2.00
2011Q4	0.28	-0.41	1.32	0.92
2012Q1	0.02	-0.71	1.66	-0.19
2012Q2	-0.28	-0.76	1.27	-0.71
2012Q3	-0.32	-0.81	1.22	-1.68
2012Q4	-0.61	-0.17	1.17	-1.54
2013Q1	-0.94	0.05	1.13	-1.08
2013Q2	-1.21	0.09	1.05	-1.04
2013Q3	-1.18	0.37	0.67	-0.28
2013Q4	-1.26	0.12	0.56	-0.01
2014Q1	-1.29	-0.02	0.16	-0.17
2014Q2	-1.20	-0.02	-0.09	0.03
2014Q3	-1.41	-0.15	-0.10	-0.11
2014Q4	-1.43	-0.13	-0.40	-0.28
2015Q1	-1.42	-0.21	-0.43	-0.44
2015Q2	-1.64	-0.01	-0.42	-0.34
2015Q3	-1.87	0.05	-0.41	-0.13
2015Q4	-1.92	-0.03	-0.54	-0.25
2016Q1	-2.25	0.29	-0.32	0.26
2016Q2	-2.22	0.23	-0.76	0.62
2016Q3	-2.05	0.07	-0.89	0.42

Appendix Table 3: Foreign, supply and demand contributions, three-variable model, EH,
supply-prior identification

Date	Foreign growth			Domestic Growth			Inflation		
	F	S	D	F	S	D	F	S	D
2008Q1	0.33	-0.50	-0.15	-0.06	2.58	0.05	-0.15	3.12	2.66
2008Q2	0.08	-0.80	-0.32	-0.11	1.71	-0.01	-0.18	3.67	1.84
2008Q3	-0.42	-1.31	-0.34	-0.25	1.71	-1.00	-0.42	3.98	-0.54
2008Q4	-2.29	-1.83	-0.57	-1.19	0.85	-1.28	-1.58	4.77	-2.74
2009Q1	-4.18	-2.18	-0.75	-1.93	0.97	-1.17	-3.26	3.97	-3.47
2009Q2	-4.11	-2.09	-0.71	-1.09	1.33	-0.96	-3.70	4.03	-4.03
2009Q3	-3.69	-1.78	-0.43	-0.35	1.80	-0.02	-3.53	3.26	-3.09
2009Q4	-2.01	-1.17	0.09	0.49	1.92	0.32	-3.12	3.43	-1.89
2010Q1	-0.11	-0.55	0.56	1.21	1.82	0.03	-1.50	3.42	-1.99
2010Q2	0.20	-0.06	0.70	0.43	1.77	-0.44	-0.59	3.62	-2.46
2010Q3	0.56	0.18	0.43	0.10	1.57	-0.80	0.10	3.80	-2.79
2010Q4	0.67	0.20	0.02	0.12	1.48	-0.71	1.36	3.72	-2.66
2011Q1	0.53	0.12	-0.27	-0.03	1.63	-0.44	1.79	3.41	-2.26
2011Q2	0.04	0.03	-0.34	-0.16	1.31	-0.08	1.82	3.56	-1.76
2011Q3	-0.14	-0.08	-0.22	-0.22	0.61	0.11	1.73	3.69	-1.30
2011Q4	-0.28	-0.25	-0.06	-0.17	0.54	-0.55	1.53	3.22	-2.32
2012Q1	0.17	-0.41	-0.14	0.11	-0.04	-0.82	1.44	3.58	-3.36
2012Q2	0.39	-0.63	-0.35	0.18	-0.36	-0.92	1.42	2.95	-3.63
2012Q3	0.14	-0.71	-0.52	-0.22	-0.19	-0.78	0.97	2.53	-3.77
2012Q4	-0.34	-0.67	-0.50	-0.55	-0.24	-0.05	0.41	2.17	-2.76
2013Q1	-0.62	-0.50	-0.24	-0.60	-0.54	0.19	0.03	2.04	-1.82
2013Q2	-0.83	-0.29	0.06	-0.53	-0.91	0.25	-0.34	2.00	-1.46
2013Q3	-0.59	-0.16	0.24	-0.27	-0.99	0.39	-0.55	1.73	-0.60
2013Q4	-0.16	-0.08	0.28	0.01	-1.19	-0.03	-0.44	1.67	-0.50
2014Q1	-0.23	-0.05	0.12	-0.21	-1.14	-0.02	-0.54	1.14	-0.42
2014Q2	-0.26	0.05	-0.07	-0.36	-0.94	0.01	-0.71	0.77	0.06
2014Q3	-0.19	0.19	-0.21	-0.27	-1.17	-0.18	-0.53	0.72	-0.22
2014Q4	-0.19	0.32	-0.31	-0.26	-1.26	-0.10	-0.46	0.36	-0.40
2015Q1	0.09	0.42	-0.35	-0.06	-1.37	-0.27	-0.32	0.32	-0.70
2015Q2	0.24	0.42	-0.37	0.00	-1.65	-0.07	-0.06	0.19	-0.72
2015Q3	-0.04	0.36	-0.27	-0.28	-1.79	0.20	-0.19	-0.04	-0.13
2015Q4	-0.41	0.29	-0.09	-0.48	-1.78	0.25	-0.43	-0.35	0.17
2016Q1	-0.83	0.25	0.08	-0.60	-2.10	0.67	-0.65	-0.34	1.10
2016Q2	-1.06	0.20	0.27	-0.55	-2.10	0.60	-0.92	-0.84	1.80
2016Q3	-1.13	0.22	0.35	-0.42	-2.04	0.41	-1.08	-1.00	1.79

Appendix Table 4: Foreign, supply and demand contributions, three-variable model, EH,
demand-prior identification

Date	Foreign growth			Domestic growth			Inflation		
	F	S	D	F	S	D	F	S	D
2008Q1	-21.46	11.80	2.61	-0.15	2.27	0.37	0.17	3.71	1.73
2008Q2	-17.15	7.22	1.17	-0.33	1.47	0.38	0.01	3.51	1.76
2008Q3	-9.50	2.25	-0.50	-0.42	1.36	-0.55	-0.08	3.72	-0.66
2008Q4	-10.36	-0.13	-8.36	-0.67	-0.23	-0.79	-0.37	3.69	-2.91
2009Q1	-17.14	-6.76	-11.57	-1.09	-0.07	-1.05	-0.69	2.17	-4.29
2009Q2	-13.60	-8.72	-14.57	-1.18	0.84	-0.46	-0.78	1.85	-4.83
2009Q3	-14.22	-5.23	-11.79	-1.29	2.16	0.48	-1.41	1.01	-3.02
2009Q4	-8.09	-1.13	-1.97	-1.11	3.07	0.70	-1.25	1.10	-1.50
2010Q1	-0.87	6.03	4.59	-1.09	3.32	0.75	-1.28	1.61	-0.47
2010Q2	-4.57	10.71	10.51	-1.14	2.81	0.00	-1.52	2.41	-0.39
2010Q3	-10.90	12.16	9.11	-1.38	2.30	-0.13	-1.58	3.05	-0.44
2010Q4	-15.74	11.07	7.16	-1.56	2.16	0.21	-2.04	3.46	0.93
2011Q1	-14.79	8.67	7.03	-1.44	2.19	0.33	-2.26	3.57	1.56
2011Q2	-13.62	5.74	3.94	-1.45	1.63	0.80	-2.54	3.62	2.46
2011Q3	-11.75	1.77	5.22	-1.41	1.13	0.70	-2.60	3.20	3.44
2011Q4	-10.58	-1.98	4.74	-1.49	1.19	0.04	-2.61	2.75	2.20
2012Q1	-7.23	-3.17	-1.00	-1.44	0.66	-0.05	-2.49	2.62	1.44
2012Q2	1.55	-4.60	-2.28	-1.20	0.44	-0.41	-2.09	1.96	0.79
2012Q3	3.85	-4.95	-6.05	-1.11	0.10	-0.26	-1.99	1.86	-0.22
2012Q4	7.35	-3.93	-7.27	-0.90	0.00	-0.01	-1.48	1.41	-0.20
2013Q1	12.11	-3.37	-4.90	-0.71	-0.43	0.12	-1.14	1.33	-0.04
2013Q2	-3.97	-2.59	-2.60	-0.97	-0.79	0.49	-1.74	1.00	0.85
2013Q3	-10.60	-2.86	2.84	-0.99	-0.27	0.31	-1.53	0.52	1.49
2013Q4	-13.02	-1.15	4.80	-1.09	-0.61	0.41	-2.16	0.72	2.07
2014Q1	-22.68	-1.03	7.28	-1.11	-0.60	0.26	-2.82	0.12	2.78
2014Q2	-11.87	-1.54	7.33	-0.94	-0.31	-0.11	-2.25	0.12	2.17
2014Q3	-2.21	0.02	3.05	-0.82	-0.92	0.03	-2.43	0.23	2.08
2014Q4	-2.94	-1.74	2.01	-0.76	-0.78	-0.17	-2.09	-0.34	1.85
2015Q1	-0.66	-2.12	-1.69	-0.96	-0.67	-0.15	-1.57	-0.16	0.94
2015Q2	-6.81	-1.31	-4.27	-1.13	-0.96	0.29	-1.95	-0.35	1.63
2015Q3	-9.38	-2.85	-1.05	-1.10	-1.04	0.19	-1.78	-0.60	1.93
2015Q4	-6.71	-2.80	-1.08	-1.11	-1.27	0.29	-1.92	-0.58	1.79
2016Q1	-11.87	-3.23	0.89	-1.13	-1.55	0.58	-2.37	-0.84	3.24
2016Q2	-9.45	-4.37	5.99	-1.09	-1.14	0.11	-2.08	-1.19	3.23
2016Q3	-12.57	-3.27	3.71	-1.30	-1.14	0.32	-2.58	-1.10	3.29

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