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INFLATION PERSISTENCE IN CHINA: A COMPARATIVE ANALYSIS ON STANDARD CIA MODEL AND CIA MODEL WITH ENDOGENOUS MONEY

In this paper we study the inflation persistence in Chinese economy using the DSGE approach. 2 monetary DSGE models are estimated — a standard CIA model and CIA model with a Taylor rule. The results show that the augmented model outperforms the standard CIA model in terms of capturing inflation persistence. At the same time, inflation must "inherit" the persistence from external shocks; backward-looking imparts some "intrinsic" persistence to inflation and autoregressive parameter of inflation constitutes the dominant source of persistence. This article uses the Bayesian method to estimate the model, and the estimated and inferred are credible due to Markov chain reaching convergence.

Keywords: *inflation persistence, DSGE model, Bayesian estimation.*

Ін Ляо, Рідун Ху

СТІЙКА ІНФЛЯЦІЯ В КИТАЇ: ПОРІВНЯЛЬНИЙ АНАЛІЗ ПО СТАНДАРТНІЙ МОДЕЛІ CIA І МОДЕЛІ CIA ЗІ ЗМІННОЮ "ЕНДОГЕННІ ГРОШІ"

У статті вивчено стійкість інфляції в економіці Китаю з використанням підходу DSGE (динамічне стохастичне моделювання загальної рівноваги). Оцінено дві фінансові моделі — стандартна CIA і модель за правилом Тейлора. Результати показали, що розширена модель перевершує стандартну модель CIA з точки зору аналізу стійкості інфляції. В той же час інфляція повинна йти за зовнішніми шоками; показник авторегресії інфляції є основним джерелом стійкості. Для оцінювання моделей використано метод Баєса, а розрахункова і орієнтовна моделі перевірені методом ланцюжків Маркова.

Ключові слова: *стійкість інфляції, динамічне стохастичне моделювання загальної рівноваги, баєсівське оцінювання.*

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Ин Ляо, Ридун Ху

УСТОЙЧИВАЯ ИНФЛЯЦИЯ В КИТАЕ: СРАВНИТЕЛЬНЫЙ АНАЛИЗ ПО СТАНДАРТНОЙ МОДЕЛИ CIA И МОДЕЛИ CIA С ПЕРЕМЕННОЙ "ЭНДОГЕННЫЕ ДЕНЬГИ"

В статье изучена устойчивость инфляции в экономике Китая с использованием подхода DSGE (динамическое стохастическое моделирование общего равновесия). Оцениваются две финансовые модели — стандартная CIA и модель по правилу Тейлора. Результаты показали, что расширенная модель превосходит стандартную модель CIA с точки зрения анализа устойчивости инфляции. В то же время инфляция должна следовать за внешними шоками; показатель авторегрессии инфляции является основным источником устойчивости. Для оценки моделей использован метод Байеса, а расчетная и ориентировочная модели проверены методом цепочек Маркова.

Ключевые слова: *устойчивость инфляции, динамическое стохастическое моделирование общего равновесия, байесовское оценивание.*

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1. Introduction. Since the scale of price rises have shrunk significantly in 2012, China still witnesses inflationary pressures. The State Council declared in Government Work Report that we should keep stable price level, do a good job in price regulation and prevent prices rebound. Therefore, it is necessary to understand indepth the inflation dynamic behavior of China. As well as the monetary authority is concerned, the key point is to clarify the microeconomic foundation of inflation inertia. This paper captures the responses of China's inflation inertia to technology shock and monetary shock in the framework of dynamic stochastic general equilibrium (DSGE) theory.

There are 2 methods of measuring inflation persistence, univariate and multivariate methods. The former uses univariate autoregressive model to fit the time series of inflation and estimates inflation persistence according to the model (Coleman, 2010; Kumar and Okimoto, 2007; Stock and Watson, 2007; Zhang and Clovis, 2010). The later "multivariable" approach estimates inflation persistence based on impulse response function of structural models (Benati, 2008; Coleman, 2010; Zhang, 2011). Univariate regression is easy to understand and estimate, but it does not figure out different sources of inflation persistence. In comparison, the multivariate methods can capture the different impacts of inflation by estimation of structural models (hybrid New Keynesian Phillips curve model or the impulse response function of the vector auto-regression model). However, the above 2 methods lack the microeconomic foundation.

In comparison, the dynamic stochastic general equilibrium model can not only capture the characteristics of inflation inertia but also provide microeconomic foundation. Firstly, DSGE model introduced money element, not only reflects the actual economic situation, but also distinguishes and portrays transmission mechanisms to different shocks. Secondly, as Lucas critique pointed out, if an economic model is not structural, any change of economic environment, policy regime and expectation may lead to the instability of the system and a big impact on analysis and evaluation. In contrast, DSGE models built on identification of structural parameters can compare different policies by the modification of local policy parameters, which provide an appropriate framework for analysis of inflation inertia to random shocks. Finally, built in the uncertain environment, DSGE model introduces a variety of exogenous shocks, which makes feasible analysis of the inflation inertia characteristics in different contexts.

The literature on inflation inertia with DSGE theory is quite limited. Wang et al. (2011) introduce into DSGE model imperfect competition, spending habits and nominal wage rigidity, calibrate parameters in the structural model with macroeconomic data in China, and compare the theoretical and empirical results. However, calibration in the article is based on previous studies instead of estimation by Bayesian technique or maximum likelihood method.

In accordance with Walsh (2003), this article constructs a standard CIA model and a CIA model with endogenous money by introducing Taylor rule based on the quarterly data during 1993-2011 in China. This paper also has a study on the characteristics of inflation inertia to technology shock and monetary shock and compares 2 models and figures out which model does better in description of the real economy in China. In order to obtain credible conclusion, this paper estimates the

key parameters and the parameters to be tested by Bayesian method. Bayesian method not only can be used to estimate parameters, but also to compare the merit of models by posterior distributions. The article also compares the theoretical inflation inertia and the inertia of the real data and analyzes the formation mechanism of inflation inertia.

This article is organized as follows: we build a standard CIA model and a CIA model with endogenous money and solve out the balanced system in Part 2; in Part 3, we calibrate the model based on Chinese macroeconomic data; Part 4 gives how the data are treated and compares the estimated results; we show the steady-state path of inflation in part 5, and at the same time, we compare theoretical inflation persistence and empirical inflation persistence; the final is conclusion.

2. The model. *2.1. Standard CIA model.*

2.1.1 Equilibrium. Equilibrium is characterized by the allocation of quantities and prices that satisfy the households' optimality conditions and budget constraint, the firms' optimality conditions and finally the market clearing conditions. According to Uhlig (1995), we solve the model by log-linearizing the equilibrium conditions around the deterministic zero-inflation steady state. Here we only present the equations necessary to characterize the equilibrium of the variables in interest:

$$\left\{\hat{y}_t,\hat{k}_t,\hat{n}_t,\hat{c}_t,\hat{\lambda}_t,\hat{r}_t,\hat{i}_t,\hat{\pi}_t,\hat{m}_t,u_t,z_t\right\}_{t=0}^{\infty}$$

Where lowercase letters denote log-deviation from their steady state counterparts, the following equations determine the equilibrium dynamics of variables above:

Production function:

$$\hat{y}_t = \alpha\hat{k}_{t-1} + (1-\alpha)\hat{n}_t + z_t \tag{1}$$

Market clearing:

$$\left(\frac{y^{ss}}{k^{ss}}\right)\hat{y}_t = \left(\frac{c^{ss}}{k^{ss}}\right)\hat{c}_t + \hat{k}_t - (1-\delta)\hat{k}_{t-1} \tag{2}$$

The optimal choice of labor-leisure:

$$\hat{y}_t = \left(1+\eta\frac{n^{ss}}{1-n^{ss}}\right)\hat{n}_t - \hat{\lambda}_t \tag{3}$$

Marginal utility of consumption:

$$\hat{\lambda}_t = -\Phi\hat{c}_t - \hat{i}_t \tag{4}$$

Marginal product of capital:

$$\hat{r}_t = \alpha\frac{y^{ss}}{k^{ss}}\left(E_t\hat{y}_{t+1} - \hat{k}_t\right) \tag{5}$$

Cash in advance constraint:

$$\hat{m}_t = \hat{c}_t \tag{6}$$

Money supply:

$$\hat{m}_t = \hat{m}_{t-1} - \hat{\pi}_t + u_t \tag{7}$$

Euler equation:

$$\hat{\lambda}_t = \hat{r}_t + E_t\hat{\lambda}_{t+1} \tag{8}$$

Fisher equation:

$$\hat{i}_t = \hat{r}_t + E_t\hat{\pi}_{t+1} \tag{9}$$

2.2. CIA model with endogenous money. According to Suh (2004), the Taylor rule is introduced into the CIA model to describe the characteristics of the monetary endogenous. Under the Taylor rule, the monetary authorities will control interest rates based on output and inflation in the economy (Taylor, 1993). The expression is as follows:

$$\hat{i}_t = \omega_1 E_t\hat{\pi}_{t+1} + \omega_2\hat{y}_t, \tag{10}$$

where ω_1 and ω_2 stand for reaction coefficients of interest to inflation and output. $\hat{i}$, $\hat{\pi}$ and $\hat{y}$ denote log-deviation from their steady state counterparts. We combine Taylor equation with Fisher equation and take the place of the original equation (15). Thus, it becomes:

$$\hat{\lambda}_t = \left(\frac{\omega_1 - 1}{\omega_1}\right)\hat{i}_t + \frac{\omega_2}{\omega_1}\hat{y}_t + E_t\hat{\lambda}_{t+1} \tag{11}$$

3. Calibrations and Estimation. The set of parameters to be estimated is given in 2 methods. First, the general static parameters are given by calibration; second, the dynamic parameters are estimated by Bayesian technology.

3.1. Calibration and Estimation of the standard CIA model. The basic idea of calibration is to determine the parameters in the model based on the relationship between economic variables which are observed. While the method is not strict, but in the case of data samples are rarely or not obtained, it may also be used to fix the parameters. In order to make the parameters calibrated reflect the actual economic situation as much as possible, the DSGE model parameters are grouped into 3 broad categories according to Negro and Schorfheide (2008).

First, the parameters set

$$\left\{\alpha,\beta,\delta,y^{ss}/k^{ss},n^{ss}/k^{ss},r^{ss},n^{ss}\right\}$$

can be easily identified from steady state relationships among the observable variables. The parameter β is calibrated as 0.989, so that the steady state nominal interest rate R is equal 1.1%, which is the average measured value for Shanghai Interbank Offered Rate (Shibor) in the 1996-2012 period. The value of α is fixed as 0.5 according to literature. Chow and Li (2002) estimate the aggregate production function with China's 1952-1998 data and find Cobb-Douglas function with constant returns to scale applicable to China. And their estimation of capital share is 0.55; other scholars' estimate on capital share are about 0.5, such as Zhang's (2002) estimate is 0.499, Wang and Fan (2000) give the estimated capital share of 0.5, which means the capital in steady state contribute 50% to the output. The quarterly depreciation rate of capital δ is computed at 0.025 (10% per year). The preference for leisure, N, is calibrated

so that in the steady state total hours worked, n^{ss}, are 1/3 to the total available time (Walsh, 2003). They are concluded as follows:

Table 1. **Parameters calibration**

Parameters:	$\alpha = 0.5,\ \delta = 0.025,\ \beta = 0.989$
Steady state value:	$\frac{y^{ss}}{k^{ss}} = \frac{1}{\alpha}\left(\frac{1}{\beta} - 1 + \delta\right)$ (12)
	$\frac{c^{ss}}{k^{ss}} = \frac{y^{ss}}{k^{ss}} - \delta$ (13)
	$r^{ss} = 1/\beta$, $n^{ss} = 1/3$ (14)

Second, the group {Φ,η} includes the coefficients of relative risk aversion consumption and working governing the DSGE model's endogenous propagation mechanism. These parameters priors are based on the microlevel data sets unrelated to each other. Therefore, our approach maintains the independence assumption that has become standard in the literature for these parameters. The paper makes the prior distribution contain the exact information as much as possible. Following Walsh (2003) and Caraiani (2009), Φ and η have normal distribution whose means are 1 and 2, respectively, and standard deviations both are 0.5.

Finally, the parameters

$$\{\rho_z, \rho_u, \phi, \sigma_z, \sigma_u\}$$

describe the propagation mechanism of the exogenous shocks (for example, autocorrelations and standard deviations) belong to the third group. Considering the literature on China, the persistence coefficient of technology shock, is set to 0.95, and its standard deviation is 0.023 (Hu and Liu, 2007); the persistence coefficient of monetary shock is set to 0.42, and its standard deviation is set to 0.057 (Wang et al., 2011). The reaction coefficient of money supply on the impact of the output is fixed to 0.3. The parameters are shown in Table 2.

3.2 Calibration and Estimation of the CIA model with endogenous money. In the model, the calibration of parameters set

$$\{\alpha, \beta, \delta, y^{ss}/k^{ss}, n^{ss}/k^{ss}, r^{ss}, n^{ss}\}$$

and the priors and initial values of

$$\{\Phi, \eta, \rho_z, \rho_u, \phi, \sigma_z, \sigma_u\}$$

are the same as in the above model. The parameters $\{\omega_1, \omega_2\}$ in the modified Fisher equation are to be estimated by Bayesian techniques. According to Ball (1999), the two parameters are assumed to follow normal distribution whose means are 1.5 and 0.5, respectively, and standard deviation is 0.25 as shown in Table 2.

Table 2. **The priors of parameters estimated**

Parameters	Priors			Parameters	Priors		
	Distribution	Mean	Standard deviation		Distribution	Mean	Standard deviation
Φ	Normal	1.5	0.5	σ_z	Inverted Gamma	0.02	infinite
η	Normal	1.5	0.5	σ_u	Inverted Gamma	0.05	infinite
ρ_z	Beta	0.5	0.25	ω_1	Normal	1.5	0.25
ρ_u	Beta	0.5	0.25	ω_2	Normal	0.5	0.25
ϕ	Beta	0.5	0.25				

4. Data and Results.

4.1. Data. This paper uses the observable data underlying per capita output and inflation in China. For the per capita output is not available, it is obtained by real GDP divided by the population[3]. The GDP series is the quarterly GDP in 1993 constant prices. The inflation rate is proxied by the GDP deflator[4]. The quarterly data are compiled by Chinese Economic Index net (CEInet) statistical database, for the period from 1993:1 to 2012:1. These series are transformed to eliminate unit roots and trends, and for that they are logged, deseasonalized by TRAMO/SEATS method and then detrended with the Hodrick Prescott filter.

4.2. Bayesian estimation. The parameters are estimated by Dynare 3.0 (Stephane et al., 2011) as reported in Table 3. As can be seen in Table 3, most parameters estimated are almost the same, except the parameter Φ. The parameters ρ_z and ρ_u are estimated as more than 0.92, and 0.73, respectively, which follows the fact of technology shocks and monetary shocks having high autocorrelation coefficients. The estimated parameter ϕ is greater than zero, indicating that the positive productivity shock leads to increase in monetary shocks. The standard deviation of the technology shock σ_z is less than the standard deviation of monetary shock, σ_u, indicating that the variance of technology shock influence economic system more than monetary shock.

The only significant difference between 2 models is that the parameter Φ is estimated to be 1.9207 and 1.2644, respectively. Obviously, the parameter in CIA model with endogenous money is closer to the initial value, 1, according to Walsh (2003). Therefore it can be concluded that CIA model with endogenous money is more consistent with apriori information.

In the CIA model with endogenous money the estimated parameters $\omega_1>\omega_2$ follow that keeping price stable is the basic policy of the central bank.

Figure 1 and 2 give the prior distribution and the posterior distribution of the two models, respectively. Obviously, the augmented CIA model corresponds to prior information. In addition, the parameters $\{\rho_z, \rho_u, \phi, \sigma_z, \sigma_u\}$ are significantly changed, which means these 2 observable series include much new information.

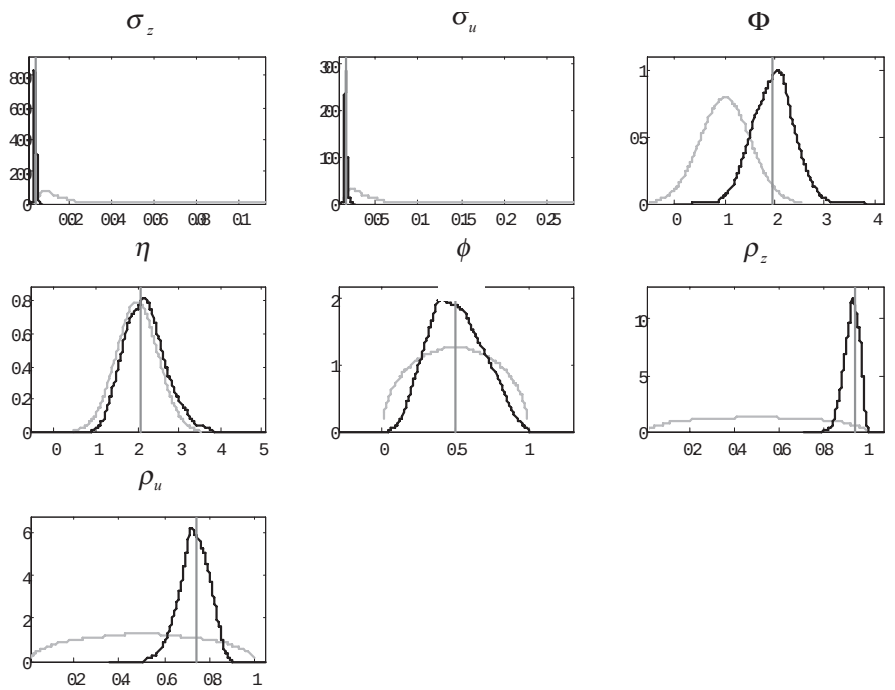
[3] Because National Bureau of Statistics do not provide the quarterly population data, we turn annual population data into quarterly population data by interpolation.

[4] Since the quarterly GDP deflator data are not provided by China's Bureau of Statistics, the data are obtained by the following two steps: first, we calculate nominal GDP growth rate and real GDP growth rate with the existing data; second, we obtain the GDP deflator by the equation:

GDP deflator = nominal GDP growth rate - real GDP growth rate.

Table 3. **The results of the Bayesian Estimation for the standard CIA model and the augmented CIA model**

Parameters	The standard CIA model			The augmented CIA model		
	Prior Distribution	Media Posterior	Confidence Interval	Prior Distribution	Media Posterior	Confidence Interval
Φ	Normal	1.9207	(1.328, 2.50)	Normal	1.2644	(0.447, 2.009)
η	Normal	2.1004	(1.291, 2.914)	Normal	2.1963	(1.474, 2.931)
ρ_z	Beta	0.9200	(0.862, 0.98)	Beta	0.9223	(0.863, 0.985)
ρ_u	Beta	0.7358	(0.641, 0.833)	Beta	0.7629	(0.654, 0.873)
ϕ	Beta	0.5266	(0.26, 0.79)	Beta	0.4719	(0.135, 0.786)
σ_z	Inverted Gamma	0.0044	(0.0037, 0.0051)	Inverted Gamma	0.0038	(0.0032, 0.0044)
σ_u	Inverted Gamma	0.0156	(0.0131, 0.0177)	Inverted Gamma	0.0190	(0.0168, 0.0214)
ω_1	-	-	-	Normal	1.5566	(1.101, 1.949)
ω_2	-	-	-	Normal	0.1053	(-0.266, 0.505)



Note: the priors are in grey, and the posteriors are in black.

Figure 1. **The results of the Bayesian Estimation for the standard CIA model**

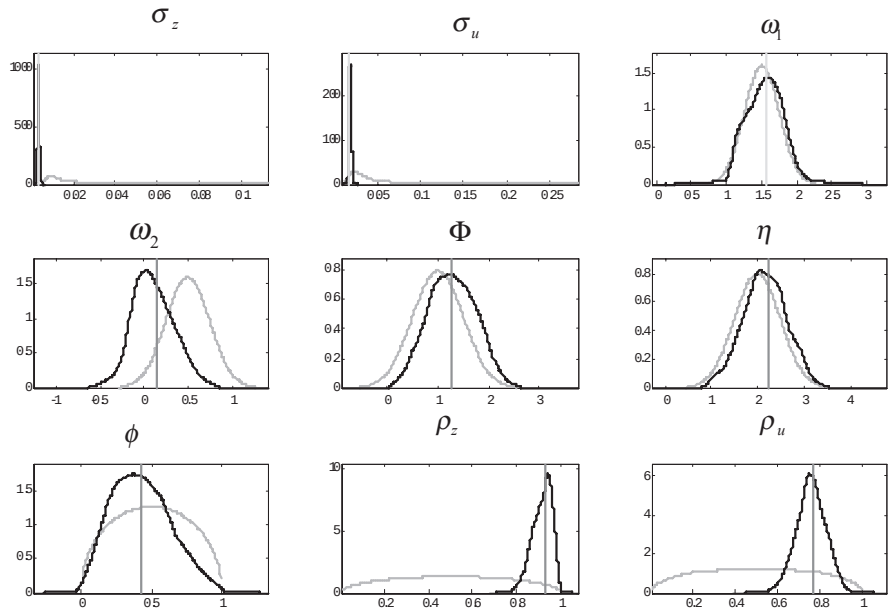


Figure 2. **The results of the Bayesian Estimation for the augmented CIA model**

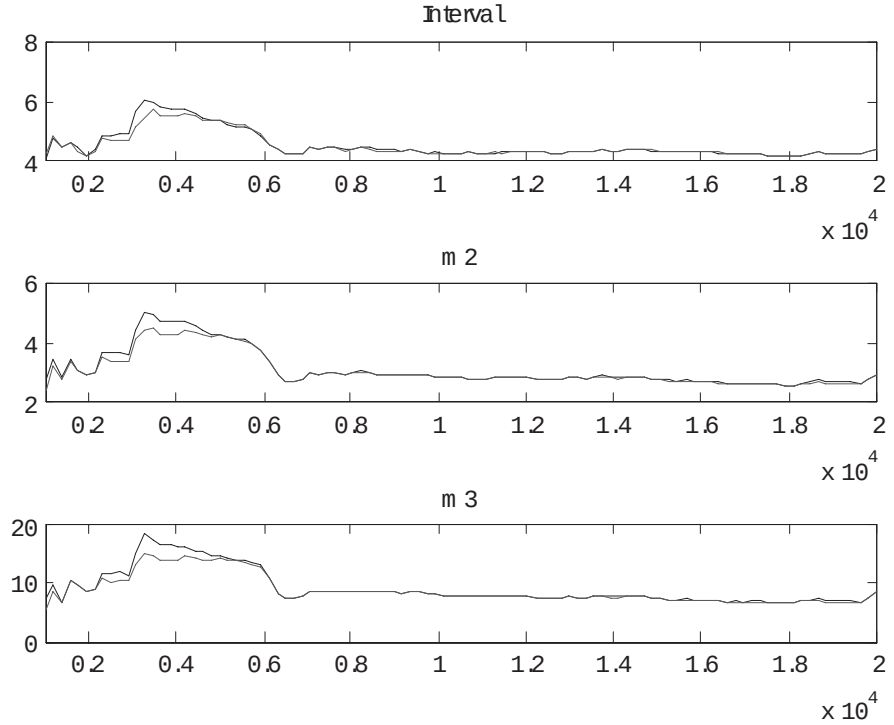


Figure 3. **Multivariate convergence diagnostics for CIA model**

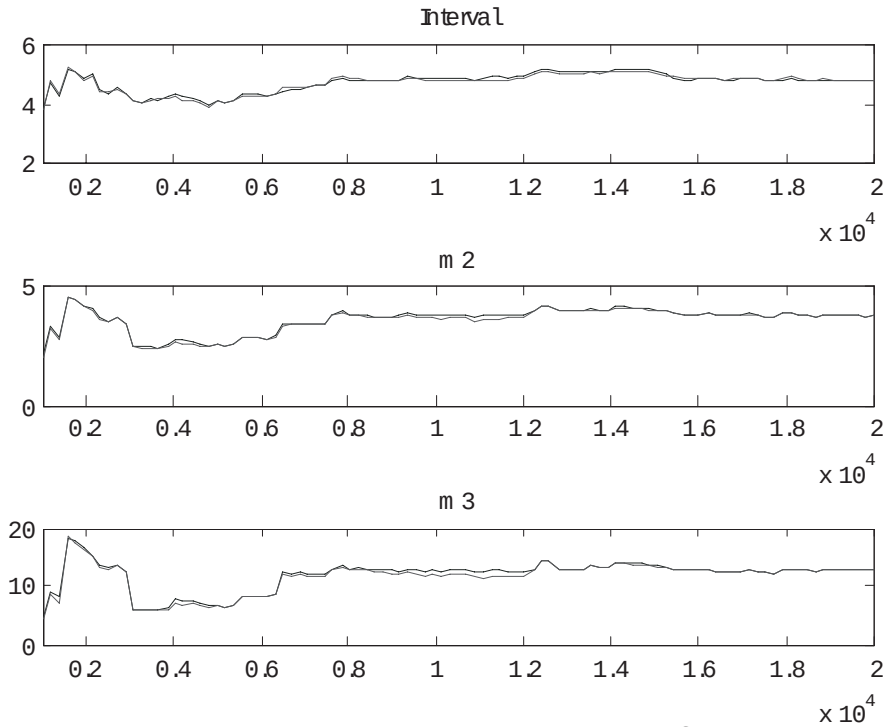


Figure 4. **Multivariate convergence diagnostics for CIA model with Endogenous Money**

The Bayesian estimation was done through 2 Markov chains of 10,000 Metropolis Hasting draws. However, any inference based on MCMC is on the assumption that the Markov chain has reached convergence. Therefore, the diagnosis of the MCMC convergence is very important to estimation and inference. Figures 3 and 4 report multivariate convergence diagnostics for 2 models, respectively. The multivariate statistics indicated that the convergences are achieved so that our estimate and inference are credible.

4.3. Bayesian comparison of the Models. Table 4, presenting the log-marginal likelihoods, gives the comparison of 2 estimations in terms of posterior odds ratio. The log-marginal likelihoods are the result of Bayesian estimations.

Table 4. **Bayesian estimation comparison**

Model	Log Marginal Likelihood	Log Bayesian Factor
Standard CIA model	505.644	-
Augmented CIA model	513.790	8.146

According to Jeffreys (1998) thumb rule, if a log-Bayesian factor[5] is higher than 2, the original model is superior to the alternative model; if the factor is less than 2, there is significantly no difference between 2 models. Obviously, the augmented CIA model is superior to the standard CIA model.

[5] Log-Bayesian factor = Log Marginal Likelihood of the original - Log Marginal Likelihood of the alternative.

5. Estimation and Comparison of Inflation Persistence. Fuhrer and Moore (1995) characterize inflation persistence in the US data using a vector autocorrelation function relating inflation and deviations of output from trend. In the vector autocorrelation function, both inflation and output are highly persistent and there are significant positive cross-correlations between inflation and output.

To learn more about the degree of the present model of inflation inertia simulation, this paper compares the autocorrelation coefficients of empirical and theoretical inflation persistence. We can see from Figure 5 that the real data has a high persistence in the first period, and then the autocorrelation coefficients descend quickly. The real data shows considerable persistence at first, and the persistence is weakened to zero after more than 3 years (12 lags). By comparison, it is found that CIA model with endogenous money capture more of inflation than the other.

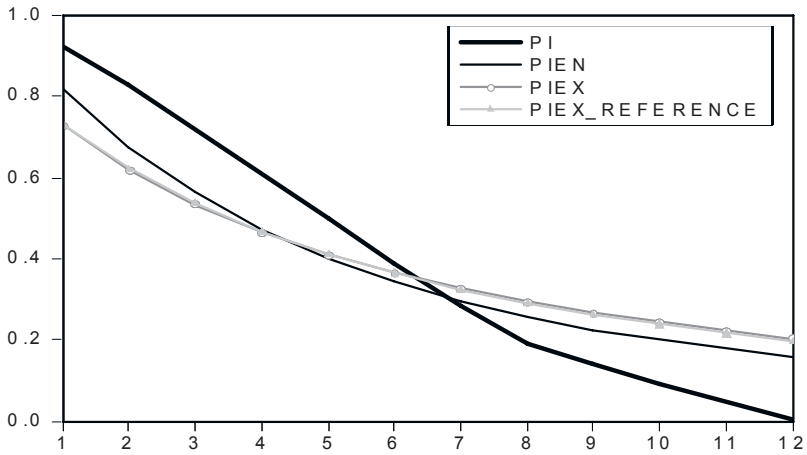


Figure 5. **Autocorrelation function of the inflation of the real data and analog data**

To obtain robust conclusions, we try the parameters estimated in the augmented CIA model into the standard CIA model, and find no difference in inflation persistence compared to the one before. In Figure 5, autocorrelation function of reference almost coincides with autocorrelation function of theoretical data with endogenous money. It is demonstrated that the superiority of the augmented CIA model is from the effect of propagation mechanism to inflation persistence rather than from the variance between fixed parameters.

Fuhrer (2006) argues that the sources of persistence are twofold. First, the "driving process" for inflation is quite persistent, and inflation must "inherit" this persistence. Second, backward-looking or indexing behavior imparts some "intrinsic" persistence to inflation. Since exogenous shocks, the production process, monetary policy and its transmission mechanism have a significant impact on the dynamic characteristics of inflation theoretically, this article attempts to change a few key parameters of the model, in order to measure the impact on inflation autocorrelation coefficients of external shocks, monetary policy as well as the change of production process.

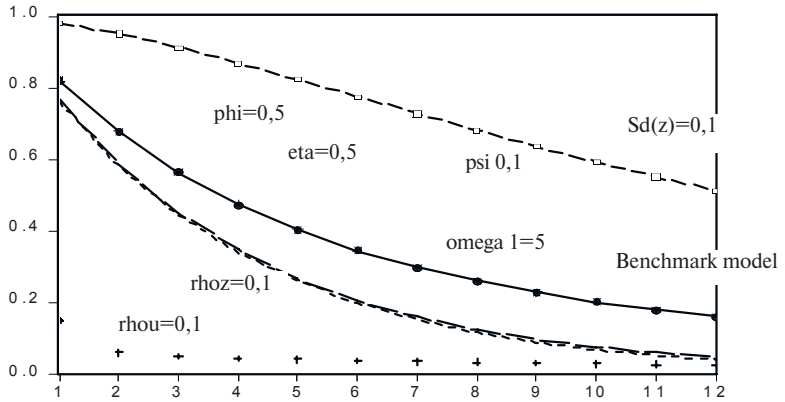


Figure 6. **Comparison with benchmark model by changing parameters**

As shown in Figure 6, the CIA model with endogenous money is treated as benchmark model. It is found that after the parameter η adjusted from 1.2644 to 0.5, η adjusted from 2.1963 to 0.5, ω_1 adjusted from 1.5566 to 5, there is no change in the inflation persistence, comparing with the benchmark model. In the figure, the curves, phi = 0.5, eta = 0.5, omega1 = 5, are almost coincident with the benchmark curve. But when ρ_z is adjusted from 0.9223 to 0.1, or ϕ is adjusted from 0.4719 to 0.1, inflation persistence descends significantly. What induces the biggest change in inflation persistence is adjusting ρ_u and σ_z. When ρ_u is fixed to 0.1 from 0.7629, inflation inertia decreases significantly to less than 0.2. When σ_z is set to 0.1 from 0.0038, inflation persistence is increased significantly, and the autocorrelation coefficient is close to 1.

In order to analyze the formation mechanism of inflation inertia in the DSGE model, this paper deduce i-order autocorrelation[6] function of the inflation, according to Fuhrer (2006) as follows:

$$\Gamma_i = \rho_u^i + \left(\frac{\rho_u^i - \rho_z^i}{\rho_u - \rho_z}\right)\frac{\phi Cov(\hat{\pi}_t, \hat{z}_t)}{Var(\hat{\pi}_t)} \tag{15}$$

where the initial value is

$$\Gamma_i = \rho_u + \frac{\phi Cov(\hat{\pi}_t, \hat{z}_t)}{Var(\hat{\pi}_t)} = \rho_u + \frac{\rho_z(1-\rho_u^2)\phi^2}{(1+\rho_u\rho_z)\phi^2 + (1-\rho_z^2)(1-\rho_u\rho_z)\frac{\sigma_u^2}{\sigma_z^2}} \tag{16}$$

It is composed of two parts: the first part decays by ρ_u; the second part is

$$\frac{\phi Cov(\hat{\pi}_t, \hat{z}_t)}{Var(\hat{\pi}_t)}$$

in the first period, and descends by

[6] See the derivation in the appendix.

$$\frac{\rho_u^i - \rho_z^i}{\rho_u - \rho_z}.$$

Γ_i depends on ρ_u, ρ_z, ϕ, σ_u^2 and σ_z^2. Obviously,

$$\frac{\partial \Gamma_i}{\partial \rho_u} > \frac{\partial \Gamma_i}{\partial \rho_z} > 0, \quad \frac{\partial \Gamma_i}{\partial \left(\sigma_u^2 / \sigma_z^2\right)} < 0, \quad \frac{\partial \Gamma_i}{\partial \phi} > 0.$$

which means that inflation persistence increase with ρ_u and ρ_z, and ρ_u matters than ρ_z; that the more variance ratio σ_u^2/σ_z^2 becomes, the less the initial value of inflation persistence becomes; the reaction coefficient ϕ descends which follows shrinking of the initial value. In short, the conclusions drawn from the auto-correlation function are similar to the results in Figure 6.

6. Conclusions. This paper builds 2 dynamic stochastic general equilibrium models with cash in advance constraint: one focuses on exogenous money; the other stresses on endogenous money. We try to capture the characteristics of inflation persistence, compare 2 models, and analyze the influencing factors of inflation inertia. Bayesian methods improve the credibility of the parameter estimated, and the main conclusions are as follows:

We can see from Bayesian estimation that technology shocks and monetary shocks following AR (1) process have a high autocorrelation coefficient; monetary shock has a positive response to the productivity shock so that the variance of productivity shock is less than the variance of monetary shock; in the augmented CIA model, $\omega_1 > \omega_2$ indicates that the monetary authority in China treats stable prices as the main target of monetary policy when balancing output gap and inflation. Due to convergence of Markov chain for Bayesian techniques, the estimation and inference are reliable.

The CIA model with endogenous money is superior to the standard CIA model. First, the posterior distribution of the augmented CIA model fits better in with the prior information; second, log marginal likelihood of the augmented CIA model is greater than the alternative model so that the former is superior to the latter; finally, inflation persistence curves report the CIA model with endogenous money is closer to the real situation. At the same time, inflation in the model inherits very much of the persistence of the driving process, the variance ratio σ_u^2/σ_z^2 and inflation persistence are positively related. Backward-looking behavior imparts some "intrinsic" persistence to inflation, and it is ρ_u that constitutes the dominant source of persistence.

There are some limitations in this study. (1) There is still a difference between empirical persistence and theoretical persistence, such as the real data has greater initial value and descends faster. (2) We only study flexible pricing situation, and in fact, sticky price assumption may be closer to the real world. Gali and Gertler (1999), Woodford (2003) and Fuhrer (2006) consider that the introduction of staggered price adjustment mechanism can increase the inertia of inflation, such as the New Keynesian Phillips curve can be obtained by staggered pricing model (Calvo, 1983) which showed that it can capture some features of the inflation dynamics. Therefore, this field deserves more research in future.

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