A comparison of an empirical stock-flow consistent model and a New Keynesian model of China

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Abstract

This paper develops an empirical ecological New Keynesian model under the same structure as an empirical ecological stock-flow model. Instead of having demand-led and endogenous money, the model is supply-driven, and money is neutral. To purely compare the differences between the theories, we employ the same methodology to estimate the parameters as in an empirical SFC framework, which does not rely on finding a steady state and calibration to data but uses long-term correction and is purely based on regression. We employ the implication of a DSGE model and transform it into structural equations. This allows us to compare the performance of the two models in terms of fitting the historical data. It shows that the New Keynesian model performs relatively poorly compared to the SFC model because the behaviour equations generated from the optimisation problem are more restricted. Then, we run baseline scenarios for prediction using the two models to compare the economic growth demand-led and supply-led. Lastly, we run a nominal wage increase shock. The baseline scenario shows that supply-led growth is much smoother and mainly driven by capital accumulation. On the contrary, household consumption is the main driver in the SFC model baseline scenario. Real GDP in the New Keynesian model shares a similar response to a positive nominal wage shock with the SFC model, but causes more unemployment because of the substitution effect between capital and labour. Unlike the results from the SFC model, a nominal wage increase may worsen income inequality and result in more air emissions in the New Keynesian model.

Keywords: *income inequality, stock-flow consistent modelling, energy balance, material emissions*
JEL codes: *D63, E12, Q43, Q58*

1 Introduction

> A model, we shall say, is a *story* with a specific structure: to explain this catch phrase is to explain what a model is. The *structure* is given by the logical and mathematical form of a set of postulates, the *assumptions* of the model. .... Often the assumptions of a model are chosen not to approximate reality, but to exaggerate or isolate some feature of reality. .... The hypothesis may be that the conclusions of an applied model are approximately true, and that that is because its assumptions are sufficiently close to the truth. In some such cases, the hypothesis is tested casually; in others, econometrically; quite different kinds of models lend themselves to the two kinds of testing. The hypothesis may, on the other hand, be that a conclusion of the applied model depicts a tendency of the situation, and that this is because the assumption caricature features of the situation and conclusion is robust under changes of caricature (Gibbard & Varian, 1978).

Economic models, as tools, have been evolving throughout history to explain economic phenomena. Starting from the Classical economics models, dominated by Marshall (1890), they could not solve the Great Depression during the 1930s. Those models identified high wages as the cause of high unemployment, but cutting wages did not solve the problem then. It gave rise to Keynesian economics, showing the link between the goods market and labour market, low demand for goods results in low demand for labour (Keynes, 1937). Hicks (1937) simplifies Keynes' idea into the well-known IS/LM model. Later, in the 1970s, the major challenge for macroeconomists was stagflation, which expansionary fiscal policy, as suggested by the IS/LM model, failed to solve. New tools were needed, giving rise to the Neo-classical theory and New Keynesian theory, which have become the mainstream economics until now. However, the failure to forecast the Global Financial Crisis in 2007 has brought attention to the financial side of the economy, i.e. credit. And the recent modelling needs to face Climate Change has brought researchers to seek alternative tools, e.g. heterodox economics (Fontana & Sawyer, 2016).

Stock-flow consistent (SFC) models, rooted back to the so-called pitiful approach, in Tobin's Nobel prize lecture (Tobin, 1982), were developed by Godley and Lavoie (2006), explicitly including the financial account in a demand-led model. This approach has flourished in studying ecological macroeconomics (Dafermos et al., 2017, Dafermos et al., 2018, Jacques et al., 2023, Carnevali et al., 2024).

Lavoie (2022) has criticised orthodox economics, arguing that the mainstream theory is unrealistic, and has given a list of theoretical proofs showing the limitations of orthodox economics in capital controversies and the Cobb-Douglas production function. However, the literature has no concrete example of comparing the two theories, New-Keynesian economics and Post-Keynesian economics.

This paper provides a modelling exercise on the case of China, comparing a New Keynesian model (based on Smets and Wouters, 2003) with an SFC model (An, 2024) in the same accounting structure. We employ the same methodology to estimate the parameters as in an empirical SFC framework, which does not rely on finding a steady state and calibration to data but uses long-term correction and is purely based on regression (Zezza & Zezza, 2019). We compare the two models in terms of fitting historical data, predicting the future, and responding to a nominal wage increase shock. Social policies, such as wage policy, could be as effective as green growth policy in reducing emissions and, additionally, achieve long-lasting reduction in inequality (D'Alessandro et al., 2020).

The following section describes the New Keynesian model. Section 3 provides a brief introduction to the data sources and parameter estimations. Section 4 presents the in-sample predictions of the New Keynesian and SFC models. Section 5 shows the baseline scenario for future predictions of the two models with a nominal wage increase shock. Lastly, section 6 concludes the paper and discusses the theoretical and technical issues.

2 The New Keynesian model

The ecological block contains the energy and material balance as in An (2024). Material and energy use are driven by real GDP. The share of renewable energy is exogenous, which determines the emission intensity. Energy intensity, emission to water intensity, and the coefficient of dissipative use of products depend on real GDP (Kaldor-Verdoon law) and income inequality (Boyce, 1994 and Jun et al., 2011), measured in Gini coefficient.

As in An (2024), the economy comprises five institutional sectors: households, firms, banks, governments, and the rest of the world (RoW). Households and governments consume the final good according to their consumption functions. Through investment decisions, households (mainly real estate acquisition), firms and governments (final good production) make investments. Banks receive deposits and issue bonds and loans. The Central Bank, which is included in the banking sector, runs an inflation-biased Taylor rule by adjusting the policy rate. Accounting equations, such as changes in loans and bonds, and the accumulation of assets and liabilities, are modelled to guarantee stock-flow consistency. The ecological block includes China's material and energy balance. They account for material and energy inflows and outflows linked to economic activities.

The New Keynesian model shares the same accounting equations with the empirical stock flow consistent model in An (2024), except that real GDP is supply driven, i.e. the production function. The main differences are the behaviour equations of the private sectors, i.e. households, firms and banks, which are derived from the optimisation problem of the agents and then verified by econometric regression based on historical data (Table 1).

Table 1: Behaviour equations

	Stock flow consistent	New Keynesian
Household consumption	Habit formation (+), income effect (+), wealth effect (+)	Final good equilibrium
Housing investment	Population (+)	Population (+), housing depreciation rate (-), shadow price (+), real housing price (-)
Firm investment	profit rate (+), capacity utilization (+)	Total factor productivity (+), firm lending rate (-), real price of capital (-), nominal wage (+)
Prices	Unit labour cost (+), import price (+), housing demand (+), exchange rate (-)	Nominal wage(+)
Production function	Leontieff	Cobb-Douglas
Labour productivity	Kaldor-Verdoorn law	Total factor productivity (+), nominal wage (+), firm lending rate (-), price of capital (-)
Nominal wage	CPI (+), labour productivity (+), unemployment rate (-),	Inflation (+), shadow price (+), employment share (+), social contribution rate (-)
Capital productivity	Kaldor-Verdoorn law, scale effect (-)	Total factor productivity (+), firm lending rate (+), real price of capital (+), nominal wage (-)
Financial assets/liabilities	Tobin profolio theory	Shadow price (+), rate of interest return (+), rate of interest payment (-), population (+)
Changes in inventories	Fixed share of real GDP	
Government consumption	Fixed share of real GDP	
Government investment	Government disposable income (+), price of capital (-), unemployment rate (+)	
Export	Foreign demand (+), export price (-), exchange rate (+), economic complexity index (+)	
Import	Fixed share of real GDP	
Exchange rate	Uncovered interest rate parity	
Central bank policy rate	Inflation biased Taylor rule	
Interest rates	Policy rate (+)	
Income inequality	Wage share (+), employment share (+), social benefits to GDP (+)	
Labour force	Population (+), unemployment rate (-)	

(+) denotes a positive effect and (-) denotes a negative effect.

2.1 Households

The model consists of a unit mass of 1 of representative households maximize their intertemporal utility with respect to consumption, $c_{h,t}$, housing, $k_{h,t}$, currencies, H_t, deposits, $D_{h,t}$, bonds held, $b_{h,t}$, and loans borrowed, $L_{h,t}$, subjected to their budget constraint,

$$\max_{c_{h,t},k_{h,t},H_t,D_{h,t},b_{h,t},L_{h,t}} E_t \sum_{t=0}^{\infty} \beta^t u^h(c_{h,t}, N_t, k_{h,t}, H_t, b_{h,t}, L_{h,t}) \tag{1}$$

$$\begin{aligned} s.t.\ P_{c,t}c_{h,t} + P_{k_h,t}k_{h,t} + H_t + D_{h,t} + P_{b_h,t}b_{h,t} - L_{h,t} \\ = (1-\tau_{sc,t})w_tN_t + (P_{k_h,t} - \delta_h P_{k_h,t-1})k_{h,t-1} + H_{t-1} + (1+r_{rh,t})D_{h,t-1} \\ + \left(\frac{P_{b_h,t}}{P_{b_h,t-1}} + r_{rh,t}\right) P_{b_h,t-1}b_{h,t-1} - (1+r_{ph,t})L_{h,t-1} + \Omega_{h,t}, \end{aligned} \tag{2}$$

where $0 < \beta < 1$ denotes the subjective discount factor of households, $u^h(\cdot)$ denotes the utility function of households, $P_{c,t}$ denotes the consumer price index, $P_{k_h,t}$ denotes the housing price, $P_{b_h,t}$ denotes the price of bonds, $\tau_{sc,t}$ denotes the social contribution payment rate, w_t denotes the nominal wage, N_t denotes employment, $\delta_{h,t}$ is the housing depreciation rate, $r_{rh,t}$ and $r_{ph,t}$ denote the rate of interest received and paid by households, respectively, and $\Omega_{h,t}$ includes other transactions in the household budget constraint that are not related to the optimization problem (see equation 76 in Appendix).

We solve the household problem by constructing a Lagrange function with the Lagrange multiplier, λ_t,

$$\begin{aligned} \mathcal{L} = E_t \sum_{t=0}^{\infty} \beta^t u^h(c_{h,t}, N_t, k_{h,t}, H_t, b_{h,t}, L_{h,t}) - \lambda_t \Big[P_{c,t}c_{h,t} + P_{k_h,t}k_{h,t} + H_t + D_{h,t} + P_{b_h,t}b_{h,t} - L_{h,t} \\ - (1-\tau_{sc,t})w_tN_t - (P_{k_h,t} - \delta_h P_{k_h,t-1})k_{h,t-1} - H_{t-1} - (1+r_{rh,t})D_{h,t-1} \\ - \left(\frac{P_{b_h,t}}{P_{b_h,t-1}} + r_{rh,t}\right) P_{b_h,t-1}b_{h,t-1} + (1+r_{ph,t})L_{h,t-1} - \Omega_{h,t} \Big]. \end{aligned} \tag{3}$$

Taking the partial derivative with respect to consumption, housing, currencies, deposits, bonds held and loans borrowed, we get the following first-order conditions,

$$0 = \frac{\partial \mathcal{L}}{\partial c_{h,t}} = \frac{\partial u_t^h}{\partial c_{h,t}} - \lambda_t P_{c,t}, \tag{4}$$

$$0 = \frac{\partial \mathcal{L}}{\partial k_{h,t}} = \frac{\partial u_t^h}{\partial k_{h,t}} - \lambda_t P_{k_h,t} + \beta E_t[\lambda_{t+1}(P_{k_h,t+1} - \delta_{h,t} P_{k_h,t})], \tag{5}$$

$$0 = \frac{\partial \mathcal{L}}{\partial H_t} = \frac{\partial u_t^h}{\partial H_t} - \lambda_t + \beta E_t \lambda_{t+1}, \tag{6}$$

$$0 = \frac{\partial \mathcal{L}}{\partial D_{h,t}} = -\lambda_t + \beta E_t[\lambda_{t+1}(1 + r_{rh,t+1})], \tag{7}$$

$$0 = \frac{\partial \mathcal{L}}{\partial b_{h,t}} = \frac{\partial u_t^h}{\partial b_{h.t}} - \lambda_t P_{b_h,t} + \beta E_t \left[\lambda_{t+1} \left(\frac{P_{b_h,t+1}}{P_{b_h,t}} + r_{rh,t+1} \right) P_{b_h,t} \right], \tag{8}$$

$$0 = \frac{\partial \mathcal{L}}{\partial L_{h,t}} = \frac{\partial u_t^h}{\partial L_{h.t}} + \lambda_t - \beta E_t \lambda_{t+1}(1 + r_{ph,t+1}). \tag{9}$$

Equation (4) gives us the shadow price, λ_t, equals the marginal utility of consumption deflated by CPI, $\frac{\partial u_t^h / \partial c_{h,t}}{P_{c,t}}$.

Combining equation (4) and (7), we get the Euler equation,

$$\frac{\partial u_t^h / \partial c_{h,t}}{P_{c,t}} = \beta E_t \left[\frac{\partial u_{t+1}^h / \partial c_{h,t+1}}{P_{c,t+1}} (1 + r_{rh,t}) \right]. \tag{10}$$

Assuming rational expectation and an Isoelastic utility for consumption, such that $\frac{\partial u_t^h}{\partial c_{h,t}} = c_{h,t}^{-\sigma}$, $0 < \sigma < 1$, we get,

$$\left(\frac{c_{h,t}}{c_{h,t-1}} \right)^{-\sigma} = \frac{1 + \pi_t}{\beta(1 + r_{rh,t})}, \tag{11}$$

where $\pi_t = \frac{\Delta P_{c,t}}{P_{c,t-1}}$ denotes CPI inflation.

The Euler equation shows the intertemporal substitution between current consumption and expected future consumption, which depends on the expected real deposit return of households, $\frac{1+r_{rh,t}}{1+\pi_t}$ and the subjective discount factor of households, β. However, we found no evidence from the data showing this relationship between household consumption and real deposit return (See Appendix Table 3). It is mainly because the explanatory variable, China's interest rate, remained relatively stable before the Great Financial crisis (Hongfei, 2023). Consequently, estimations of the elasticity of intertemporal are often small or insignificant (Hall, 1988; Koedijk and Smant, 1994; Yogo, 2004). We keep household consumption as an endogenous variable through final good market equilibrium in Section 2.4.

Combining equation (4) and (5), we have,

$$\frac{P_{k_h,t}}{P_{c,t}} \frac{\partial u_t^h}{\partial c_{h,t}} = \frac{\partial u_t^h}{\partial k_{h,t}} + \beta E_t \left[\frac{\partial u_{t+1}^h / \partial c_{h,t+1}}{P_{c,t+1}} (P_{k_h,t+1} - \delta_{h,t} P_{k_h,t}) \right]. \tag{12}$$

Assuming static expectation and rearranging the equation, we have,

$$\frac{\partial u_t^h}{\partial k_{h,t}} = [1 - \beta(1 - \delta_{h,t})] \frac{\partial u_t^h}{\partial c_{h,t}} \frac{P_{k_h,t}}{P_{c,h}}. \tag{13}$$

After empirical verification, we get the housing demand in our model,

$$\begin{aligned} \Delta \ln \frac{k_{h,t}}{POP_t} = {} & k_{h1} \Delta \ln \delta_{h,t} + k_{h2} \Delta \ln \frac{c_{h,t}}{POP_t} + k_{h3} \Delta \ln \frac{P_{k_h,t}}{P_{c,t}} \\ & + k_{h4} \left(\ln \frac{k_{h,t-1}}{POP_{t-1}} - k_{h5} - k_{h6} \ln \delta_{h,t-1} - k_{h7} \ln \frac{c_{h,t-1}}{POP_{t-1}} \right), \end{aligned} \tag{14}$$

where $k_{h1} < 0$ denotes the short-run elasticity of housing per capita to housing depreciation rate, $k_{h2} > 0$ denotes the short-run elasticity of housing per capita to household consumption per capita, $k_{h3} < 0$ denotes the short-run elasticity of housing per capita to real housing price per capita, $-1 < k_{h4} < 0$ is the long-run correction parameter of housing per capita, k_{h5} is the level of housing per capita in logarithm under full depreciation rate and household consumption per capita is 1 million rmb, $k_{h6} < 0$ is the long-run elasticity of housing per capita to housing depreciation rate, and $k_{h7} > 0$ is the long-run elasticity fo housing per capita to household consumption per capita.

Combining equation (4) and (6), we have,

$$\frac{\partial u_t^h}{\partial H_t} = \frac{\partial u_t^h / \partial c_t^h}{P_{c,t}} - \beta E_t \frac{\partial u_{t+1}^h / \partial c_{t+1}^h}{P_{c,t+1}}. \tag{15}$$

Assuming static expectation and rearranging the equation, we have,

$$\frac{\partial u_t^h}{\partial H_t} = (1-\beta)\frac{\partial u_t^h/\partial c_{h,t}}{P_{c,t}}. \tag{16}$$

After empirical verification, we get the currency demand in our model,

$$\Delta \ln \frac{H_t}{POP_t} = h_1 \Delta \ln \frac{c_{h,t}}{POP_t}, \tag{17}$$

where $h_1 > 0$ denotes the sensitivity of the growth rate of currency per capita to the growth rate of household consumption per capita.

Similarly, from equations (4) and (8), and by assuming $P_{b_h,t} = \frac{1}{r_{rh,t}}$ (Godley & Lavoie, 2006), we have household bonds demand,

$$\Delta \ln \frac{b_{h,t}}{POP_t} = b_{h1} \Delta \ln r_{rh,t}, \tag{18}$$

where $b_{h1} > 0$ is the sensitivity of the growth rate of household bonds per capita to the growth rate of interest rate received by households.

And, from equations (4) and (9), we have household loans borrowed,

$$\Delta \ln \frac{L_{h,t}}{POP_t} = l_{h1} \ln \frac{c_{h,t}}{POP_t}, \tag{19}$$

where $l_{h1} > 0$ is the sensitivity of the growth rate of household loans borrowed to the growth rate of household consumption.

Households supply a unit mass of one heterogeneous labourer. Labourers are bundled through a Dixit-Stiglitz constant elasticity substitution (CES) technology. The labour bundler solves the following profit maximisation problem,

$$\max_{N_{j,t}} w_t N_t - \int_0^1 w_{j,t} N_{j,t} dj \tag{20}$$

$$s.t.\ N_t = \left(\int_0^1 N_{j,t}^{\frac{\psi_n - 1}{\psi_n}}\right)^{\frac{\psi_n}{\psi_n - 1}}, \tag{21}$$

where $j \in [0,1]$ is the subscript of a specific type of labour, and $\psi_n \in (0,1) \cup (1,+\infty)$ is the elasticity of substitution between labours. Solving the first-order condition, we derive the specific labour demand for type j,

$$N_{j,t} = N_t \left(\frac{w_t}{w_{j,t}}\right)^{\psi_n}. \tag{22}$$

Substituting equation (22) into equation (21), we get the aggregation of wage,

$$w_t = \left(\int_0^1 w_{j,t}^{1-\psi_n} dj\right)^{\frac{1}{1-\psi_n}}. \tag{23}$$

We assume sticky wages à la Calvo (Calvo, 1983). In period t, a θ_w fraction of households cannot choose their wages and their wages only update with the inflation rate in a one-period delay, $w_{j,t} = (1+\pi_{t-1})w_{j,t-1}$. The other $1-\theta_w$ fractions of households that can choose wages in period t knows that, even choosing optimal wages $w_{j,t}^*$ for the period, it faces a θ_w^k probability of these wages equal $w_{j,t}\prod_{s=1}^k(1+\pi_{t+s-1})$ for k future periods. They solve the following optimisation problem to supply labour,

$$\max_{w_{j,t}} E_t \sum_{t=0}^{\infty} (\beta\theta_w)^k \left\{ u_t^h(N_{j,t+k}) - \lambda_{t+k}\left[-(1-\tau_{sc,t})w_{j,t}\prod_{s=1}^k(1+\pi_{t+s-1})N_{j,t+k}\right]\right\}, \tag{24}$$

$$s.t.\ N_{j,t+k} = N_{t+k}\left[\frac{w_{t+k}}{w_{j,t}\prod_{s=1}^k(1+\pi_{t+s-1})}\right]^{\psi_n}. \tag{25}$$

From the first-order condition, we derive the optimal wage for labour j,

$$w_{j,t}^* = \frac{\psi_n}{(1-\tau_{sc,t})(1-\psi_n)}\left[P_{c,t}\frac{\partial u_t^h/\partial N_t}{\partial u_t^h/\partial c_{h,t}} + E_t\sum_{k=1}^{\infty}\frac{(\partial u_{t+k}^h/\partial N_{t+k})P_{c,t+k}}{(\partial u_{t+k}^h/\partial c_{h,t+k})\prod_{s=1}^k(1+\pi_{t+s-1})}\right]. \tag{26}$$

Assuming static expectation, we have,

$$w_{j,t}^* = \frac{\psi_n(1+\pi_t)P_{c,t}\partial u_t^h/\partial N_t}{(1-\tau_{sc,t})(1-\psi_n)\pi_t\partial u_t^h/\partial c_{h,t}}. \tag{27}$$

Also, from equation (23), we get the aggregate wage,

$$w_t^{1-\psi_n} = \int_0^{\theta_w} [(1+\pi_{t-1}))w_{t-1}]^{1-\psi_n}dj + \int_{\theta_w}^1 (w_t^*)^{1-\psi_n}dj,$$

$$w_t = \{\theta_w[(1-\pi_{t-1})w_{t-1}]^{1-\psi_n} + (1-\theta_w)(w_t^*)^{1-\psi_n}\}^{\frac{1}{1-\psi_n}}. \tag{28}$$

After empirical verification, we get the labour supply in our model,

$$\begin{aligned}\Delta \ln w_t = w_1 \Delta \ln \frac{c_{h,t}}{POP_t} + w_2 \Delta \ln \frac{P_{c,t}}{1-\tau_{sc,t}} \\ + w_3 \left\{ \ln w_{t-1} - w_4 \ln[(1-\pi_{t-2})w_{t-2}] - w_5 \ln \frac{c_{h,t-1}}{POP_{t-1}} - w_6 \ln \frac{N_{t-1}}{POP_{t-1}} \right\},\end{aligned} \tag{29}$$

where $w_1 > 0$ denotes the short-run elasticity of nominal wage to real consumption per capita, $w_2 > 0$ denotes the short-run elasticity of of nominal wage to CPI over one minus social contribution rate, $-1 < w_3 < 0$ denotes the long-run correction parameter of nominal wage, $0 < w_4 < 1$ represents the stickiness of nominal wage, $w_5 > 0$ denotes the long-run elasticity of nominal wage to real consumption per capita, and $w_6 > 0$ denotes the elasticity of nominal wage to employment per capita.

2.2 Firms

The production process occurs in two processes; a unit mass of one wholesale firm produces heterogeneous intermediate goods, $y_{i,t}$, for $i \in [0,1]$, and competes in a monopolistic competition market; retail firms bundle intermediate goods to produce four types of final goods, namely, consumption good, capital good, housing, export good, and compete in a perfect competition market.

Wholesale firms employ fixed capital and labour to produce intermediate goods. They minimize their expenditure with respect to labour and fixed capital subject to their production technology in the form of a Cobb-Douglas function,

$$\min_{N_{i,t},k_{i,1f,t}} w_tN_{i,t} + r_{pf,t}P_{k_1,t-1}k_{i,1f,t-1} + \tau_{L_f,t}y_{i,t}, \tag{30}$$

$$s.t.\ y_{i,t} = TFP_{i,t}k_{i,1f,t-1}^{\alpha}N_{i,t}^{1-\alpha},\ 0<\alpha<1, \tag{31}$$

where $r_{pf,t}$ denotes the interest rate paid by firms, $P_{k_1,t}$ denotes the price of fixed capita, $k_{i,1f,t}$ denotes the fixed capital in volume of firm i, $0 < \tau_{L_f,t} < 1$ is the net production tax rate paid by firms, $TFP_{i,t}$ denotes the total factor productivity of firm i.

We divide both side of equation (31) by $TFP_{i,t}$ and $N_{i,t}$ (Solow, 1956),

$$\frac{y_{i,t}}{TFP_{i,t}N_{i,t}} = \left(\frac{k_{i,1f,t-1}}{N_{i,t}}\right)^{\alpha}. \tag{32}$$

Assuming wholesale firms are identical, we run the following regression and get our production equation in the model,

$$\Delta \ln \frac{y_t}{TFP_tN_t} = y_1 \Delta \ln \frac{k_{1f,t-1}}{N_t}, \tag{33}$$

where $y_1 \approx \alpha$ denotes the elasticity of effective labour productivity to capital labour intensity.

Let's denote $\mu_{i,t}$ as the marginal cost of production of wholesale firm i. We construct a Lagrange function to solve the above expenditure minimisation problem,

$$\mathcal{L}^f = w_tN_{i,t} + r_{pf,t}P_{k_1,t-1}k_{i,1f,t-1} + \tau_{L_f,t}y_{i,t} + \mu_{i,t}[y_{i,t} - TFP_{i,t}k_{i,1f,t-1}^{\alpha}N_{i,t}^{1-\alpha}]. \tag{34}$$

Solving the first-order condition, we have,

$$0 = \frac{\partial \mathcal{L}^f}{\partial N_{i,t}} = w_t - (1-\alpha)\mu_{i,t}\frac{y_{i,t}}{N_{i,t}}, \tag{35}$$

$$0 = \frac{\partial \mathcal{L}^f}{\partial k_{i,1f,t}} = E_t \left(r_{pf,t+1} P_{k_1,t} - \alpha \mu_{i,t+1} \frac{y_{i,t+1}}{k_{i,t}} \right). \tag{36}$$

Assuming static expectation, equation (36) becomes

$$r_{pf,t} P_{k_1,t} = \alpha \mu_{i,t} \frac{y_{i,t}}{k_{i,t}}. \tag{37}$$

One can derive the marginal cost of production from equations (30), (31), (35) and (36) (see Appendix),

$$\mu_{i,t} = \frac{1}{TFP_{i,t}} \left(\frac{w_t}{1-\alpha} \right)^{1-\alpha} \left(\frac{r_{pf,t} P_{k_1,t-1}}{\alpha} \right)^{\alpha} + \tau_{L_f,t}. \tag{38}$$

From equations (35) and (38), we run the following regression and get the determinant of labour demand in our model,

$$\Delta \ln \frac{y_t}{N_t} = n_1 \Delta \ln (r_{pf,t} P_{k_1,t}) + n_2 \Delta \ln w_t, \tag{39}$$

where $n_1 < 0$ denotes the sensitivity of the growth rate of labour productivity to the growth rate of capital cost of production and $n_2 > 0$ denotes the sensitivity of the growth rate of labour productivity to the growth rate of labour cost of production, i.e. nominal wage.

Similarly, from equations (36) and (38), we have capital demand in the model determined by,

$$\Delta \ln \frac{y_t}{k_{1f,t}} = k_1 \Delta \ln TFP_t + k_2 \Delta \ln (r_{pf,t} P_{k_1,t}) + k_3 \Delta \ln w_t + k_4 \left(\ln \frac{y_{t-1}}{k_{1f,t-1}} - k_5 - k_6 \ln TFP_{t-1} - k_7 \ln w_{t-1} \right), \tag{40}$$

where $k_1 > 0$ denotes the short-run elasticity of capital productivity to total factor productivity, $k_2 > 0$ denotes the short-run elasticity of capital productivity to the capital cost of production, $k_3 < 0$ denotes the short-run elasticity of capital productivity to the labour cost of production, $-1 < k_4 < 0$ denotes the long-run correction parameter of capital productivity, k_5 is the level of capital productivity in logarithm when total factor productivity equals one and nominal wage equals 1 million rmb, $k_6 > 0$ denotes the long-run elasticity of capital productivity to total factor productivity, and $k_7 < 0$ denotes the long-run elasticity of capital productivity to nominal wage.

Retail firms buy the intermediate goods produced by the wholesale firms and produce final goods through a Dixit-Stiglitz CES technology. They solve the following profit maximisation problem,

$$\max_{y_{i,t}} \pi_t = P_t y_t - \int_0^1 P_{i,t} y_{i,t} di, \tag{41}$$

$$s.t. \; y_t = \left(\int_0^1 y_{i,t}^{\frac{\psi-1}{\psi}} \right)^{\frac{\psi}{\psi-1}}, \tag{42}$$

where $\psi \in (0,1) \cup (1,+\infty)$ denotes the elasticity of substitution between intermediate goods. Solving the first-order condition, we derive the demand for intermediate good i,

$$y_{i,t} = \left(\frac{y_t}{y_{i,t}} \right)^{\psi}. \tag{43}$$

Substituting equation (43) into equation (42), we get the aggregation of price,

$$P_t = \left(\int_0^1 P_{i,t}^{1-\psi} di \right)^{\frac{1}{1-\psi}}. \tag{44}$$

Similarly to sticky wages, we assume sticky prices à la Calvo (Calvo, 1983). In period t, a θ fraction of wholesale firms cannot change their prices and their only update is with the inflation rate in one period delay, $P_{i,t} = (1+\pi_{t-1})P_{i,t-1}$. The other $1-\theta$ fractions of whole-sale firms that can choose prices in period t know that, even choosing optimal prices $P^*_{i,t}$ for the period, it faces a θ^k probability of these prices equal $P_{i,t} \prod_{s=1}^{k} (1+\pi_{t+s-1})$ for k future periods. They solve the following profit maximisation problem to set prices,

$$\max_{P_{i,t}} E_t \sum_{k=0}^{\infty} (\beta\theta)^k \left[P_{i,t} \prod_{s=1}^{k} (1+\pi_{t+s-1}) y_{i,t+k} - \mu_{i,t+k} y_{i,t+k} \right], \tag{45}$$

$$s.t.\ y_{i,t+k} = y_{t+k} \left[\frac{P_{t+k}}{P_{i,t} \prod_{s=1}^{k} (1+\pi_{t+s-1})} \right]^{\psi}. \tag{46}$$

From the first-order condition, we derive the optimal price for wholesale firm i,

$$P_{i,t}^* = \frac{\psi}{\psi - 1} \left[\mu_{i,t} + E_t \sum_{k=1}^{\infty} \frac{\mu_{i,t+k}}{\prod_{s=1}^{k}(1+\pi_{t+s-1})} \right]. \tag{47}$$

Assuming static expectation, we have,

$$P_{i,t}^* = \frac{\psi(1+\pi_t)}{(\psi-1)\pi_t} \mu_{i,t}. \tag{48}$$

Also, from equation (44), we get the aggregate price,

$$P_t^{1-\psi} = \int_0^{\theta} [(1+\pi_{t-1})P_{t-1}]^{1-\psi} di + \int_{\theta}^{1} (P_t^*)^{1-\psi} di,$$

$$P_t = \{\theta[(1-\pi_{t-1})P_{t-1}]^{1-\psi} + (1-\theta)(P_{t^*})^{1-\psi}\}^{\frac{1}{1-\psi}}. \tag{49}$$

After empirical verification, we get CPI, price of fixed capital, price of housing and price of exports, $P_{x,t}$, in our model,

$$\Delta \ln P_{\zeta,t} = p_{\zeta 1} \Delta \ln w_t, \tag{50}$$

where $\zeta = c_h, k_1, k_h, x$ denotes the subscript for consumption goods, fixed capital, housing and exports, respectively. $p_{\zeta 1} > 0$ is the sensitivity of the price growth of a specific final good to the growth of the nominal wage.

As for firm financial investment or borrowing decision, they have preferences in saving deposits, $D_{f,t}$, borrowing bonds, $b_{f,t}$, and investing abroad in the form of outward foreign direct investment (FDI), $fdi_{out,t}$.[1] They maximise their utility with respect to these financial instruments, subject to their budget constraint,

$$\max_{D_{f,t}, b_{f,t}, fdi_{out,t}} E_t \sum_{t=0}^{\infty} \beta^t u^f(D_{f,t}, b_{f,t}, fdi_{out,t}), \tag{51}$$

$$\begin{aligned} s.t.\ & D_{f,t} + (P_{b_f,t} - r_{pf,t} P_{b_f,t-1}) b_{f,t-1} + P_{fdi_{out},t} fdi_{out,t} \\ &= (1 + r_{rf,t} - r_{pf,t}) D_{f,t-1} + P_{b_f,t} b_{f,t} + [P_{fdi_{out},t} + (\gamma_{DIV_{rf}} - r_{pf,t}) P_{fdi_{out},t-1}] fdi_{out,t-1} + \Omega_{f,t}, \end{aligned} \tag{52}$$

where $u^f(\cdot)$ denotes the utility function of firms, $P_{b_f,t}$ denotes the price of firm bonds, $P_{fdi_{out},t}$ denotes the price of outward foreign direct investment, $r_{rf,t}$ and $r_{pf,t}$ denote the rate of interest received and paid by firms, respectively. $\gamma_{DIV_{rf}}$ denotes the dividend rate received by firms, and $\Omega_{f,t}$ includes other transactions in the firm budget constraint that are not related to the optimization problem (see Appendix equation 87). Since the subjective discount factor is already determined by household deposit demand, i.e. the Euler equation (equation 10), we consider firm loan interest payment as an opportunity cost when they save in deposits, borrowed through bond, or invest abroad through outward FDI in equation (52).

We construct a Lagrange function as in the household problem with the shadow price, λ_t, as the multiplier,

$$\begin{aligned} \mathcal{L}^{\mathcal{F}} = E_t \sum_{t=0}^{\infty} \beta^t \{ & u^f(D_{f,t}, b_{f,t}, fdi_{ou,t}) \\ & - \lambda_t [D_{f,t} + (P_{b_f,t} - r_{pf,t} P_{b_f,t-1}) b_{f,t-1} + P_{fdi_{in},t} fdi_{out,t} - (1 + r_{rf,t} - r_{pf,t}) D_{f,t-1}] \} \end{aligned} \tag{53}$$

Taking the partial derivative with respect to deposits, bonds, and outward FDI, we get the following first-order conditions,

$$0 = \frac{\partial \mathcal{L}^{\mathcal{F}}}{\partial D_{f,t}} = \frac{\partial u_t^f}{\partial D_{f,t}} - \lambda_t + \beta E_t \lambda_{t+1} (1 + r_{rf,t+1} - r_{pf,t+1}), \tag{54}$$

[1] The purpose of assuming preferences on firm assets and liabilities is to derive the demand or supply of these assets and liabilities from the optimization problem through a non-linear utility function.

$$0 = \frac{\partial \mathcal{L}^{\mathcal{F}}}{\partial b_{f,t}} = \frac{\partial u_t^f}{\partial b_{f,t}} + \lambda_t (P_{b_f,t} - r_{pf,t} P_{b_f,t-1}) - \beta E_t \lambda_{t+1} P_{b_f,t+1}, \tag{55}$$

$$0 = \frac{\partial \mathcal{L}^{\mathcal{F}}}{\partial fdi_{out,t}} = \frac{\partial u_t^f}{\partial fdi_{out,t}} - \lambda_t P_{fdi_{out},t} + \beta E_t \lambda_{t+1} [P_{fdi_{out},t+1} + (\gamma_{DIV_{rf}} - r_{pf,t+1}) P_{fdi_{out},t}]. \tag{56}$$

Similarly to the household problem, from equations (4) and (54), we get firm deposit demand,

$$\Delta \ln \frac{D_{f,t}}{POP_t} = d_{f1} \Delta \ln \frac{c_{h,t}}{POP_t} + d_{f2} \left[\ln \frac{D_{f,t-1}}{POP_{t-1}} - d_{f3} - d_{f4} \ln \frac{c_{h,t-1}}{POP_{t-1}} - d_{f5}(r_{rf,t-1} - r_{pf,t-1}) \right], \tag{57}$$

where $d_{f1} > 0$ denotes the short-run elasticity of firm deposit per capita to real household consumption per capita, $-1 < d_{f2} < 0$ denotes the long-run correction parameter of firm deposit per capita, d_{f3} denotes the level of firm deposit per capita in logarithm when household consumption per capita equals 100 million rmb and the rate of interest received and paid by firms are equal, $d_{f4} > 0$ denotes the long-run elasticity of firm deposit per capita to real household consumption per capita, and $d_{f5} > 0$ denotes the semi-elasticity of firm deposit per capita to the difference between the rates of interest received and paid by firms.

From equations (4) and (55), we get firm bond supply,

$$\Delta \ln \frac{b_{f,t}}{POP_t} = b_{f1} \Delta \ln \frac{c_{h,t}}{POP_t}, \tag{58}$$

where $b_{f1} > 0$ denotes the sensitivity of the growth rate of firm bond in volume per capita to the growth rate of real household consumption per capita.

And from equations (4) and (56), we get outward FDI demand,

$$\begin{aligned} \Delta \ln \frac{fdi_{out,t}}{POP_t} &= fdi_{out1} \Delta \ln \frac{c_{h,t}}{POP_t} \\ &+ fdi_{out2} \left(\ln \frac{fdi_{out,t-1}}{POP_{t-1}} - fdi_{out3} - fdi_{out4} \ln \frac{c_{h,t-1}}{POP_t - 1} - fdi_{out5} \ln \frac{P_{fdi_{out},t-1}}{P_{c,t-1}} \right), \end{aligned} \tag{59}$$

where $fdi_{out1} > 0$ denotes the short-run elasticity of outward FDI in volume per capita to real household consumption per capita, $-1 < fdi_{out2} < 0$ denotes the long-run correction parameter of outward FDI in volume per capita, fdi_{out3} denotes the level of outward FDI in volume per capita in logarithm when real households consumption per capita equal 100 million rmb and the price outward FDI equal CPI, $fdi_{out4} > 0$ denotes the long-run elasticity of outward FDI in volume per capita to real household consumption per capita, $fdi_{out5} < 0$ denotes the elasticity of outward FDI in volume per capita to the price of inward FDI deflated by CPI.

2.3 Banks

Banks set interest rates based on the policy rate. They receive currencies and deposits, buy bonds, and provide loans to the other sectors. Bank fixed capital, $k_{1b,t}$, interbank assets and liabilities, i.e. deposits held by banks, $D_{b,t}$, and bonds issued by banks $B_{lb,t}$, is determined by the following optimization problem, subject to bank budget constraint,

$$\max_{k_{1b,t}, D_{b,t}, b_{lb,t}} E_t \sum_{t=0}^{\infty} u^b(D_{b,t}, b_{lb,t}), \tag{60}$$

$$\begin{aligned} s.t.\ & P_{k_1,t} k_{1b,t} + D_{b,t} + (1 + r_{pb,t}) P_{b_{lb},t-1} b_{lb,t-1} \\ &= (1 - \tau_{L_b,t}) P_{y,t} y_{b,t} + (P_{k_1,t} - \delta_b) k_{1b,t-1} + (1 + r_{rb,t}) D_{b,t-1} + P_{b_{lb},t} b_{lb,t} + \Omega_{b,t}, \end{aligned} \tag{61}$$

where $u^b(\cdot)$ denotes the utility function of banks, $r_{pb,t}$ denotes the rate of interest paid by banks, $P_{b_{lb},t-1}$ denotes the price of bank bond issued, $\tau_{L_b,t}$ denotes the net production tax rate paid by banks, $P_{y,t}$ denotes the GDP deflator, $y_{b,t}$ denotes bank value added in volume, δ_b denotes bank fixed capital depreciation rate, $r_{rb,t}$ denotes the rate of interest received by banks, and $\Omega_{b,t}$ includes other transactions in the bank budget constraint that are not related to the optimization problem (see equation 92 in Appendix).

We construct a Lagrange function as in the household and firm problems with the shadow price, λ_t, as the multiplier,

$$\mathcal{L}^b = E_t \sum_{t=0}^{\infty} \beta^t \{u^b(D_{b,t}, b_{lb,t}) - \lambda_t [P_{k_1,t} k_{1b,t} + D_{b,t} + (1 + r_{pb,t}) P_{b_{lb},t-1} b_{lb,t-1}$$
$$- (1 - \tau_{L_b,t}) P_{y,t} y_{b,t} - (P_{k_1,t} - \delta_b) k_{1b,t-1} - (1 + r_{rb,t}) D_{b,t-1} - P_{b_{lb},t} b_{lb,t} - \Omega_{b,t}]\}. \quad (62)$$

Taking the partial derivative with respect to fixed capital in volume, deposits held, and bonds issued, we get the following first-order conditions,

$$0 = \frac{\partial \mathcal{L}^b}{\partial k_{1b,t}} = -\lambda_t \left[P_{k_1,t} - (1 - \tau_{L_b,t}) P_{y,t} \frac{\partial y_{b,t}}{\partial k_{1b,t}} \right] + \beta E_t \lambda_{t+1} (P_{k_1,t+1} \delta_{b,t+1} P_{k_1,t}), \quad (63)$$

$$0 = \frac{\partial \mathcal{L}^b}{\partial D_{b,t}} = \frac{\partial u_t^b}{\partial D_{b,t}} - \lambda_t + \beta E_t \lambda_{t+1} (1 + r_{rb,t+1}), \quad (64)$$

$$0 = \frac{\partial \mathcal{L}^b}{\partial b_{lb,t}} = \frac{\partial u_t^b}{\partial b_{lb,t}} + \lambda_t P_{b_{lb},t} - \beta E_t \lambda_{t+1} (1 + r_{pb,t+1}) P_{b_{lb},t}. \quad (65)$$

Combining equations (4) and (63), and by assuming $y_{b,t} = TFP_t k_{1b,t}^{\alpha_b}$, $0 < \alpha_b < 1$, we get bank fixed capital demand after empirical verification,

$$\Delta \ln \frac{k_{1b,t}}{POP_t} = k_{b1} \Delta \ln \left[\frac{(1 + r_{rh,t})(1 - \tau_{L_b,t}) P_{y,t} TFP_t}{(r_{rh,t} + \delta_{b,t}) P_{k_1,t}} \right], \quad (66)$$

where $k_{b1} > 0$.

Similarly to household and firm problems, from equations (4) and (64), we get bank deposit demand,

$$\Delta \ln \frac{D_{b,t}}{POP_t} = d_{b1} \Delta \ln \frac{c_{h,t}}{POP_t} + d_{b2} \Delta \ln r_{rb,t}, \quad (67)$$

where $d_{b1} > 0$ and $d_{b2} > 0$ denote the sensitivity of the growth rate of bank deposits held per capita to the growth rate of household consumption per capita and to the growth rate of bank interest rate received, respectively.

And, from equation (4) and (91), we get bank bond supply,

$$\Delta \ln \frac{b_{lb,t}}{POP_t} = b_{lb1} \pi_t, \quad (68)$$

where $b_{lb1} > 0$ denotes the sensitivity of the growth rate of bank bonds issued per capita to CPI inflation.

2.4 Final good market

Household consumption closes the final good market,

$$c_{h,t} = y_t - (c_{g,t} + i_{1f,t} + i_{1b,t} + i_{1g,t} + i_{h,t} + i_{2f,t} + i_{2g,t} + x_t - m_t + nx_{adj,t} - eo_t + y_{adj,t}), \quad (69)$$

where $c_{g,t}$ denotes government consumption in volume, $i_{1f,t}$ denotes firm fixed capital formation in volume, $i_{1b,t}$ denotes bank fixed capital formation in volume, $i_{1g,t}$ denotes government fixed capital formation in volume, $i_{h,t}$ denotes housing investment in volume, $i_{2f,t}$ and $i_{2g,t}$ denotes changes in firm and government inventories, respectively, x_t denotes exports in volume, m_t denotes imports in volume, $nx_{adj,t}$ denotes net exports adjustment in volume, eo_t denotes total errors and omissions in volume, $y_{adj,t}$ denotes real GDP adjustment.

3 Data and parameters

We employ the same data set of An (2024) with an additional variable, total factor productivity, from the Federal Reserve Economic Data (FRED). Table 4 in the Appendix gives an overall description of parameters for the New Keynesian model behaviour equations in Section 2. Parameters in the behaviour equations are estimated by running simple OLS regressions with the Durbin-Watson test to ensure they do not reject the homoskedasticity hypothesis. Moreover, we run Augmented Dickey-Fuller (ADF) tests on the residuals to ensure co-integrations between the variables. Other parameters, such as ratios and shares, are calculated based on the data, same with An (2024).

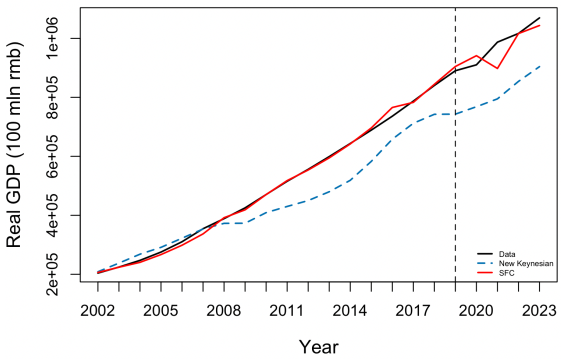
4 Model validation

We run an in-sample prediction to check the model's performance. Specifically, we run a dynamic simulation of the model from 2002 to 2023 and compare it with the data and the in-sample prediction of the SFC model in An (2024).[2] Endogenous variables only employ the 2002 values as the initial values. Exogenous variables employ the data. Ratios and shares become moving parameters and employ the data.

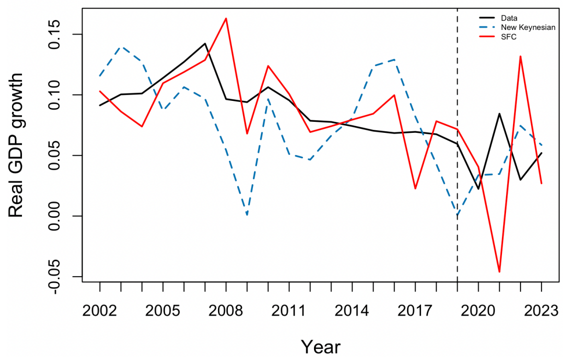
Figure 1 shows the in-sample prediction results. The solid black line represents the data. The solid red line is the in-sample prediction of An (2024). The blue dashed line is the in-sample prediction of the New-Keynesian model. The vertical dashed line represents the year 2019, which is the last period of available data for the stock variables. Compared to the SFC model, the New-Keynesian model performs some business cycle features and underestimates GDP growth in the long run. (Figure 1a, 1b). It can also be observed from the production inputs, fixed capital of firms and labour (Figure 1c and 1d). The New-Keynesian model performs more stably than the SFC model in predicting CPI inflation (Figure 1e). The Gini coefficient is more volatile because of the volatility of the unemployment rate (Figure 1f). The financial side is poorly predicted (Figure 1i). Energy intensity fluctuates significantly because of the fluctuation of real GDP and Gini coefficient (Figure 1i). Emissions to air, dissipative use of products and emissions water fit relatively bad with the data, compared to the SFC model (Figure 1j, 1k and 1l).

Overall, the New-Keynesian model in the paper performs worse than the SFC model in fitting the historical trend, except for price inflation. Our results partly provide evidence that New-Keynesian models, e.g., DSGE models, aim to explain the economy in the short run, but not to describe longer-run movements in capital, output, or employment (Vines & Wills, 2020).

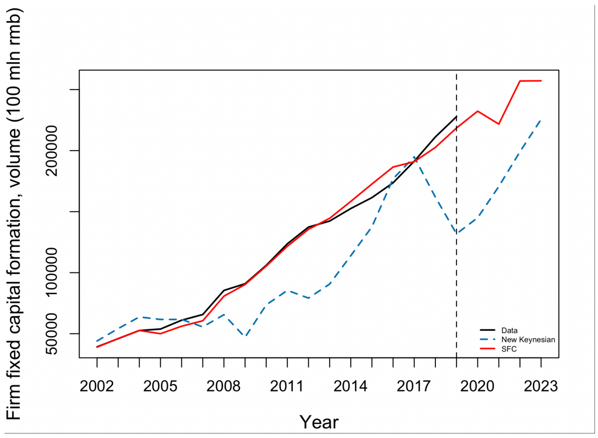
[2] A dynamic simulation accumulates model errors over time. We could also run a static simulation, which will have a better performance but only show model errors of each year because it employs the data for the lagged variables. This model is built for future scenario prediction. It would be reasonable to check the model validation dynamically.



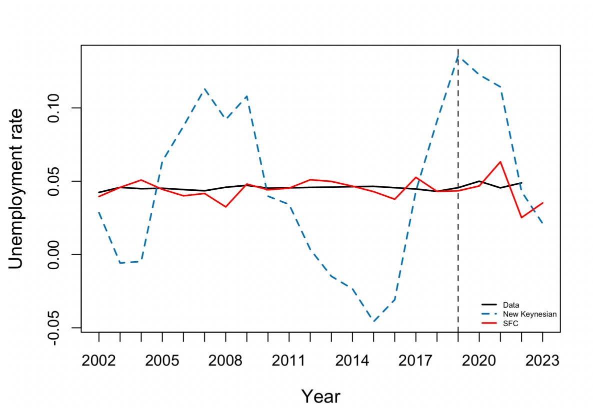
(a) Real GDP



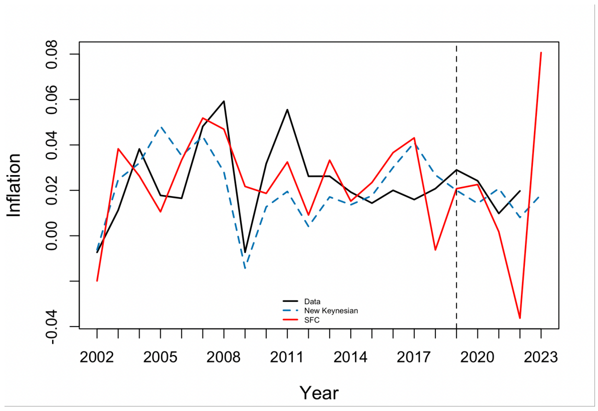
(b) Real GDP growth



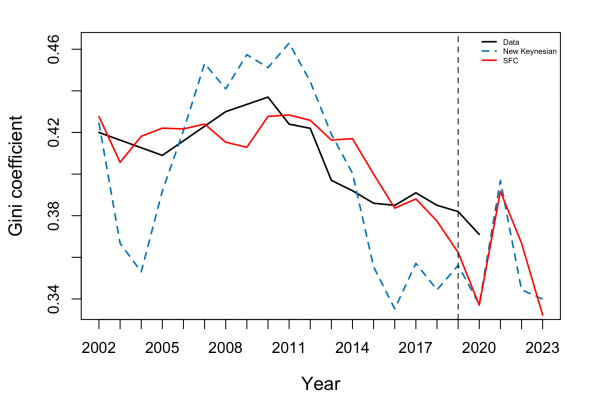
(c) Firm investment



(d) Unemployment rate



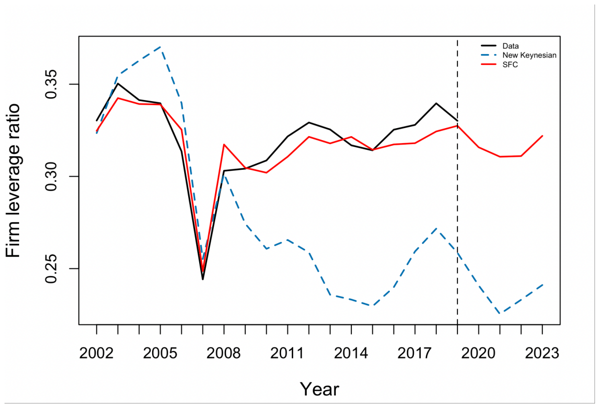
(e) Inflation



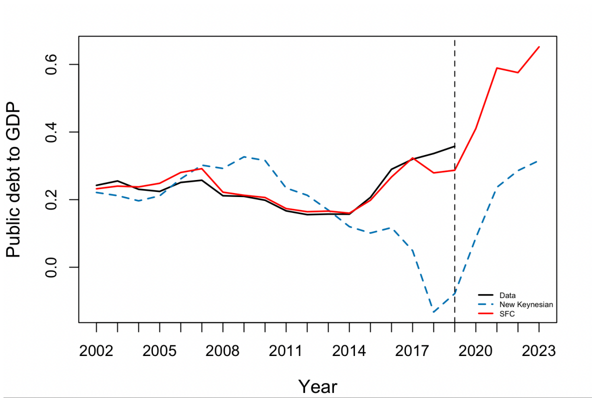
(f) Gini coefficient

Figure 1: In-sample prediction

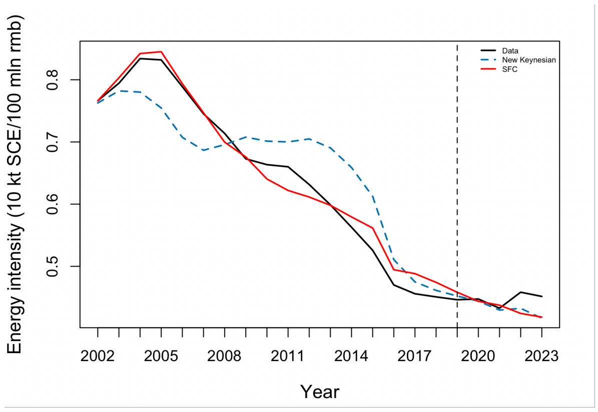
Note: The black solid line is the data. The red solid line is the in-sample prediction of An (2024). The blue dashed line represents the in-sample prediction of the New Keynesian model. The black vertical dashed line is the year 2019, which is the last period of data availability for the stock variables.



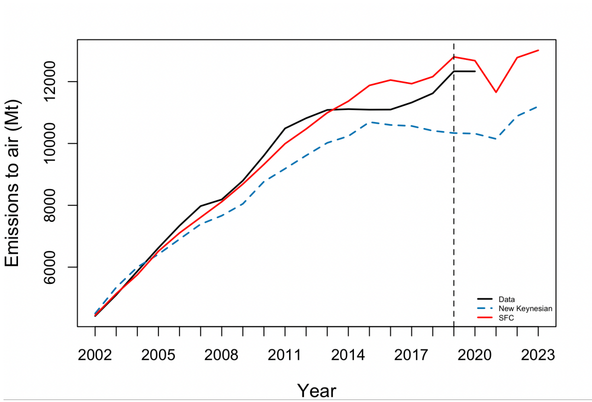
(g) Firm leverage ratio



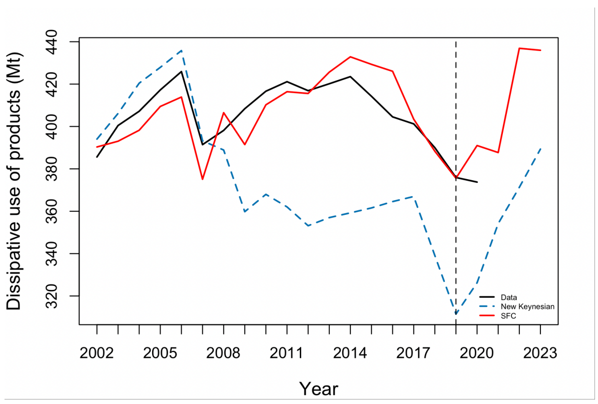
(h) Public debt to GDP



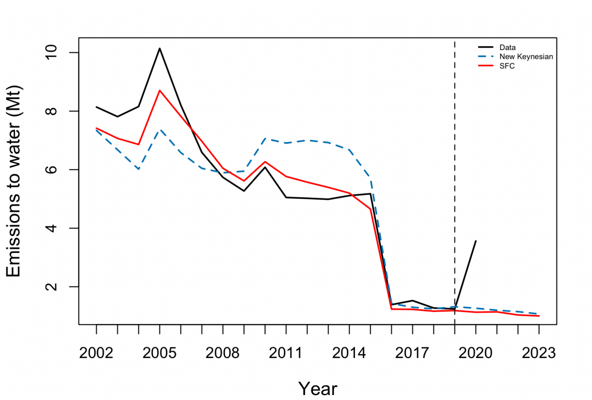
(i) Energy intensity



(j) Emissions to air



(k) Dissipative use of products



(l) Emissions to water

Figure 1: In-sample prediction

Note: The black solid line is the data. The red solid line is the in-sample prediction of An (2024). The blue dashed line represents the in-sample prediction of the New Keynesian model. The black vertical dashed line is the year 2019, which is the last period of data availability for the stock variables.

5 Prediction

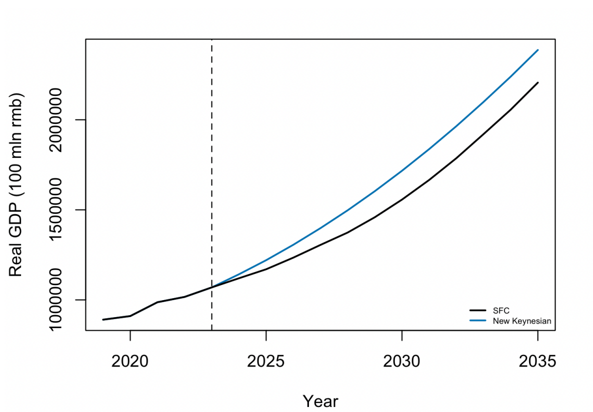
In this section, we run a model's baseline scenario from 2019 to 2035 as a prediction reference. Then, we run a wage policy scenario (nominal wage increases by 1%). We compare the wage policy scenario with the baseline to check its impulse response and with the same impulse responses of the SFC model.

We utilise the latest available data for the variables and extrapolate the exogenous variables under specific assumptions. We assume that all adjustment variables, errors and omissions, and other changes in values are 0. For exogenous domestic prices, we use the 4-year mean growth rate of the last eight years to extrapolate them, i.e. $\left[\frac{Mean(Variable_{t-8}, Variable_{t-7}, Variable_{t-6}, Variable_{t-5})}{Mean(Variable_{t-4}, Variable_{t-3}, Variable_{t-2}, Variable_{t-1})}\right]^{\frac{1}{4}} - 1$. We assume that the nominal foreign GDP grows at a rate of 5% and the foreign price, i.e., the import price, grows at a rate of 3%. The population uses the prediction of the World Bank. The share of renewable energy is expected to grow at a rate of 2.57% to reach 25% in 2030, which is one of the policy goals of China (14th Five-Year Plan). Other shares and ratios are assumed to be constant. For the New Keynesian model, we assume total factor productivity remain constant after 2019.[3]

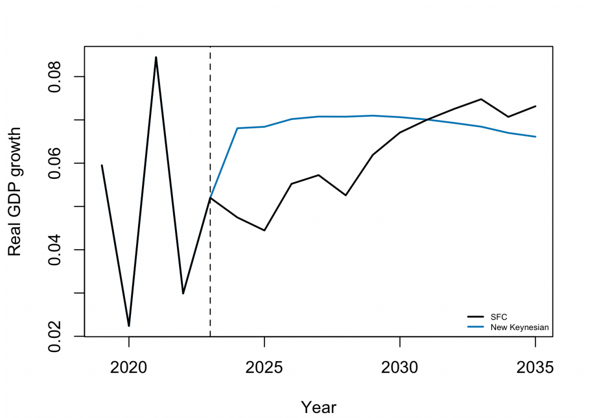
5.1 Baseline

Figure 2 shows the prediction simulation results. The solid black line is the simulation of the SFC model. The solid blue line is the simulation of the New Keynesian model. The vertical dashed line indicates the end of the data period, at which point the simulation results begin to display. The New Keynesian model shows a smoother economic growth than the SFC model (Figures 2a and 2b). Capital accumulation is the primary driver of economic growth in the New Keynesian model, while household consumption is the main driver of economic growth in the SFC model (Figures 2c and 2d). Inflation in the New Keynesian is exceptionally stable, remaining around 1.5% for a decade (Figure 2e). The simulation of unemployment shows a larger inverted hump-shape than the SFC model (Figure 2f). Income inequality decreases in large part in the long run due to the increase in the wage share (Figures 2g and 2h). Emissions to air intensity decrease over time due to the commitment to the green transition and due to the decreasing energy intensity resulting from GDP growth and decreasing income inequality (Figure 2i). Emissions to air still increase over time due to economic growth, showing that the green transition alone is not enough to stop the increase in emissions to air, which is one of China's policy objectives (14th Five-Year Plan). However, the New Keynesian model shows less air emissions in the long run due to less income inequality (Figure 2j). Similarly, the dissipative use of products in the New Keynesian model slows down in the long run (Figure 2k). However, there is no significant difference in emissions to water between the New Keynesian model and the SFC model (Figure 2l).

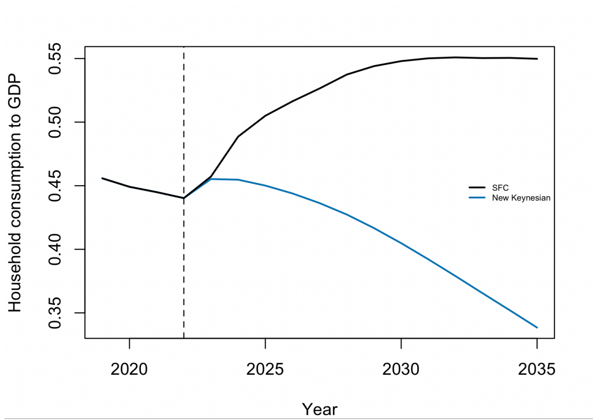
[3]We do not find any reliable future prediction on China's total factor productivity.



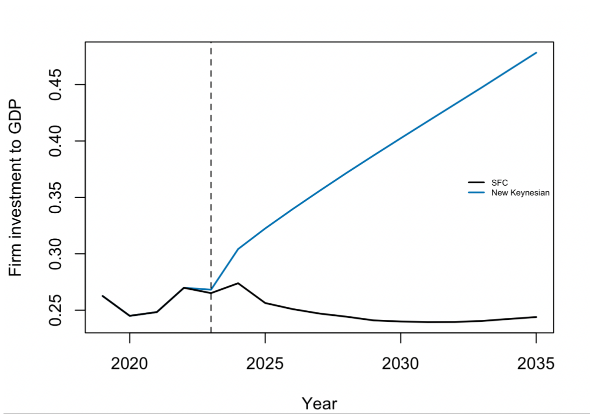
(a) Real GDP



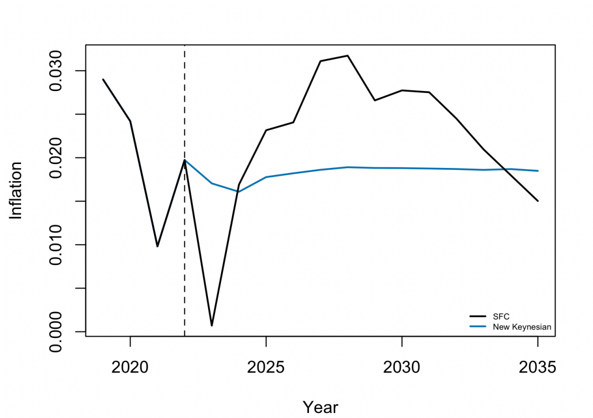
(b) Real GDP growth



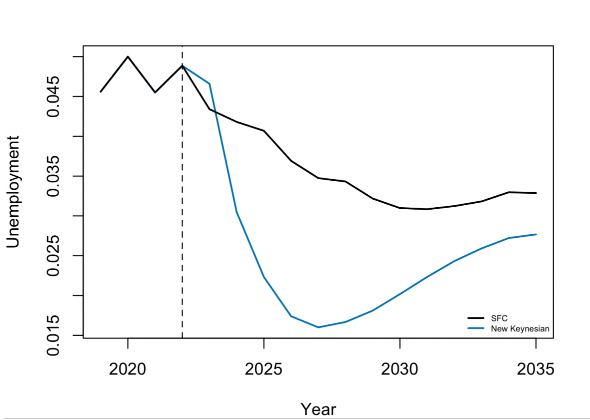
(c) Household consumption to GDP



(d) Firm investment to GDP



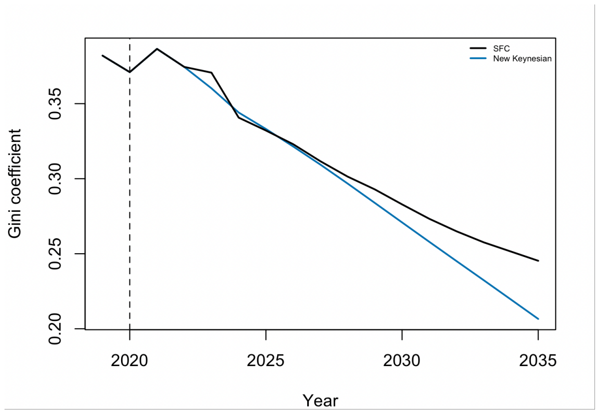
(e) Inflation



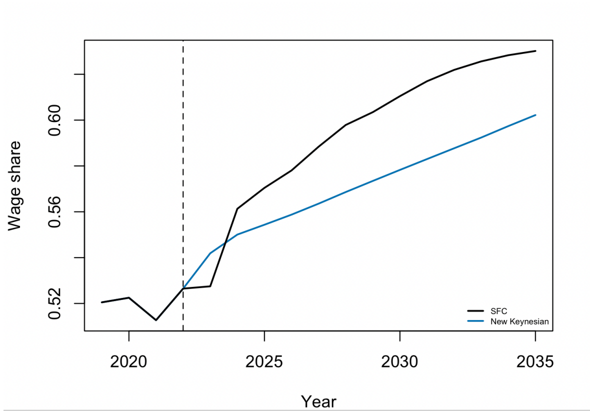
(f) Unemployment rate

Figure 2: Baseline scenario

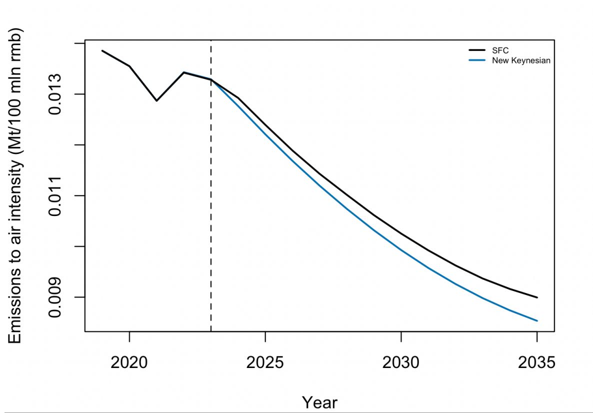
Note: The solid black line is the simulation of the SFC model. The solid blue line is the simulation of the New-Keynesian model. The vertical dashed line signifies the end of the data period, where the simulation result starts to display.



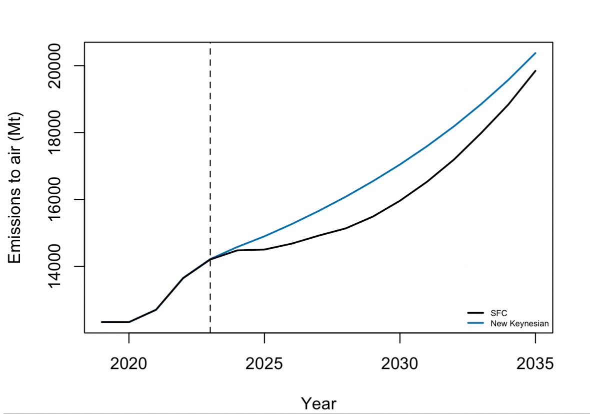
(g) Income inequality



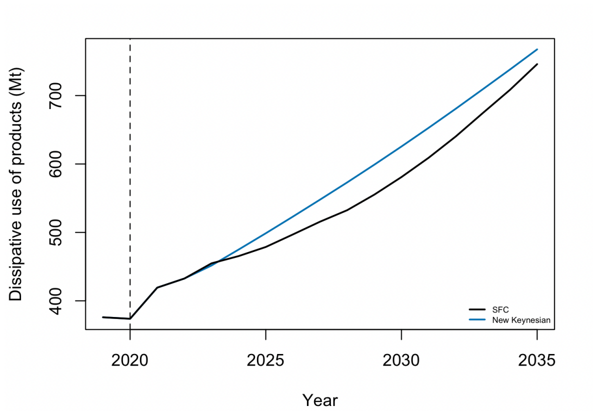
(h) Wage share



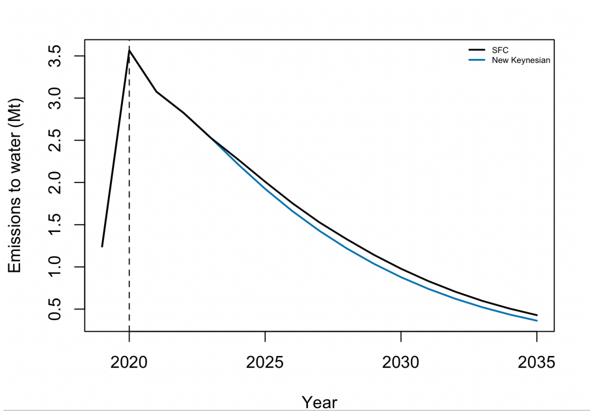
(i) Emissions to air intensity



(j) Emissions to air



(k) Dissipative use of products



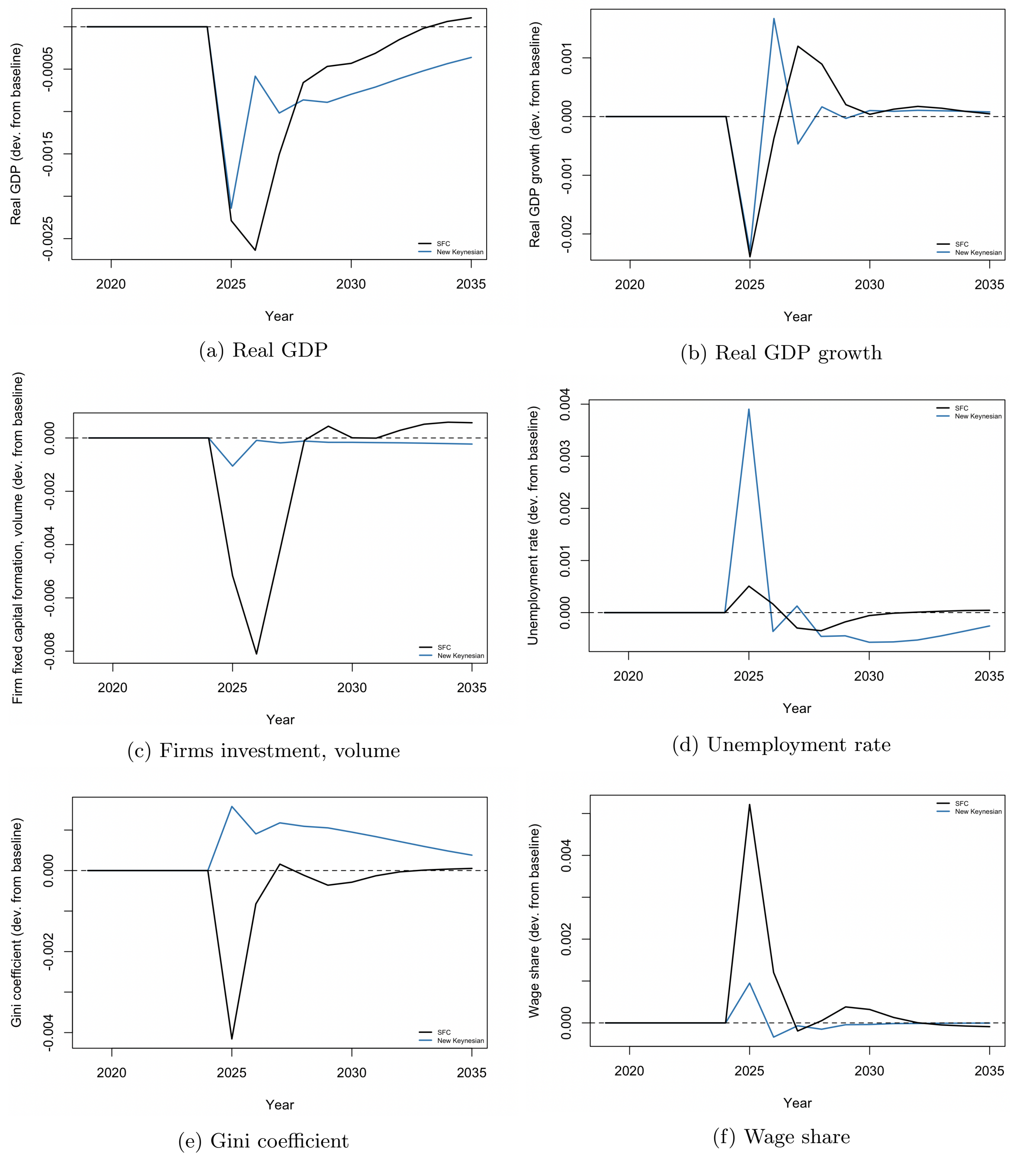
(l) Emissions to water

Figure 2: Baseline scenario

Note: The solid black line is the simulation of the SFC model. The solid blue line is the simulation of the New-Keynesian model. The vertical dashed line signifies the end of the data period, where the simulation result starts to display.

5.2 Wage policy

Figure 3 shows the impulse responses to an 1% increase in nominal wage in 2025. The black line is the impulse response of the SFC model. The blue line is the impulse response of the New Keynesian model. The two models show a similar response of real GDP to a nominal wage shock regarding the magnitude of GDP reduction and recovery timing (Figures 3a and 3b). However, with respect to production inputs, the New Keynesian model shows less reduction in firm fixed capital but a larger reduction in labour due to the substitution between labour and capital. When labour becomes more expensive, firms would invest more in fixed capital for production (Figure 3c and 3d).[4] Income inequality in the New Keynesian model does not decrease but slightly increases, because of the rise in unemployment in the short term, and the wage share remains unchanged (Figure 3e and 3f). Energy intensity increases with more income inequality. As a consequence, emissions to air in the New Keynesian model increase in the long term, though they decrease in the short term because of the drops in real GDP (Figure 3g and 3h).



(a) Real GDP

(b) Real GDP growth

(c) Firms investment, volume

(d) Unemployment rate

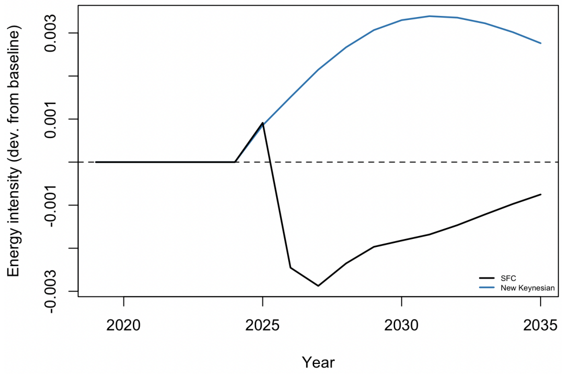
(e) Gini coefficient

(f) Wage share

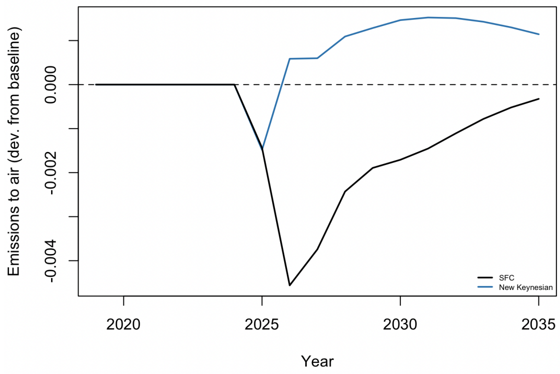
Figure 3: Nominal wage increase

Note: The black line is the impulse response of the SFC model. The blue line is the impulse response of the New Keynesian model.

[4]Unemployment in the New Keynesian model increases in the short run and starts to recover as the economy recovers. But it shows an overshooting effect in the medium run, because the labour force adjusts to unemployment. Workers leave the labour market when the unemployment rate is high.



(g) Energy intensity



(h) Emissions to air

Figure 3: Nominal wage increase
Note: The black line is the impulse response of the SFC model. The blue line is the impulse response of the New Keynesian model.

6 Conclusion and discussion

Economic theories help us to understand the economy through the linkage of variables. However, the story can be very different under different assumptions. This paper has compared a New Keynesian model, which is supply-driven, and an SFC model, in which the economy is demand-driven. We run in-sample predictions to examine the performance of the two models. The results show that the New Keynesian model cannot explain the historical trend of the data compared to the SFC model, except that inflation simulated by the New Keynesian model is more stable. We argue that the behaviour equations derived from the agent optimisation problem are too restricted. For example, household consumption merely depends on the intertemporal substitution, i.e. the Euler equation, which neglects any income or wealth effect. Also, Vines and Wills (2020) raises the point,

> We no longer think that this [microfounded manner] is an appropriate restriction of the macroeconomic research programme; structural economic models must be constructed alongside models of the NK-DSGE (New Keynesian Dynamic Stochastic General Equilibrium) kind, in which behaviour need not be fully microfounded.

Then, we run a baseline scenario simulation for future predictions from 2019 to 2035. The New Keynesian model shows smoother real GDP growth than the SFC model. The former is mainly driven by firm investment. The latter by household consumption. Regarding income inequality and environmental quality, the New Keynesian model generates more optimistic results in the long term, with less income inequality and emissions. Our results coincide with Rezai et al. (2013), which argues that this unrealistic smoothness is a common shortcoming of supply-led models.

Based on the baseline scenario, we tested a wage policy shock: a 1% increase in nominal wage. A nominal wage shock in the New Keynesian model shows a similar real GDP response to the SFC model. We arrive at the same conclusion using two different economic theories, suggesting that the impact of a wage shock on real GDP is robust. However, because of the substitution between capital and labour, firm fixed capital is more favoured in the production process, which declines much less than the SFC model, and labour demand decreases further than the SFC model. Consequently, the wage share does not increase, income inequality rises, energy intensity increases, and air emissions increase. Our findings suggest that policymakers should be aware of these differences when making policy decisions based on a specific economic theory to model the economy.

An issue with the New Keynesian model in this paper is that it fails to have any fiscal policy response. It is challenging to introduce public expenditure into a supply-led context (Costa, 2018, p.190). One possible solution is to introduce public consumption in the form of goods consumed by households, thereby affecting household utility. However, the effect of public consumption in this setup leads to a reduction of labour supply, i.e. nominal wage increases, because the shadow price increases, and also reduces private consumption due to the substitution effect (Aiyagari et al., 1992). In contrast, a demand-led model does not need this additional assumption to introduce public spending.

We found a technical issue in this modelling exercise: the simultaneity between real GDP and firm fixed capital. China has experienced incredible economic growth in the past few decades, driven by firm investment. Firm fixed capital formation as a significant component of real GDP makes the model unstable when having firm fixed capital and real GDP simultaneously determined. One solution is to employ the lag variable as in equation (31). But when the final good market closes on the demand side components, taking the lag does not make any sense from a theoretical perspective; alternative solutions will be needed.

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Appendix

Households

Household budget constraint,

$$\begin{aligned}
&P_{c,t}c_{h,t} + I_{h,t} + W_{h,t} + TL_{h,t} + r_{ph,t}L_{h,t-1} + T_{h,t} + \tau_{sc,t}w_tN_t + O_{h,t} \\
&\qquad + \Delta H_t + \Delta D_{h,t} + \Delta B_{h,t} + \Delta IFS_{h,t} + \Delta A_{h,t} + \Delta Z_{h,t} \\
&= Y_{h,t} + w_tN_t + r_{rh,t}D_{h,t-1} + r_{rh,t}B_{h,t-1} + DIV_{h,t} + OIP_{h,t} + SB_t + STR_t + EO_{h,t} + \Delta L_{h,t}, \quad (70)
\end{aligned}$$

where $I_{h,t}$ denotes household fixed capital formation in value (mainly housing), $W_{h,t}$ denotes the wage bill paid by households, $TL_{h.t}$ denotes net production tax paid by households, $T_{h,t}$ denotes income tax paid by households, $O_{h,t}$ denotes other current transfers paid by households, $\Delta IFS_{h,t}$ denotes the household investment in investment fund shares, ΔA_t denotes household acquisition of insurance, $\Delta Z_{h,t}$ denotes household acquisition of other accounts payable/receivable, $Y_{h,t}$ denotes household value added, $DIV_{h,t}$ denotes dividend received by households, $OIP_{h,t}$ denotes household other income from properties, SB_t denotes social transfers received by households, STR_t denotes social transfers in kind received by households, $EO_{h,t}$ denotes household errors and omissions.

Household fixed capital formation in value,

$$I_{h,t} = P_{k_h,t}k_{h,t} - P_{k_h,t-1}k_{h,t-1}(1-\delta_{h,t}) - \Delta P_{k_h,t}k_{h,t-1} - OCV_{k_h,t}, \quad (71)$$

where $OCV_{k_h,t}$ denotes other changes in value of household fixed assets.

Households currency saving,

$$\Delta H_t = H_t - H_{t-1} - OCV_{h,t}, \quad (72)$$

where $OCV_{h,t}$ denotes other changes in value of household currencies.

Household deposit saving,

$$\Delta D_{h,t} = D_{h,t} - D_{h,t-1} - OCV_{d_h,t}, \quad (73)$$

where $OCV_{d_h,t}$ denotes other changes in value of household deposits.

Household bond investment,

$$\Delta B_{h,t} = P_{b_h,t}b_{h,t} - P_{b_h,t-1}b_{h,t-1} - OCV_{b_h,t}, \quad (74)$$

where $OCV_{b_h,t}$ denotes other changes in value of household bonds held.

Household loan borrowing,

$$\Delta L_{h,t} = L_{h,t} - L_{h,t-1} - OCV_{l_h,t}, \quad (75)$$

where $OCV_{l_h,t}$ denotes other changes in value of household loans borrowed.

Substituting equations (71), (73), (74), (74) and (75) into equation (70), we get equation (2), with

$$\begin{aligned}
\Omega_{h,t} \equiv\ & Y_{h,t} - W_{h,t} - TL_{h,t} + DIV_{h,t} + OIP_{h,t} - T_{h,t} + SB_t + STR_t - O_{h,t} + EP_{h,t} \\
&- \Delta IFS_{h,t} - \Delta A_{h,t} - \Delta Z_{h,t} + OCV_{k_h,t} + OCV_{h,t} + OCV_{b_h,t} - OCV_{l_h,t}. \quad (76)
\end{aligned}$$

Firms:

Combining equations (35) and (36), we get the labour-capital production frontier,

$$N_{i,t} = \frac{(1-\alpha)r_{pf,t}P_{k_1,t-1}k_{i,1f,t-1}}{\alpha w_t}. \quad (77)$$

Substituting equation (77) into equation (31), we derive capital demand in terms of production and input cost ratio,

$$k_{i,1f,t-1} = \frac{y_{i,t}}{TFP_{i,t}} \left[\frac{\alpha w_t}{(1-\alpha) r_{pf,t} P_{k_1,t-1}} \right]^{1-\alpha}. \tag{78}$$

Same for labour,

$$N_{i,t} = \frac{y_{i,t}}{TFP_{i,t}} \left[\frac{\alpha w_t}{(1-\alpha) r_{pf,t} P_{k_1,t-1}} \right]^{-\alpha} \tag{79}$$

Substituting equations (78) and (79) into (30), we get the total cost of whole-sale firm production,

$$TC_{i,t} = \frac{y_{i,t}}{TFP_{i,t}} \left(\frac{w_t}{1-\alpha} \right)^{1-\alpha} \left(\frac{r_{pf,t} P_{k_1,t-1}}{\alpha} \right)^{\alpha} + \tau_{L_f,t} y_{i,t}. \tag{80}$$

By definition, we derive the marginal cost of production of whole-sale firms by taking the partial derivative of the total cost of whole-sale firm production with respect to the quantity of production, $\mu_{i,t} = \frac{\partial TC_{i,t}}{\partial y_{i,t}}$, and get equation (38).

Firm budget constraint,

$$\begin{aligned} I_{1_f,t} + I_{2_f,t} + I_{3,t} + W_{f,t} + TL_{f,t} + r_{pf,t} P_{b_f,t-1} b_{f,t-1} + r_{pf,t} L_{f,t-1} + DIV_{p_f,t} + T_{f,t} + O_{f,t} \\ + \Delta D_{f,t} + \Delta FDI_{out,t} + \Delta A_{f,t} + \Delta Z_{f,t} \\ = Y_{f,t} + r_{rf,t} D_{f,t-1} + \gamma_{DIV_{rf}} (E_{af,t-1} + P_{fdi_{out},t-1} fdi_{out,t-1}) + OIP_{f,t} + TRK_t + EO_{f,t} \\ + \Delta B_{f,t} + \Delta L_{f,t} + \Delta FDI_{in,t}, \end{aligned} \tag{81}$$

where $I_{1_f,t}$ denotes firm fixed capital formation in value, $I_{2_f,t}$ denotes firm change in inventories in value, $I_{3f,t}$ denotes firm acquisition/disposal of other non-financial assets, $W_{f,t}$ denotes the wage bill paid by firm, $TL_{f,t}$ denotes the net production tax paid by firms, $DIV_{pf,t}$ denotes the dividend paid by firms, $T_{f,t}$ denotes the income tax paid by firms, $O_{f,t}$ denotes other current transfers paid by firms, $\Delta D_{f,t}$ denotes firm deposits savings, $\Delta FDI_{out,t}$ denotes the flow of outward foreign direct investment in value, $\Delta A_{f,t}$ denotes firm insurance acquisition, $\Delta Z_{f,t}$ denotes firm changes in other account payable/receivables, $Y_{f,t}$ denotes firm value added, $E_{af,t}$ denotes firm equity held, $OIP_{f,t}$ denotes the other income from properties received by firms, TRK_t denotes capital transfers received by firms, $EO_{f,t}$ denotes firm errors and omissions, $\Delta B_{f,t}$ denotes firm bond borrowing in value, $\Delta FDI_{in,t}$ denotes the flow of inward FDI in value.

Firm deposit savings,

$$\Delta D_{f,t} = D_{f,t} - D_{f,t-1} - OCV_{d_f,t}, \tag{82}$$

where $OCV_{d_f,t}$ denotes other changes in value of firm deposits.

Firm bond borrowing,

$$\Delta B_{f,t} = P_{b_f,t}(b_{f,t} - b_{f,t-1}) - OCV_{b_f,t}, \tag{83}$$

where $OCV_{b_f,t}$ denotes other changes in value of firm bonds.

Firm equity issued (zero net worth),

$$E_{lf,t} = K_{1_f,t} + K_{2_f,t} + K_{3_f,t} + D_{f,t} - P_{b_f,t} b_{f,t} - L_{f,t} + E_{af,t} + P_{fdi_{out},t} fdi_{out,t} - FDI_{in,t} + A_{f,t} + Z_{f,t}, \tag{84}$$

where $K_{1_f,t}$ denotes firm fixed capital in value, $K_{2_f,t}$ denotes firm inventories in value, $K_{3_f,t}$ denotes firm other non-financial assets in value, $FDI_{in,t}$ denotes the stock of inward FDI in value, $A_{f,t}$ denotes firm insurance held, and $Z_{f,t}$ denotes firm other account payable/receivables.

From equation (84), we get firm loan issued satisfies

$$L_{f,t} = K_{1_f,t} + K_{2_f,t} + K_{3_f,t} + D_{f,t} - P_{b_f,t} b_{f,t} + E_{af,t} - E_{lf,t} + P_{fdi_{out},t} fdi_{out,t} - FDI_{in,t} + A_{f,t} + Z_{f,t}. \tag{85}$$

Firm outward FDI flow in value,

$$\Delta FDI_{out,t} = P_{fdi_{out},t}(fdi_{out,t} - fdi_{out,t-1}). \tag{86}$$

Substituting equations (82), (83), (85) in one lagged, and (86) into equation (81), we get equation (52), with

$$\begin{aligned} \Omega_{f,t} \equiv Y_{f,t} + \gamma_{DIV_{rf}} E_{af,t-1} + OIP_{f,t} + TRK_{f,t} + EO_{f,t} + \Delta L_{f,t} + \Delta FDI_{in,t} + OCV_{d_f,t} \\ - I_{1_f,t} - I_{2_f,t} - I_{3,t} - W_{f,t} - r_{pf,t}(K_{1_f,t-1} - K_{2_f,t-1} + E_{af,t-1} - E_{lf,t-1} - FDI_{in,t-1} + A_{f,t-1} + Z_{f,t-1}) \\ - DIV_{pf,t} - T_{f,t} - O_{f,t} - \Delta A_{f,t} - \Delta Z_{f,t} - OCV_{b_f,t}. \end{aligned} \tag{87}$$

Banks:
Bank budget constraint,

$$
\begin{aligned}
&I_{1_b,t} + W_{b,t} + r_{p,t} P_{b_{lb},t} b_{lb,t} + DIV_{pb,t} + OIP_{b,t} + T_{b,t} \\
&\qquad + \Delta G_t + \Delta D_{b,t} + \Delta B_{ab,t} + \Delta L_{b,t} + \Delta IFS_{ab,t} + \Delta Z_{b,t} \\
&= (1 - \tau_{Lb,t}) P_{y,t} y_{b,t} + r_{rb,t} D_{b,t-1} + INT_{b_{rb},t} + INT_{lb,t} + DIV_{rb,t} + O_{b,t} + EO_{b,t} \\
&\qquad + \Delta H_t + \Delta D_t + \Delta B_{lb,t} + \Delta IFS_{lb,t} + \Delta A_t, \quad (88)
\end{aligned}
$$

where $I_{1_b,t}$ denotes bank fixed capital formation in value, $W_{b,t}$ denotes the wage bill paid by banks, $DIV_{pb,t}$ denotes the dividend received by banks, $OIP_{b,t}$ denotes the other income from properties paid by banks, $T_{b,t}$ denotes the income tax paid by banks, ΔG_t denotes changes in international reserves, $\Delta D_{b,t}$ denotes bank deposit savings, $\Delta B_{ab,t}$ denotes bank acquisition of bonds, $\Delta L_{b,t}$ denotes bank loan lending, $\Delta IFS_{ab,t}$ denotes bank acquisition of investment fund shares, $\Delta Z_{b,t}$ denotes bank changes of other accounts receivable/payable, $INT_{b_{rb},t}$ denotes bank interest received from bonds, $INT_{lb,t}$ denotes bank interest received from loans, $DIV_{rb,t}$ denotes the dividends received by banks, $O_{b,t}$ denotes other current transfers received by banks, $EO_{b,t}$ denotes bank errors and omissions, ΔD_t denotes total deposits received by banks, $\Delta B_{lb,t}$ denotes bank bond issuing, $\Delta IFS_{lb,t}$ denotes bank investment fund shares issuing, and ΔA_t denotes total insurance received by bank.

Bank fixed capital formation in value,

$$
I_{1_b,t} = P_{k_1,t}(k_{1_b,t} - k_{1_b,t-1}) + \delta_{b,t} P_{k_1,t-1} k_{1_b,t-1} - OCV_{k_{1b},t}, \quad (89)
$$

where $OCV_{k_{1b},t}$ denotes the other changes in value of bank fixed capital.

Bank deposit savings,

$$
\Delta D_{b,t} = D_{b,t} - D_{b,t-1} - OCV_{d_b,t}, \quad (90)
$$

where $OCV_{d_b,t}$ denotes the other changes in value of bank deposit held.

Bank bond issuing,

$$
\Delta B_{lb,t} = P_{b_{lb},t}(b_{lb,t} - b_{lb,t-1}) + OCV_{b_{lb},t}, \quad (91)
$$

where $OCV_{b_{lb},t}$ denotes the other changes in value of bank bond issued.

Substituting equations (89), (90) and (91) into equation (88), we get equation (61) with

$$
\begin{aligned}
\Omega_{b,t} \equiv\ & INT_{b_{rb},t} + INT_{b_{lb},t} + DIV_{rb,t} + O_{b,t} + EO_{b,t} \\
&+ \Delta H_t + \Delta D_t + \Delta IFS_{lb,t} + \Delta A_t + OCV_{k_{1b},t} + OCV_{d_b,t} \\
&- W_{b,t} - INT_{d,t} - DIV_{pb,t} - OIP_{b,t} - T_{b,t} \\
&- \Delta G_t - \Delta B_{ab,t} - \Delta L_{b,t} - \Delta IFS_{ab,t} - \Delta Z_{b,t} - OCV_{b_{lb},t}. \quad (92)
\end{aligned}
$$

Table 3: Euler equation estimation

	(1)	(2)
$\log \frac{1+r_{rh,t}}{1+\pi_t}$	-0.3543	0.2575
	[-0.9841, 0.2756]	[-0.2565, 0.7715]
Dum_{2007}		0.0473
		[0.016, 0.0787]
Dum_{2010}		0.0308
		[0.0004, 0.0612]
Dum_{2011}		0.0586
		[0.0261, 0.091]
Constant	0.092	0.077
	[0.08, 0.1044]	[0.066, 0.088]
Adjusted R^2	0.0222	0.5497

Note: Numbers in the middle bracket denote the 95% confidence interval of the coefficients. Dum denotes the respective year dummy variable.

Table 4: Parameters of the New Keynesian model

Symbol	Description	Value	T-statistic
b_{f1}	Sensitivity of the growth rate of firm bond in volume per capita to the growth rate of real household consumption per capita	2.519	5.16
b_{h1}	Sensitivity of the growth rate household bonds per capita to the growth rate of interest rate receive by households	0.7981	12.59
b_{lb1}	Sensitivity of the growth rate of bank bond issued per capita to CPI inflation	3.6634	3.36
c_{h1}	Inverse of household constant relative risk aversion coefficient	3.5002	8.35
d_{b1}	Sensitivity of the growth rate of bank deposit held per capita to the growth rate of household consumption per capita	3.6807	5.76
d_{b2}	Sensitivity of the growth rate of bank deposit held per capita to the growth rate of bank rate of interest received	2.0401	4.12
d_{f1}	Short-run elasticity of firm deposit per capita to real household consumption per capita	1.2817	8.85
d_{f2}	Long-run correction parameter of firm deposit per capita	-0.027	-0.2
d_{f3}	Level of firm deposit per capita in logarithm when household consumption per capita equals 100 million rmb and the rate of interest received and paid by firms are equal	-4.2395	-23.3
d_{f4}	Long- run elasticity of firm deposit per capita to real household consumption per capita	1.4424	74.33
d_{f5}	Semi-elasticity of firm deposit per capita to the difference between the rates of interest received and paid by firms	12.73	7.42
fdi_{out1}	Short-run elasticity of outward FDI in volume per capita to real household consumption per capita	1.2856	10.07
fdi_{out2}	Long-run correction parameter of outward FDI in volume per capita	-0.4832	-3.02
fdi_{out3}	Level of outward FDI in volume per capita in logarithm when real households consumption per capita equal 100 million rmb and the price outward FDI equal CPI	9.6282	-10.22
fdi_{out4}	Long-run elasticity of outward FDI in volume per capita to real household consumption per capita	1.8155	19.14
fdi_{out5}	Elasticity of outward FDI in volume per capita to the price of inward FDI deflated by CPI	-0.4093	-2.58
h_1	Sensitivity of the growth rate of currency per capita to the growth rate of household consumption per capita	0.905	12.74
k_1	Short-run elasticity of capital productivity to total factor productivity	1.0516	7
k_2	Short-run elasticity of capital productivity to the capital cost of production	0.0661	4.66
k_3	Short-run elasticity of capital productivity to the labour cost of production	-0.516	-17.87
k_4	Long-run correction parameter of capital productivity	-0.261	-4.27
k_5	Level of capital productivity in logarithm when total factor productivity equals 1 and nominal wage equals 1 million rmb	5.076	17.68
k_6	Long-run elasticity of capital productivity to total factor productivity	1.6413	6.69
k_7	Long-run elasticity of capital productivity to nominal wage	-0.5017	-18.55
k_{b1}		0.2761	6.44
k_{h1}	Short-run elasticity of housing per capita to housing depreciation rate	-3.7492	-7.96
k_{h2}	Short-run elasticity of housing per capita to household consumption per capita	0.4446	11.85
k_{h3}	Short-run elasticity of housing per capita to real housing price per capita	-0.0855	-2.47
k_{h4}	Long-run correction parameter of housing per capita	-0.7669	-7.03
k_{h5}	Level of housing per capita in logarithm under full depreciation rate and household consumption per capita is 1 million rmb	-14.25	-3.86
k_{h6}	Long-run elasticity of housing per capita to housing depreciation rate	-5.9083	-5.67
k_{h7}	Long-run elasticity fo housing per capita to household consumption per capita	0.2603	6.06
l_{h1}	Sensitivity of the growth rate of household loans borrowed to the growth rate of household consumption	2.2536	20.74
n_1	Sensitivity of the growth rate of labour productivity to the growth rate of capital cost of production	-0.0607	-3
n_2	Sensitivity of the growth rate of labour productivity to the growth rate of labour cost of production	0.6981	28.23
p_{c1}	Sensitivity of inflation to nominal wage growth	0.2324	12.47
p_{k1}	Sensitivity of capital price growth to nominal wage growth	0.2273	4.68
p_{kh1}	Sensitivity of housing price growth to nominal wage growth	0.5921	8.47
p_{x1}	Sensitivity of export price growth to nominal wage growth	0.1004	1.94
w_1	Short-run elasticity of nominal wage to real consumption per capita	1.2768	27.08
w_2	Short-run elasticity of of nominal wage to CPI over one minus social contribution rate	-0.0119	-0.47
w_3	Long-run correction parameter of nominal	-0.2984	1.79
w_4	Stickiness of nominal wage	0.7714	19.97
w_5	Long-run elasticity of nominal wage to real consumption per capita	0.3317	6.22
w_6	Elasticity of nominal wage to employment per capita	1.2732	5.12
y_1	Elasticity of effective labour productivity to capital labour intensity	0.5674	15.58