Is economic policy uncertainty a major fluctuation factor? Based on a new mixed identification method

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To investigate to what extent economic policy uncertainty affects China's macroeconomic fluctuations, we construct a mixed identification scheme that combines some regular sign restrictions with zero restriction in a SVAR model, aiming to simultaneously identify economic policy uncertainty shocks and the three conventional structural shocks of demand, supply and monetary policy. The research shows that (1) economic policy uncertainty shocks, though not the major factor for economic fluctuations in China, exhibit characteristics similar to those of negative demand shocks with inflation effect obviously stronger than output effect; (2) in the full sample period, demand shocks are the primary driving factor for China's economic fluctuations, followed by supply shocks; (3) supply shocks are the most important driving force behind inflation and monetary policy adds fuel to the flame, while economic policy uncertainty shocks exert obvious inhibition on inflation. The academic contribution of this paper is showing some robust empirical facts of economic policy uncertainty's effects on macroeconomic fluctuations from the biggest developing country, and the policy implication of our research is to provide academic support for the decision of "macroeconomic policies should remain stable".

Keywords: macroeconomic fluctuations, economic policy uncertainty (EPU), mixed identification method

1. Introduction

The stability of macroeconomic policy has drawn much attention from both the decision-makers and the public. That "macroeconomic policies should remain stable" has been repeatedly stressed at the meetings of the Political Bureau of the Central Committee. The reports on the work of the government from 2014 to 2016 have all stated that "the continuity and stability of macroeconomic policies should be maintained". This indicates on one hand that the decision-makers at the national level have fully recognized the importance of maintain a stable macroeconomic

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policy environment so they will decrease the policy uncertainty, on the other hand that policies are "not stable enough", and are to the disadvantage of the formation of macroeconomic policy expectations. In fact, examine the monetary policy, fiscal policy, real estate control policy and stock market regulation policy over the past decade, and we will easily find that the standpoints of these macroeconomic policies frequently shift, displaying a strong feature of "discretion" and causing extensive policy uncertainty. Meanwhile, with macro-economy entering the transition stage of "three period superimposed" and public attention on economic prospect and the macroeconomic policy trend increasing, certain researcher believes that the recently rising macroeconomic policy uncertainty dampens the investment of non-state-owned enterprises and then impedes macroeconomic recovery (Huang, 2016), while other researchers hold that the effect of policy uncertainty needs further assessment.

China's economic policy uncertainty index worked out by the team led by Prof. Bloom and Prof. Baker from Stanford University and Prof. Davis from Chicago University proved the existence of policy uncertainty. Their research shows that since the beginning of the 21st century economic policy uncertainty has been high in general and there have been several big positive fluctuations with many peaks corresponding to major political and economic events in China (Baker *et al*., 2015).[1] On the other hand, with the deepening of market-based reforms, China's macroeconomic policies exhibit obvious countercyclical characteristics, which contributes to smooth economic performance; the complication of economic operating mechanism also weakens the effects of macroeconomic policies (Liu, 2015). These factors will undoubtedly weaken the impacts of policy uncertainty on real economy.

Then, with the coexistence of positive and negative mechanism, rigorous quantitative research is needed to measure the actual effects of macroeconomic policy uncertainty on fluctuations of real economy. What effects does economic policy uncertainty have on macroeconomic fluctuations in the biggest developing country where state-owned economy dominates and transition to full market economy is under way? Compared to conventional structural shocks, are EPU's shocks an important driving factor for economic fluctuations? In China what features do the effects of EPU's shocks on macro-economy have?

Two difficulties are to be overcome in the research of macroeconomic effects by EPU in China: one is the indexing of EPU, and the other is to identify the macroeconomic effect by the new structural shock of EPU in the mainstream analytical framework. The first difficulty has been overcome as the team led by Prof. Bloom and Prof. Baker from Stanford University and Prof. Davis from Chicago University has worked out the EPU index of China and made explorative analysis. But the second difficulty still constitutes a barrier in front of researchers.

Identifying structural shocks being a fundamental question in business cycle theory,

[1] The mean of China's economic policy uncertainty index from January 2001 to July 2016 is 135.13, the benchmark being 100.

economists follow the guideline of "let data speak", use timing model to identify major driving factors for macroeconomic fluctuations and measure their effects. In SVAR model, the leading paradigm is to represent key macroeconomic sequence as linear combination of unrelated structural shocks and the core step is to identify structural shocks. For quite a long time conventional identification methods by Blanchard and Quah (1989), and Gali (1992) were used extensively to identify aggregate demand shocks, aggregate supply shocks and monetary policy shocks. Domestic literature by Gong and Li (2007), Ouyang and Shi (2010), and Huang and Zhao (2010) used these methods. Later much literature began to question the identification effect of this type of method (Faust and Leeper, 1997; Peersman, 2005). With the advent of sign restriction identification method, Peersman (2005) chose to use it to identify supply shocks, demand shocks and monetary policy shocks. Compared with conventional identification method, the advantages of sign restriction identification method lie in that it specifies identifying assumptions on the basis of classical economic models or widely-accepted empirical facts, and it does not specify impulse response signs of interested endogenous variables but "let data speak". This method clarifies identifying assumptions and empirical conclusions and to the greatest extent weakens the dependence of empirical results on specific identifying assumptions, letting data determine empirical results (Uhlig, 2005; using sign restriction identification method Chen and Tian, 2014). Wang *et al.* (2015), Zhao and Zhang (2012) identified fiscal policy shocks and monetary policy shocks respectively.

However, when it comes to the new structural shocks of EPU, it is not feasible to singly use sign restriction identification method in that with the academic circle just starting research on the effects of EPU shocks on key macroeconomic variables, widely-accepted theoretical models and empirical facts are far from being established, thus credible sign restriction identifying conditions cannot be specified. Then, how to construct a new identification method for structural shocks to simultaneously identify four structural shocks from aggregate demand, aggregate supply, monetary policy and policy uncertainty becomes the primary prerequisite for scientific research on the macroeconomic effects of China's EPU.

Based on this, to systematically examine the major factors affecting China's macroeconomic fluctuations since the beginning of the 21st century, in particular EPU's effects on economic fluctuations, this paper first constructs in SVAR model a mixed identification method that combines sign restrictions with zero restriction, which simultaneously identifies aggregate demand, aggregate supply, monetary policy and EPU shocks; then conducts impulse response analysis to test whether SVAR model specification and identification method are in line with economic theories and empirical facts; finally measures the contribution of each structural shock to fluctuations of key macroeconomic variables at specific period using historical decomposition method and tests whether the results are in line with economic facts. It should be noted that this papers uses median model for the first time to conduct accurate historical

decomposition in sign restriction identification framework.

This shows that the academic contribution of this paper includes as follows: (1) constructing a SVAR model based on Keynesian macroeconomic theory, and aggregate demand, aggregate supply, monetary policy and EPU are four structural shocks driving macroeconomic system of the model; (2) constructing a new identification method for structural shocks (mixed identification method) to simultaneously identify multiple shocks and then compare the effects of EPU shocks on macroeconomic fluctuations with those of the three conventional structural shocks on macroeconomic fluctuations; (3) quantifying EPU's macroeconomic effects in expansion, recession and inflation.

The following part is thus arranged: the second part is literature review; the third part introduces empirical model, including the construction of mixed identification method and SVAR model specification; the fourth part presents empirical results and rational analysis; the fifth part contains research conclusions and policy implications.

2. Literature review

EPU's macroeconomic effect is a hot topic of international macroeconomics but the depth and scope of the research is still at a preliminary stage (Bloom, 2014). This paper combs relevant domestic and foreign literature from three aspects with the extent of EPU's effect as the entry point.

2.1. Significant effect

During the financial crisis, uncertainty level of economic prospect and policy of the leading nations increased substantially, and quite a number of policymakers and economists believe that the uncertainty impeded economic recovery. Marked by Bloom (2009), research on the effects of uncertainty on macro-economy by international scholars entered a new stage. Bloom built an extended corporate investment model to study the effect of uncertainty shocks on investment, employment and then real output. Numerical simulation results show that uncertainty shocks caused a quick drop in output and employment, and then there was a rebound and "outshoot". Using micro-data, research by Kellogg (2014), Handley and Limão (2015), Gulen and Ion (2015) find that the effect of real options[1] caused by uncertainty significantly affects the investment decisions of the enterprises.

Uncertainty shocks have an effect on enterprises' investment, recruitment needs and consumption needs at the micro-level, and at the macro-level the effect is naturally

[1] There are three microeconomic theories of the effect of uncertainty on enterprises' investment: Hartman-Abel effect (Abel, 1983; Hartman, 1972), effect of real options (Bernanke, 1983), precautionary savings (Leland, 1968). Among the three, Hartman-Abel effect means that uncertainty will lead enterprises to increase current investment, while the latter two hold that uncertainty causes enterprises to decrease current investment. Empirical evidence supports effect of real options more.

shown as impact on output, price level and unemployment rate. Much literature has started to study the effect of uncertainty shocks on macroeconomic fluctuations with the help of SVAR model and DSGE model. Baker *et al*. (2015) compiled policy uncertainty index of the major economies in the world, using conventional Cholesky decomposition identification method to identify policy uncertainty shocks in SVAR model, and found that both output and employment dropped and showed an inverted hump-shaped trajectory. Leduc and Liu (2012) used University of Michigan Consumer Survey Data and UK Industrial Survey Data respectively to construct uncertainty index, identified uncertainty shocks with Cholesky decomposition identification method in SVAR model, and found uncertainty shocks similar to certain aggregate demand shocks which led output and price level to drop and unemployment rate to rise. Basu and Bundick (2012) found in a mono-sector DSGE that when an elastic price was set uncertainty shocks could not produce macroeconomic fluctuations in line with practical data; when sticky price and counter-cyclical cost plus were set, the model could simulate the features of practical business cycle; monetary policy is an important factor that writes off the effect of uncertainty shocks. Bloom *et al*. (2015) believed that uncertainty shocks are a new driving factor for business cycle and the empirical evidence from this paper shows that the uncertainty is counter-cyclical, as during recession, especially the recession between 2007 and 2009, uncertainty level of micro-enterprises increased sharply. Introducing time varying uncertainty shocks into DSGE model, the simulation indicates that one uncertainty shock of reasonable size can explain about 3% of fluctuations in US's GDP. Fernandez-Villaverde *et al*. (2015) first used timing model to estimate the fiscal policy uncertainty of US, then introduced this exogenous process depicting fiscal policy uncertainty level into VAR model and DSGE model, and found that the fiscal policy uncertainty shocks had important effects on fluctuations of key macroeconomic variables.

2.2. Insignificant effect

Different from the above-mentioned literature, other literature found that under general equilibrium uncertainty shocks were not major factors affecting business cycle. Bachmann *et al*. (2013) constructed uncertainty index with IFO business climate index using German enterprises as respondents, conducted empirical analysis on the basis of SVAR model, and found that German output response pattern was in line with "wait and see" response mechanism proposed by Bloom (2009), with output dropping 0.75% at most but uncertainty shocks' explanation for output forecast variance being only about 10%, so uncertainty was not major shock driving output fluctuations. Bachmann and Bayer (2013) built a DSGE model of heterogeneous enterprise; in the model the enterprise was faced with fixed adjustment costs, and when there were uncertainty shocks the enterprise adopted "wait and see" response mechanism to adjust its investment. Using USTAN calibration model of German Enterprise Database,

this paper concluded that uncertainty was not major shock driving unconditional business cycle dynamics. Born and Pfeifer (2014) adopted same method as used by Fernandez-Villaverde *et al*. (2015) to study the effect of monetary policy and fiscal policy uncertainty shocks on economic fluctuations. They found that the effects of EPU shocks on macro-economy have been overestimated, as although stronger than the effects of TFP uncertainty shocks, uncertainty shocks of two policies of standard deviation only led GDP to drop by 0.045%, for which result strong general equilibrium effect may be a major cause.

2.3. Domestic research and direction of improvement

The topic of EPU has drawn domestic scholars' attention and research at both macro and micro levels has been conducted. Li and Yang (2015) found micro evidence for inhibiting effect of EPU on enterprise investment using China's EPU index; Huang and Guo (2015) using the same index found that EPU had inhibiting effect on investment, consumption and then real output at macro-level.

Moreover, much domestic research studied the effect of uncertainty from the perspective of officials' turnover. Zhang and Gao (2007), Wang *et al.* (2009), Cao (2013), Xu *et al.* (2013) using officials' turnover to represent political environment uncertainty empirically analyzed the effect of political uncertainty on economic growth and enterprise investment from macro-level and micro-level respectively. In analyzing the empirical results all the above literature stressed that local governments had great influence intervening enterprises' decision-making of operation and investment, and that the time of officials' turnover coincided with the highest uncertainty risk of local economic policy confronted by the enterprises within the jurisdiction. Among this, Cao (2013), Xu *et al.* (2013) using micro data respectively studied the effect of political uncertainty on state-owned enterprises and private enterprises, and found that the logic of political uncertainty affecting enterprise investment as proposed by Julio and Yook (2012) also existed in China, investment expenditure of both state-owned enterprises and private enterprises dropping when confronted with political uncertainty.

It should be noted that there are two important differences between the uncertainty caused by officials' turnover and economic policy uncertainty in this paper: (1) uncertainty caused by officials' turnover is local and the scope of its effect is limited to enterprises within that certain territory, while the economic policies in this paper refer to macroeconomic policies (fiscal policy, monetary policy, regulatory policy) that are made by the central government and have influence on the overall situation; (2) uncertainty of officials' turnover only occurs at the time of officials' turnover, while the uncertainty of macroeconomic policy may occur at all time.

To summarize the above literature: (1) uncertainty shocks are drawing more and more attention, and international academic circle has conducted quite exhaustive research on the theoretical mechanism of their effect on investment, consumption

and then output, however, more empirical research is needed as there is still much controversy over the extent of uncertainty shocks' effect and research on macroeconomic effect of China's EPU is almost blank; (2) leading paradigm of domestic empirical literature is to identify structural shocks on the basis of SVAR model but it is still at the stage of using conventional equality constraint identification method and limited to the identification of supply shocks and demand shocks, so more robust identification method is needed and at the time more structural shocks with more definite economic significance are to be identified; (3) since 2012 China's economic growth has slowed down quite markedly, which has drawn attention of much literature, but there is little literature that quantifies or measures the factors for continuing slowdown in economic growth. In light of all this, this paper, using SVAR model on the basis of mixed identification method, analyzes macroeconomic effects of demand shocks, supply shocks, monetary policy shocks and policy uncertainty shocks with impulse response analysis, and examines the explanation power of different shocks for fluctuations in output and price with historical decomposition, thus further deepens understanding of the above issue.

3. Constructing SVAR model and mixed identification method

3.1. Constructing SVAR model

Using classical documents by Blanchard and Quah (1989), Gali (1992) for reference, this paper assumes that benchmark IS-LM-Phillips curve model can describe macro-economy of China,[1] thus endogenous variables in SVAR model need to include real output, price level and money supply. Meanwhile, referring to SVAR modeling by Baker *et al*. (2015), Leduc and Liu (2012), Fernandez-Villaverde *et al*. (2015), this paper introduces EPU index of China that representing economic policy uncertainty level into SVAR model, i.e., this paper will construct a SVAR model with 4 variables, aggregate demand, aggregate supply, monetary policy an EPU being four structural shocks driving macroeconomic system of the model.

The starting point of SVAR model is reduced form VAR model:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + u_t, \ t = 1, 2, \ldots, T \tag{1}$$

Here, Y_t is $m\times 1$ D endogenous variable vector, p being lag, T being sample length;

[1] The assumptions of this paper are in line with existing domestic literature, for example, Gong and Li (2007), Ouyang and Shi (2010), Huang and Zhao (2010) all use benchmark AS-AD model to depict macro-economy of China; and in standard textbooks of macroeconomics AS-AD model can be deduced from IS-LM-Phillips curve model. Meanwhile, to keep in line with theoretical model, this paper has not appealed to extending the scale of VAR model. From VAR model containing more variables Tian and Lin (2016) obtained impulse response results in line with this paper, hence we believe that the scale of VAR model will not affect this paper's major conclusions.

A_i is $m \times m$ D matrix of coefficients; u_t is forecast error of covariance matrix $\sum$. The element of u_t has no definite economic significance, so SVAR model is needed. Let ε_t be $m \times 1$ D structural shocks vector, and assume $u_t = B\varepsilon_t$, $\text{var}(\varepsilon_t) = I_m$, i.e., $\text{var}(u_t) = BB' = \sum$, where matrix B is called loading matrix, and identification is realized in Cholesky decomposition identification method by assuming B to be lower triangular matrix.

VAR(p) process in equation (1) can be presented in the following VAR(1):

$$X_t = FX_{t-1} + V_t \tag{2}$$

Here, $X_t = (Y'_t, Y'_{t-1}, \ldots, Y'_{t-p+1})'$, $V_t = ((B\varepsilon_t)', 0', \ldots, 0')'$, F is matrix of coefficients. After iteration we have:

$$X_t = F^t X_0 + F^{t-1} V_1 + F^{t-2} V_2 + \cdots F^1 V_{t-1} + V_t \tag{3}$$

Once equation (1) is estimated and loading matrix B of structural shocks is identified, equation (3) can be written as:

$$X_t = f^t X_0 + f^{t-1} v_1 + f^{t-2} v_2 + \cdots f^1 v_{t-1} + v_t \tag{4}$$

Here, f^i is estimate to which F^i corresponds, i=1,2,…, t; v_j is estimate to which V_j corresponds, j=1,2, …, t; i.e., raw sequence $\{X_t\}_{t=1}^T$ can be linearly expressed by initial value X_0 and estimated structural shocks sequence $\{\hat{\varepsilon}_t\}_{t=1}^T$. Based on equation (4), historical decomposition can be conducted by changing the value of $\{\hat{\varepsilon}_t\}_{t=1}^T$ during a certain period, and the explanation share of certain shocks for macroeconomic variables during a certain period can be measured.

In this paper industrial value added is used to represent output. As National Bureau of Statistics has only released year-to-year growth rate of industrial value added instead of current price level value since December, 2006, current price level value from December, 2006 to October, 2013 is calculated according to formula of year-to-year growth rate of industrial value added in this paper. Industrial value added sequence is inflation-adjusted with CPI month-on-month sequence and real output is obtained; $CPI_{\text{Jan, 2005}} = 1$, meaning that the base period of CPI month-on-month sequence is January, 2005. Meanwhile, level value of M2 is introduced into SVAR model to correspond to IS-LM-Phillips curve model. The sample period is from January, 2001 to October, 2013.

Currently there are two types of methods to measure EPU: one type is to estimate directly the variable sequence of monetary (fiscal) policy with monetary (fiscal) policy uncertainty represented by time-varying standard deviation, and the method adopted by Fernandez-Villaverder *et al*. (2015), Born and Pfeifer (2014) belongs to this type which is characterized by definite economic significance and easy to build connections with existing financial and monetary theories; the other type is to compile policy uncertainty index based on news reports, which has the advantages

of covering more economic policies and updating timely. Research team headed by Prof. Bloom and Prof. Baker from Stanford University and Prof. Davis from University of Chicago compiled EPU of major economies in the world using the second method, and the index has been included and released by the well-known FRED Database of Federal Reserve Bank of St. Louis. Given that the research object is the uncertainty of multiple macroeconomic policies rather than only fiscal or monetary policy, this paper adopted China's EPU compiled by Baker *et al*. (2015), and here the "economic policy" refers to macroeconomic policies including fiscal policy, monetary policy and regulatory policy which are made by the central government and have power to affect the overall situation. This index is compiled based on news reports on *South China Morning Post*, famous English newspaper in Hong Kong (Tian and Lin, 2016).

Necessary data processing is needed before SVAR model estimation. Considering that the often used X12 seasonal adjustment method is designed according to holidays in the US and cannot deal with holiday effect in China effectively, this paper detrended and seasonally adjusted output, price level and M2 using Linde (2005), Wang *et al.* (2011) for reference. Taking the variable of output as an example, first take the log of the data, then conduct dummy variable regression of the constant term, time trend and season, the residual sequence obtained is sequence of output trend dispersion. In this paper $\{y_t\}_{t=1}^{T}$, $\{p_t\}_{t=1}^{T}$, $\{M2_t\}_{t=1}^{T}$ is used to represent trend dispersion sequence of output, price level and M2 respectively; meanwhile referring to the method by Bloom (2009), Carrire and Cespedes (2013), this paper introduces EPU level value of China (represented by $\{index_t\}_{t=1}^{T}$) into SVAR model, then the estimated benchmark VAR model is $\{y_t, p_t, M2_t, index_t\}$. Trend dispersion sequence shows that, real output was in obvious expansion from February, 2004 to August, 2006 and in contraction from November, 2011 to October, 2013; price level presented a steep uptrend from July, 2011 to April, 2013.

This paper examines lag of VAR model with "VARS" software package in R software, and chooses lag $p = 2$ a on the basis of 4 results from 4 principles (lag being 3 according to AIC, HQ, and FPE, and lag being 1 according to SC) and taking sample length into account; moreover, this paper tests the stationarity of VAR model with OLS-MOSUM, and on structural breaks are detected. Finally, this paper estimates parameters of VAR model in a Bayesian framework as Bayesian method is immune to non-stationary data (Uhlig, 1994, 2005).

3.2. Constructing a mixed identification method

This part first dwells on the necessity to construct a mixed identification method, then presents specific conditions for mixed identification, and finally briefly explains the implementation steps of mixed identification and median model.

3.2.1. Necessity to construct a mixed identification method

Sign restriction identification method cannot identify the new shocks of EPU. The premise for sign restriction identification method is to set sign restrictions for impulse response function, and the restrictions derive from widely-accepted economic theories or empirical facts, for example, most economist agree that under the shocks of tightening monetary policy, short-term benchmark interest-rate will not drop, non-loan reserves by Central Bank will not increase and price level will not rise. Based on this common belief, Uhlig (2005) identified tightening monetary policy shocks by imposing sign restriction on impulse response function of short-term benchmark interest-rate, non-loan reserves and price level. Unlike monetary policy shocks, as EPU shocks belong to a new category, researchers have little understanding of their macroeconomic effects and no consensus has been reached, hence no appropriate sign restrictions can be set. It is due to the above-mentioned reasons that Baker *et al*. (2015), Leduc and Liu (2012), Fernandez-Villaverde *et al*. (2015) all adopted the classical Cholesky decomposition identification method, but this method cannot identify simultaneously EPU shocks and other structural shocks.[1] It should be noted that, according to the classification of Rubio-Ramirez *et al.* (2010), Cholesky identification method belongs to conventional identification method as it identifies by imposing zero restriction on loading matrix.

To identify simultaneously conventional structural shocks (from aggregate demand, aggregate supply and monetary policy), we need to refer to Mumtaz and Surico (2009), Kilian and Murphy (2012) to construct a new mixed identification method in the framework of sign restriction identification method by imposing sign restrictions on impulse response function and zero restriction on loading matrix.

3.2.2. Contents of mixed identification conditions

The basic approach of mixed identification method is to identify aggregate demand shocks, aggregate supply shocks and monetary policy shocks by setting regular sign restrictions for impulse response of specific endogenous variables and to identify EPU shocks by setting zero restriction for loading matrix.

Based on some widely-accepted empirical facts (Gali, 1992; Peersman, 2005), this paper sets regular sign restrictions: in a certain period after the shocks, positive aggregate demand shocks will not lead real output and price level to decline, and positive aggregate supply shocks will not lead real output to decline and price level to rise; tightening monetary policy shocks will not lead real output and price level to rise but fall with decreasing money supply. Apparently the above sign restrictions apply to

[1] As expounded by Bjørnland (2009), the premise of Cholesky decomposition identification method (i.e. loop identification method) in identifying structural shocks is the existence of sequence in variables' response, and the method cannot be used when there is no time difference between the responses of two variables (for example, interest rate and exchange rate respond simultaneously to monetary policy and output and price respond simultaneously to demand shocks).

the reality of China's macro-economy.

Recent literature all uses Cholesky decomposition method to identify uncertainty shocks. This paper sets corresponding zero restriction: uncertainty shocks have no current effect on the variables of output, price and monetary policy, while structural shocks corresponding to the three variables have current effect on EPU index. The thinking of this assumption is in line with Baker *et al*. (2015), Leduc and Liu (2012), all of which take into account the sequence of variables' interaction. But given the special circumstances in China where many economic policies are post mortem, i.e., relevant authorities adopt corresponding policies to prevent the situation from worsening after problems arise, this paper assumes that the change in output, price and mobility affects change in current economic policy and then causes change in EPU. It needs to be noted that empirical results of these zero restrictions are highly robust (including changing the sequence of variables). Restrictions of the mixed identification method are presented in Table 1.

Table 1
Identification conditions of sign restrictions and zero restriction

	Output	Price	M2	EPU index
Aggregate demand shocks	⩾0	⩾0	⊙	⊙
Aggregate supply shocks	⩾0	⩽0	⊙	⊙
Monetary policy shocks	⩽0	⩽0	<0	⊙
EPU shocks	0 when k=0, ⊙ otherwise ⊙	⊙ 0 when k=0, ⊙ otherwise ⊙	0 when k=0, ⊙ otherwise⊙ ⊙	>0

Notes: Given impulse response period k, impulse response of corresponding endogenous variable to certain structural shocks are set to be non-positive (⩽0), non-negative (⩾0) and non-defined.

Referring to Mumtaz and Surico (2009), this paper explains current identification conditions of mixed identification method with the form of structural models. As VAR model includes 4 endogenous variables of real output (*lv*), CPI (*lc*), M2 (*lm*), and EPU index of China (*index*), correspondingly, innovation $u_t(4\times1)$ in reduced VAR model can be written as $u_t=(u_{lv}, u_{lp}, u_{lm}, u_{index})'$, and structural innovation $\varepsilon_t(4\times1)$ can be written as $\varepsilon_t=(\varepsilon_{AD}, \varepsilon_{AS}, \varepsilon_{mp}, \varepsilon_{un})'$, where ε_{AD} represents aggregate demand shocks, ε_{AS} represents aggregate supply shocks, ε_{mp} represents monetary policy shocks, and ε_{un} represents EPU shocks. Structural shocks identification matrix $B_{4\times4}$ is:

$$\begin{pmatrix} u_{lv} \\ u_{lp} \\ u_{lm} \\ u_{index} \end{pmatrix} = \begin{pmatrix} + & + & - & 0 \\ + & - & - & 0 \\ \times & \times & - & 0 \\ \times & \times & \times & + \end{pmatrix} \begin{pmatrix} \varepsilon_{AD} \\ \varepsilon_{AS} \\ \varepsilon_{mp} \\ \varepsilon_{un} \end{pmatrix} \tag{5}$$

Here, "×" represents uncertain effect, "+" represents positive effect, "–" represents negative effect, "0" represents no effect.

3.2.3. Implementation steps of the mixed identification method

The basic implementation steps of sign restriction identification method in SVAR framework are: imposing restrictions on signs of relevant endogenous variables' impulse response to certain shocks in a specific period based on explicitly stated assumptions. Let $A=[A_1, A_2, \cdots, A_p]$ represent coefficient matrix of equation (1), B being Cholesky decomposition matrix of $\sum$, $QQ'=I_m$ being orthogonal matrix, and realizing sign restriction identification method is equivalent to seeking matrix set $Q \in q$, letting impulse response function that $[A, Q'B]$ corresponds to satisfy sign restriction conditions (Fry and Pagan, 2011; Rubio-Ramirez *et al*., 2010).

Detailed implementation steps of the mixed identification method in this paper include: (1) using Uhlig (2005) for reference, this paper first estimates parameters of equation (1) in a Bayesian framework and gets $[A, \sum]$ posterior distribution probability space; (2) sampling random matrix $X_{(m-1)\times(m-1)}$ in which each element is in independent and standard normal distribution, conducting QR decomposition and normalizing upper triangular matrix R; (3) letting $P=Q$ and $I(1:(m-1),1:(m-1))=Q$, in which I_m is identity matrix, producing impulse response function that $[A, I'B]$ corresponds to; (4) keeping P if the impulse response function produced in the previous step satisfies sign restrictions, otherwise returning to step (2) and resampling; (5) getting median model using Minimum Distance proposed by Fry and Pagan (2011) and getting impulse response and historical decomposition based on median model.

3.2.4. Median model

$[A, \sum]$ posterior distribution probability space is obtained when sign restriction is used to identify structural shocks. Here sample i is represented by $[A_i, B_i]$, $i=1,2,\ldots n$,and the impulse response function that the sample corresponds to satisfies sign restriction condition; if we use $ir_{i,j,k}$, $i=1, 2, \ldots, n$, $j=1, 2, \ldots, m$, $k=0, 1, \ldots, K$ to represent impulse response value of endogenous variable j in period k, then what impulse response of pointwise posterior medians and 68% confidence interval mean is, for all $k=0, 1, \ldots K$, sort $\{ir_{i,j,k}\}_{i=1}^{n}$ respectively, and quantiles 16%, 50% and 84% are obtained, then by putting the quantile in each period in time order pointwise median impulse response sequence $\{ir_{*,j,k}\}_{k=0}^{K}$ and 68% confidence interval are obtained. Most literature uses pointwise median and 68% confidence interval to present impulse response results, while Fry and Pagan (2011) believe that as pointwise median impulse response comes from different structural models (i.e., different " i "), it is hard to understand precisely the economic significance of impulse response, and variance decomposition and historical decomposition cannot be conducted. Hence, Fry and Pagan (2011) propose

median model, that is, they standardize all the impulse responses and select samples of impulse response which are closest to pointwise median impulse response; and the model producing the impulse response is median model, which can be written as[A_i*, B_i*], then based on this model variance decomposition and historical decomposition can be conducted.

4. Analysis of empirical results

4.1. Analysis of impulse response

Figures 1 to 4 present the impulse response results of endogenous variables to aggregate demand, aggregate supply, monetary policy and EPU shocks. Impulse response curve to which median model corresponds is highly consistent with pointwise posterior median impulse response curve, indicating that the median model found by this paper is representative of empirical results; meanwhile, there is clear-cut distinction between impulse response confidence interval of real output and price level and steady-state line (i.e., the line of y=0), indicating statistical significance. Most impulse response curves are in line with standard macroeconomic theories and widely-accepted empirical facts in form, intensity and sign, showing rationality in economics.

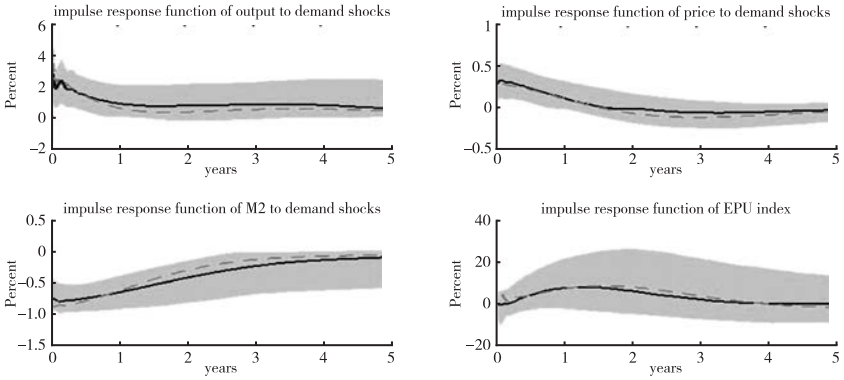

Figure 1. Impulse response of demand shocks

Notes: This figure presents impulse response of 4 endogenous variables to one standard variation positive aggregate demand shocks. The dotted line is impulse response curve that median model corresponds to, solid line is pointwise posterior median impulse response curve, and the dash area is 68% confidence interval. Hereinafter the same.

Key results that need emphasis include: (1) in response to policy uncertainty shocks real output presents the pattern of "wait and see" verified by Bloom (2009), but only to a small extent, that is to say, compared with conventional structural shocks, policy uncertainty shocks only have weak effects on output; (2) comparison of impulse response curves of real output to three conventional structural shocks shows that supply

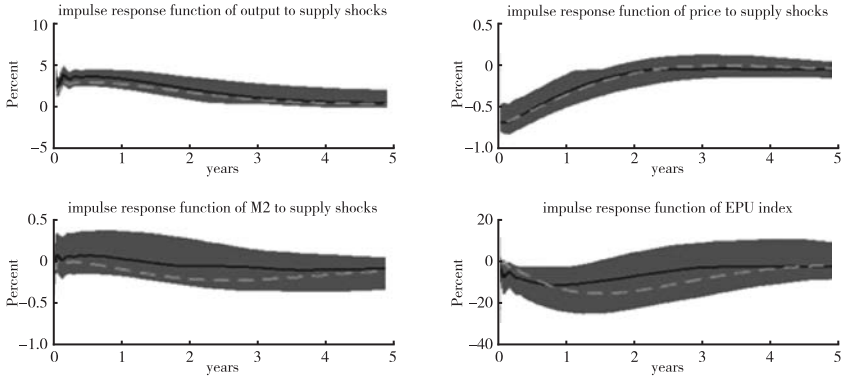

Figure 2. Impulse response of supply shocks

Note: This figure presents impulse response of 4 endogenous variables to one standard variation positive aggregate supply shocks.

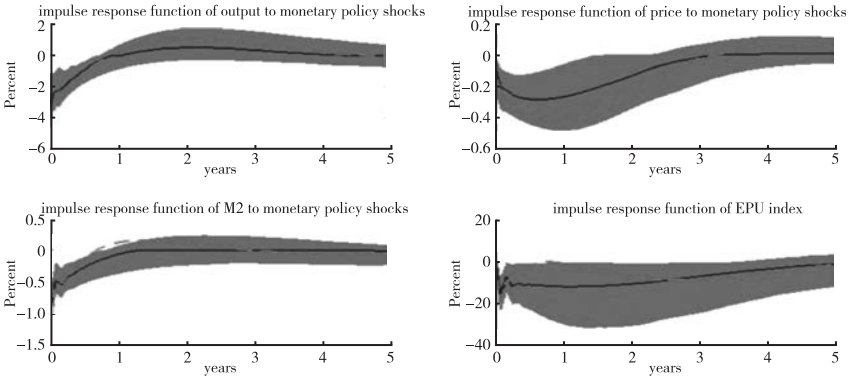

Figure 3. Impulse response of monetary policy shocks

Notes: This figure presents impulse response of 4 endogenous variables to one standard variation tightening monetary policy shocks.

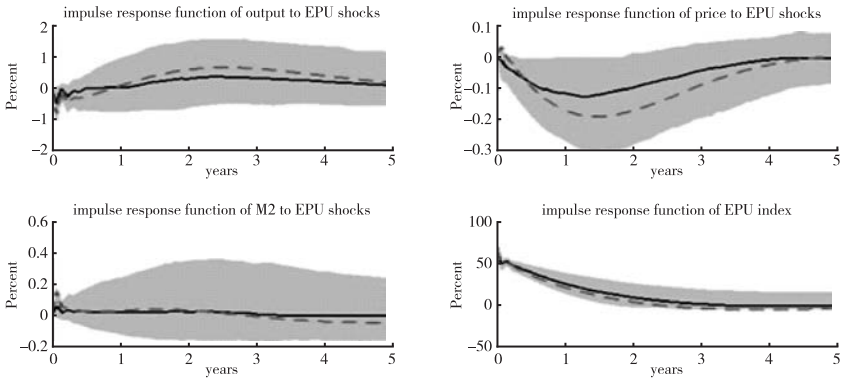

Figure 4. Impulse response of EPU shocks

Notes: This figure presents impulse response of 4 endogenous variables to one standard variation positive EPU shocks.

shocks have the strongest initial impact and continuity of impact while the continuity of monetary shocks is the weakest, which is in line with the discussion about output effect of supply shocks, demand shocks and monetary policy shocks in standard textbooks of macroeconomics (Dornbusch *et al*., 2010); (3) aggregate supply shocks and aggregate demand shocks have strong initial impact on price level, but the continuity is rather weak; monetary policy shocks and policy uncertainty shocks have continuous impact on price but the initial impact is weak; it is to be stressed that, unlike impulse response results of real output, policy uncertainty shocks have significant effect on price level.

Here we try to provide one explanation for impulse response results of policy uncertainty shocks. (1) From the perspective of aggregate demand, policy uncertainty inhibits investment and consumption, and reduces aggregate demand, by means of two mechanisms of "effect of real options" and its interaction with financial frictions, while in the sample period China depends more on investment and exports to achieve economic growth, so we focus on the effect on investment. Investment by state-owned enterprises and investment by non-state-owned enterprises should be distinguished here. State-owned enterprises are featured by obvious soft-budget constraint and their investment decisions are influenced by planned economy (Ma and Li, 2013), as a result policy uncertainty only has weak "effect of real options" on them; meanwhile, state-owned enterprises suffer weaker financial frictions, the above two reasons lead to weak negative shock effect of policy uncertainty on investment by state-owned enterprises. (2) Compared with developed market economies, Chinese government have stronger control and intervening power over economic activities, and had stronger appeal for continuous and fast economic growth (Zhou, 2007). During the sample period, whenever the economic growth is at a low, the Central Government will take a series of policy measures to stimulate economic growth. Hence, in economic downturns, state-owned enterprises, especially those in the field of infrastructure, will expect government at the national and local level to introduce stimulus policies, which prompts the enterprises to make bolder and more radical investment decisions, as a result, policy uncertainty shocks can only have weak "effect of real options" on these enterprises. To sum up, the fact that EPU can only have weak "effect of real options" on investment led by state-owned enterprises and the government, combined with government's "bottom-line thinking" for economic growth, causes weak inhibiting effect of EPU shocks on real output.

In contrast to output, strong inhibiting effect of EPU on price may result from the fact that EPU has strong "effect of real options" on the investment of private enterprises and consumption, the two of which are key factors affecting the trend of PPI and CPI.[1] Unlike state-owned enterprises, private enterprises do not have to dwell

[1] As discussed above, EPU has weak effect on investment led by the government (including state-owned enterprises), but this does not mean that it has no effect on market-based investment; the existence of "effect of real options" is proved by the empirical results by Xu *et al*. (2013) that political uncertainty has significant inhibiting effect on private enterprise investment.

on policy goals such as "ensuring steady growth" and "satisfying the need of national development", instead they can focus on their own profit goals, that is to say, their investment decisions are more market-oriented (Ma and Li, 2013), hence they are more sensitive to the change in economic policy environment. Compared with state-owned enterprises, private enterprises are confronted with more severe financial constraints, and these financial constraints further magnify "effect of real options" of EPU (Song *et al*., 2011; Gilchrist *et al*., 2010). Meanwhile, state-owned enterprises generally occupy the industries in the upstream of industrial chain, such as mineral, power, energy, while the downstream enterprises producing end consumptions goods are mostly non-state-owned enterprises (Li *et al*., 2015), and EPU inhibits the investment needs of the downstream enterprises, inevitably causing downward pressure on prices.

On the whole, impulse response results that EPU corresponds to are in line with the reality of China's economy, and the impulse response results that three conventional structural shocks correspond to are also in line with theoretical expectations of IS-LM-Phillips model.

4.2. Analysis of historical decomposition

What impulse response measures is average effect of structural shocks on macroeconomic variables, and the relative significance in a certain period cannot be reflected. So, historical variance decomposition based on estimated SVAR model is needed to quantify and identify dominant factors driving macroeconomic fluctuations in China during the sample period. Take aggregate demand shocks as an example to explain the steps of historical decomposition: (1) selecting one sample period according to research aim, assuming the sequence value of aggregate demand shocks during that period to be 0, and keeping the sequence value of other structural shocks constant; (2) substitution of assumed shocks vectors into the model yields simulative outputs; (3) comparing the sequence of real outputs with that of simulative outputs, and calculating the mean of the differences between the two sequences; as the sequences of outputs have been logarithmized, the mean of the differences can be approximated to percentage. The following part first presents historical decomposition results of real outputs from February, 2004 to August, 2006, when was in obvious expansion; then respectively presents historical decomposition results of real outputs from November, 2011 to October, 2013 and historical decomposition results of price level sequence from July, 2011 to April, 2013, the above two periods corresponding to contraction of economic growth and rise of price level respectively. On the basis of discussion about whether the decomposition results are in line with economic facts, key driving factors for macroeconomic fluctuations are summarized.

4.2.1. Historical decomposition of real outputs in expansion (February, 2004 to August, 2006)

Here historical decomposition is used to analyze real outputs from February, 2004

to August, 2006 and measure the contribution of four structural shocks to this period of expansion. Figure 5 presents the contribution of four structural shocks of aggregate demand, aggregate supply, monetary policy and EPU. Results show that, aggregate demand shocks occupy the greatest contribution, as closing the sequence of aggregate demand shocks with positive mean will cause real output to fall by about 14 percentage points; the proportions of changes that aggregate supply shocks and monetary policy shocks correspond to are 1.35% and 0.33% respectively; while closing the sequence of EPU shocks with positive mean will cause real output to rise by 0.17% on average, which means that the economic expansion from February, 2004 to August, 2006 was mainly caused by aggregate demand, and the factors of aggregate supply and monetary policy had certain explanatory power, yet EPU had only weak inhibiting effect on real output growth.

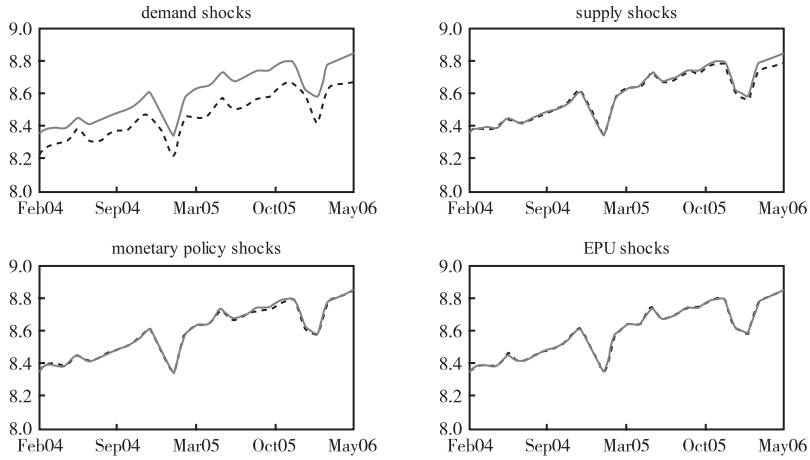

Figure 5. Historical decomposition of real outputs from February, 2004 to August, 2006

Notes: Figure 5 presents historical decomposition results of real outputs from February, 2004 to August, 2006. Here the solid line is real sequence of real output (logarithmized), and the dotted line is simulative sequence of real output.

The historical decomposition result is consistent with corresponding macroeconomic facts. It is well-known that external demand became important engine driving China's economic growth in the more than10 years after China joined WTO in December, 2001. *China Statistical Yearbook 2013* indicates that the contribution of net export to GDP growth from 2004 to 2006 reaches 10.6%. During the same period, large-scale infrastructure construction was under way, including Western Development Strategy, West-East Pipeline, West-East Electricity Transmission, hydro-junction and arterial highways, which greatly promoted domestic demand. *China Statistical Yearbook 2013* indicates that the contribution of gross capita formation to GDP growth from 2002 to 2006 reaches 49.6%. This proves chief driving factors for this period of continuous

expansion include domestic investment demand mainly in the form of large-scale infrastructure construction and external demand in the form of net export. It should be noted that supply shocks are not key driving factor for this expansion. In this period, as reform of state-owned enterprises had been completed and TFP growth caused by factor allocation efficiency and technological progress slowed down, TFP's contribution to industrial growth decreased significantly (Zhang *et al*., 2009; Nie and Jia, 2011)

4.2.2. Historical decomposition of real outputs in contraction (November, 2011 to October, 2013)

Since the first quarter of 2012, China's GDP growth rate has been higher than 7%. Figure 6 presents the contribution of four structural shocks from November, 2011 to October, 2013. The results indicate that, aggregate demand shocks still occupy the greatest explanatory share, as closing the sequence of aggregate demand shocks will cause the real output to rise by about 6.6 percentage points; closing aggregate supply shocks with negative mean will cause real output to rise by about 0.12%, while closing monetary policy shocks[1] with positive mean will cause real output to rise by 0.48%; consistent with expectations, EPU shocks have weak effects on real output, i.e., the latest round of declining economic growth rate is mainly caused by demand.

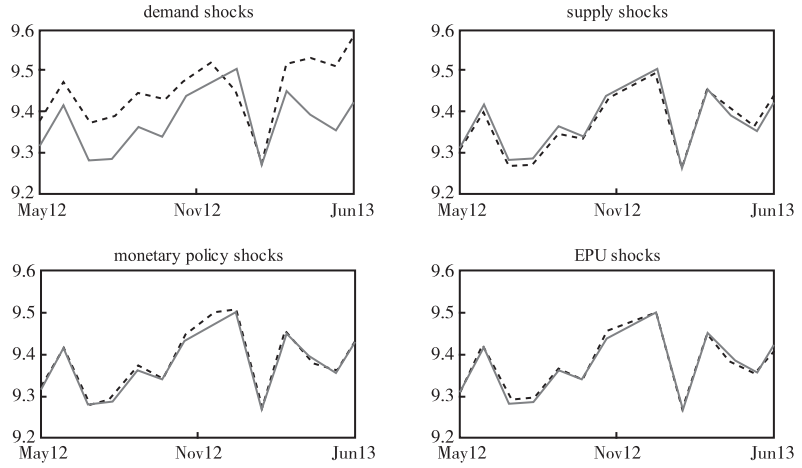

Figure 6. Historical decomposition of real outputs from November, 2011 to October, 2013

Notes: Figure 6 presents historical decomposition results of real outputs from November, 2011 to October, 2013. Here the solid line is real sequence of real output (logarithmized), and the dotted line is simulative sequence of real output.

[1] It should be noted here that, impulse response results in Figure 3 show that, with time going by real output's response to tightening monetary policy shocks will be positive, and from the perspective of measurement only, this means the sequence of monetary policy shocks with positive mean may correspond to negative output sequence.

The characteristics of China's economy from 2009 to 2013 can be summarized as policy stimulus, overcapacity and deleveraging, i.e., large-scale government-led investment led to substantial growth in credit, then causing great increase in enterprises' liabilities, finally the painful and slow deleveraging process. Specifically, to resistant the severe impact of international financial crisis, the Central Government implemented "4000 billion" investment scheme, local governments also implemented their local versions of "4000 billion" investment scheme. Government-led investments maintained the economic growth at a rate over 9% from 2009 to 2011, contribution of capital formation being 87.6%, 52.9% and 47.7% respectively in those three years. But from the latter half of 2011, the stimulating effects of government investments began to weaken and some undesirable consequences started to show. In comparison to the period from March 2009 to June 2011, the growth rate of fixed assets investments during the period from July 2011 to October 2013 markedly declined, and accordingly growth rate of industrial value added began to show a marked declining trend from the latter half of 2010. In the same period, under the circumstance of weak global economy recovery, external demand recovery was significantly affected. From July 2011 to October 2013, average accumulative growth rate of China's gross export value was 12.86%, far below 30.18% from January 2010 to July 2011. The above economic facts show that negative demand shocks are main factor for declining economic growth.

In the context of large-scale investment projects being developed by national and local governments, many projects were constructed without full demonstration, resulting in overcapacity and overlapping projects in many industries (such as steel, cement, coal-chemical, and electrolytic aluminum). [1] Overcapacity causes enterprises' difficulty in increasing economic benefits and operation efficiency, and a large quantity of non-performing loans, also exacerbates resource misallocation, leading to slow TFP growth in China (Hsieh and Klenow, 2009; Brandt *et al.*, 2013), which can partly explain negative supply shocks. However, in the overall situation of surplus supply and insufficient demand, supply shocks cannot offer too much explanation for negative fluctuation of real output.

In 2009 and 2010 M2 and credit exploded, and quite a portion of new credit went into state-owned enterprises and government financing vehicles, and real estate market, that is to say, new mobility did not go effectively into real economy sector. By 2013, the frequent phenomenon of "money shortage not short of cash" indicated that the misallocation of credit had been rather severe[2]. Statistics show that from 2009 to 2013 (except 2011) there had always been the phenomenon that credit growth exceeds

[1] *Notification about Several Decisions on Restraining Overcapacity and Overlapping Projects and Guiding Healthy Development of Certain Industries Approved by the State Council and Forwarded to Departments including National Development and Reform Commission* (the State Council [2009] 38); *The high-level will issue overall plan to resolve overcapacity with 5 industries involved*, China Securities Journal, July, 30, 2013.

[2] *Money shortage not short of cash: where did the cash go*, finance.qq.com, June, 24, 2013, http://finance.qq.com/zt2013/cjgc/qh.htm.

nominal GDP growth which is referred to as "China's credit puzzle" by economists. Though economists offer various explanations for this phenomenon, one definite fact is that effects of new mobility promoting economic growth have been rather weak during that period. It can be seen that historical decomposition results as shown by Figure 6 are in line with this economic reality, i.e., close the sequence of monetary policy shocks with positive mean, and real output will increase slightly.

As discussed above, EPU has little or no inhibiting effect on government-led investments, but has strong "effect of real options" on investment demand of private enterprises and consumption demands of consumers; as positive fluctuations of real output during this period were mainly driven by government-led investments, EPU at the overall level had only weak explanatory power for real output.

4.2.3. Identification of driving factors for inflation (historical decomposition of price level sequence from July, 2011 to April, 2013)

Scholars have two opinions on the types of driving factor for inflation in China, i.e., demand-pull and cost-push. Countermeasures for the former tend to be macro policies tightening demands, while countermeasures for the latter tend to focus on supply management. Peng *et al*. (2012), from micro-empirical perspective, find that apart from the factor of demand-pull, the rise of wage costs is also an important cause for inflation in China.

This paper offers new insights from macro-empirical perspective. Figure 7 presents in turn the explanatory share of 4 structural shocks on the sequence of price level from July 2011 to April 2013. It can be seen that supply factors are primary cause for continuous rise in price level, as closing the sequence of aggregate supply shocks will lead price level to fall by about 0.74% on average; monetary policy is the second important factor for continuous rise in price level, as closing the sequence of monetary policy shocks will lead price level to fall by about 0.13% on average; it needs to be emphasized that price level will rise by 0.58% on average if there are no EPU shocks with positive mean; finally, negative aggregate demand shocks almost have no explanatory power for fluctuations of price level.

In fact, according to *China Monetary Policy Report* issued quarterly by the People's Bank of China, the latest round of positive fluctuations in price level originated at the end of 2010 have the following characteristics: firstly, the rise of food prices is far higher than that of non-food prices; secondly, the rise of resource products such as farm produce, minerals, coal, oil, electricity is far higher than that of processed products; thirdly, the rise of import price is higher than that of export price, all of the above three points showing that the negative supply shocks are primary driving factor for price rise from the end of 2010 to the first half of 2013; on the other hand, investment and operation activities of downstream enterprises in the industrial chain (mostly private enterprises) have direct effect on price level expressed in terms of CPI,

and EPU has strong inhibiting effects on these activities, thus it is understandable that EPU has strong inhibiting effects on price level of this period.

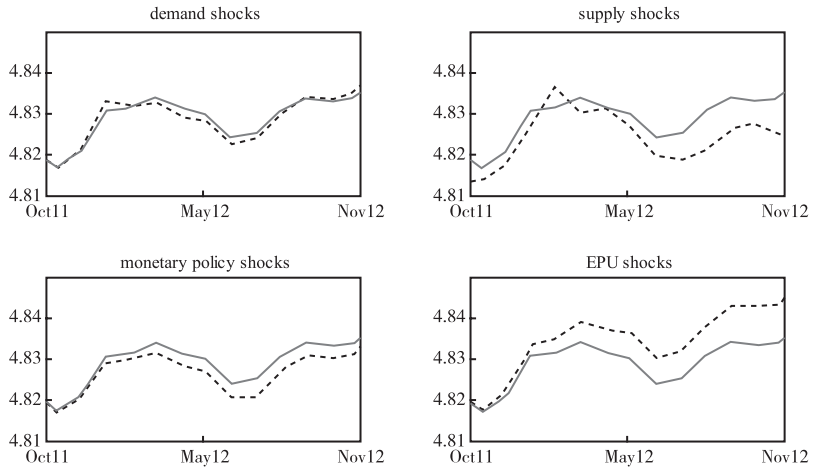

Figure 7. Historical decomposition of price level from November, 2011 to April, 2013

Notes: Figure 7 presents explanatory power of the sequence of price level fluctuations from November, 2011 to April, 2013. Here the solid line is real sequence of price level (logarithmized), and the dotted line is simulative sequence of price level.

5. Conclusions

To comprehensively examine EPU's effects on macroeconomic fluctuations, this paper constructs SVAR model based on macroeconomic reality of China to measure the source of shocks on economic fluctuations and their relative importance. In order to identify simultaneously four structural shocks of aggregate demand, aggregate supply, monetary policy and EPU, this paper designs a mixed identification method combining regular sign identification method and classical Cholesky decomposition identification method, and measure the contribution of demand, supply, monetary policy and EPU to macroeconomic fluctuations at a specific period using historical decomposition.

We find that, compared with the three conventional structural shocks, EPU does not have obvious effects on fluctuations of output yet, but it has sustained inhibiting effects on price; in the whole sample period, demand shocks are the most important driving factor for output fluctuations, followed by supply shocks; in inflation, negative supply shocks and easy monetary policy are key driving forces, while EPU has obvious inhibiting effects on price.

Our research is of great importance to the topic of EPU's macroeconomic effects. (1) It not only finds that EPU shocks have Chinese characteristics of "inflation effect stronger than output effect", but also offers a logically consistent explanation on the

basis of China's economic features including heterogeneity of state-owned enterprises and private enterprises and government's "bottom-line thinking" for economic growth. This explanation provides a useful perspective for future micro-mechanism modeling. (2) The mixed identification method can not only effectively avoid the mistake of confusing EPU with other structural shocks, but also systematically compare the explanatory power of each type of structural shocks for macroeconomic fluctuations. It is this comparison that provides more convincing evidence for the opinion that EPU is a negative demand shock.

Conclusions of this paper also have obvious policy implications: (1) Efforts should be made to decrease EPU that investments by enterprises, especially by private enterprises, are confronted with. We believe that weak effect of real options on investments led by governments and state-owned enterprises causes weal output effect of EPU, while the strong effect of real options on investments led by private enterprises and on consumption causes sustained inhibiting effect on inflation. Considering macroeconomic reality at present, chronic lack of economic growth in investments by private enterprises means that the government should attach more importance to the policy environment facing private enterprises, clarify and effectively implement key policies that stimulate growth in investments by private enterprises, and decrease EPU; meanwhile, in playing the underpinning role of positive fiscal policy, the government should avoid EPU generated from incomplete implementation of policies, for example the tax cuts in force now. (2) Insufficiency of effective demand is the primary cause for economic growth slowdown in recent years; insufficiency of effective demand and insufficiency of effective supply are two sides of one coin, in other words, they are symbiotic, so economic operation efficiency should be promoted on the basis of supply-side reform to achieve sustained improvement in supply, but in the process of reform, the Central Government should strengthen the coordination among competent authorities (National Development and Reform Commission, Ministry of Finance, People's Bank of China, etc.), clarify path and measures of reform, and reduce EPU in the implementation of reform.

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