Macro Regime and Economic Growth in China*

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Abstract

In this paper, we investigate the relationship between Chinese macroeconomic policy and economic growth, and examine how the choice of macroeconomic regime affects economic performance in China. An open-economy model is developed for this purpose. It is a three-sector "almost small" open-economy macroeconomic model, with asset markets and forward-looking agents. This open-economy model is then adopted to analyse the implications of both domestic and external growth shocks to the Chinese economy under two alternative macroeconomic policy regimes. These policy regimes have two extreme assumptions on the exchange rate, with differing degrees of financial capital mobility. The simulation results show that greater flexibility in the exchange rate regime allows the central bank to conduct independent monetary policy in the Chinese economy, the benefit from which increases as financial capital becomes more internationally mobile. Most growth shocks cause an expansion in the real GDP level, and there is a deflation in the price level and depreciation in the real exchange rate when the economy operates a floating exchange rate regime with high financial capital mobility. Overall, the expansionary effects in this macroeconomic environment will be beneficial to the Chinese economy.

Keywords: Macroeconomics, Economic Growth, Monetary Policy, Exchange Rate, Capital Mobility, Chinese Economy, Computable General Equilibrium (CGE) Modelling.

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1. Introduction

As recently as almost three decades ago, China started its economic reform and made the transition from a centrally planned economy to a market oriented one.[1] Since then, China has been one of the fastest growing economies in the world[2] at an average GDP growth rate of more than 9 percent over a twenty-five year period. With this unprecedented economic growth, China is predicted to become the world's largest economy in the foreseeable future,[3] and it will continue its unfinished economic revolution and its integration into the global economy.[4] In this project, the focus is not to understand why China has been growing so rapidly over long time, but to investigate the relationship between Chinese macroeconomic policy and economic growth.

China has achieved extraordinary economic progress during the last three decades, and hence there have been numerous studies on economic growth in China. However, there is a need for more work to be done which studies how we can make the Chinese economy resilient to large shocks and ensure the sustainability of its economic growth. On the other hand, macroeconomic policy is also very important. When an economy opens up to the world, its macroeconomic policy plays a significant role in reducing vulnerability to domestic and external shocks, and spurring economic growth. Hence, there is a linkage between macroeconomic policy and economic growth, and this relationship is our interest and the topic of this paper.

This project takes on the links between the macroeconomic policy regime and the economic growth rate, for the important case of China. The research question which is addressed in this paper is: What macroeconomic policy regime best facilitates rapid economic growth in China? In order to answer this question, our objectives are to look in depth at the choice of macroeconomic policy regimes in China, to compare their reactions to those economic growth shocks that the Chinese economy faces and will face, and to consider, among other things, the policy implications for long run economic

[1]There are numerous books which record Chinese economic reform and development strategy, including Chow (2002, 2004), Garnaut and Song (1999, 2003, 2004, 2006), Lin, Cai and Li (2003), and Naughton (1995).

[2]China has already become the fourth largest economy and the third largest trading nation in the world (Lardy, 2006; Yusuf and Nabeshima, 2006).

[3]Lin *et al.* (2003) predict China's economic scale will become larger than that of the United States and Japan, and China will thus be the biggest economy in the near future. In addition, Maddison (2004) forecasts Chinese per capita income probably be equal to the world average and China will again be the world's biggest economy by 2030.

[4]See Lardy (1998, 2002).

growth in China. Under the two alternative macroeconomic policy regime, we subject the model to a range of shocks associated with economic growth and the scale of the growth response is also recorded. The emphasis is comparative and reflects a search for the optimal macroeconomic policy regime which best fosters economic growth in China.

The rest of the paper proceeds as follows. *Section 2* introduces a three-sector "almost small" open economy macroeconomic model for the Chinese economy. In *Section 3*, we apply this macroeconomic model to analyse both the short run and the long run responses of economic growth shocks to the Chinese economy. Four distinct growth shocks appear important during the current economic reform period in China: a productivity gain among three sectors in the domestic economy; a reduction in the risk premium on investment in China; trade liberalisation in the agriculture sector; and an increase in the private saving rates in the Chinese economy. Finally, *Section 4* gives a summary of this paper, its findings, and offers conclusion.

2. Analytical Framework

The main objective of this section is to establish our model, focusing on the macroeconomics of the economy. In order to complete the analytical framework, this section introduces a three-sector "almost small" open economy macroeconomic model, which extends that of the two-sector "almost small" open economy macroeconomic model in Rees and Tyers (2004b), and this three-sector macroeconomic model adds macroeconomic behaviour to the three-sector microeconomic model as in Dai (2006).[5] In combination with the microeconomic foundation, our analytical framework offers both the short run and the long run responses from the model economy, and provides a basis for answering the fundamental questions posed in this paper.

2.1 Model Overview

This three-sector open economy macroeconomic[6] model extends the Rees-Tyers (2004b) model by adding a third factor - land, and a third sector - service. It is, thereby, a macroeconomic extension of the microeconomic

[5]In Dai (2006), the three-sector microeconomic model is a Chinese version of the extension to the microeconomic model in Tyers and Coleman (2005).

[6]Open economy macroeconomics includes exchange rate policy, the external effects of fiscal policy, current account, and related issues from the viewpoint of an individual economy (Corden, 1994).

model as in Dai (2006), but this model adds key macroeconomic variables to capture the short run behaviour in the economy, which is not represented in the long run microeconomic model.

The products that are produced in the home economy are also differentiated from those which are supplied in the rest of the world. This model also includes saving, investment; money, bonds; and forward-looking agents. It has a government, which implements fiscal policy and monetary policy in the home economy. The macroeconomics is introduced without explicit dynamics. This is done by solving the model for the long run and the short run responses to shocks. The long run results are used to form expectations in the short run analysis.

Macro Extensions

This three-sector "almost small" open economy macroeconomic model is developed by modifying some parts of the Rees-Tyers (2004b) model, and extending that of the three-sector microeconomic model in Dai (2006), in order to represent the Chinese economy in recent years. The differences and departures from the Rees-Tyers model and the three-sector microeconomic model are described as follows.

First, we model the agriculture sector to be a net importing sector, which is the case for the primary sector in China, and to model the industry sector as a net exporter. Second, we add a third factor, land, and a third sector, the service sector. This service sector is modelled as non-traded, and is based on the tertiary sector in China. These two additions to the model are done by adding new coefficients, variables, formulae and equations, and redefining some formulae and equations.

The next difficult step is the construction of the initial database for this model. The goal of this construction is to have a typical representation of the Chinese economy in recent years. Our data[7] are mostly calibrated from the 2005 China Statistical Yearbook[8] (NBS, 2005) and GTAP database 1997.

[7]Some data are adapted from my previous research work on the Chinese database for the one-sector macroeconomic model in Roberts and Tyers (2003).

[8]The 2005 China Statistical Yearbook (SYB) has the Chinese data from the previous year, that is, the Year 2004. On the other hand, the electronic version of the 2006 China Statistical Yearbook just came out early October 2006. So we could use 2006 SYB to recalibrate our data and reconstruct the initial database for the Chinese economy in this macroeconomic model, and test the sensitivity of our simulation results under the growth shocks in future research.

In particular, the output elasticity of factor i in sector j, BETA is also constructed from the factor share in the production of each sector in China from GTAP Version 5 global database for the Year 1997, which divides the world into 66 countries and regions, in order to construct the matrix of output elasticity. In the GTAP database, they have four industries, which are food, manufacture, services and capital goods; and they have five factors, which are land, unskilled labour, skilled labour, capital and natural resources. We do some changes to these initial data in order to adapt them for our purpose. For the industries, we regard food industry as the agriculture sector, and we omit the capital goods industry, because there is no value for this industry in the database. So we have three industries now, that is, agriculture, manufacture and services, which are the same as the primary, secondary, and tertiary industries in China. For the factors, we regard unskilled labour as raw labour. In addition, we regard skilled labour as human capital, and include them in capital. Then we combine natural resources to land. So we have three factors now, that is, labour, capital and land.

One of the most difficult steps in the two-sector macroeconomic model is the calibration of the total factor productivity (TFP) coefficient.[9] In this three-sector model, we use our results from the firm's cost minimisation problem[10] , from which the TFP coefficient is derived.[11] In particular, a full and internally-balanced equilibrium must first be constructed and this is done by calibrating some key parameters to available data.

In contrast with the three-sector microeconomic model, this macroeconomic version of the model has tax in it. There are five taxes in the macroeconomic model, which include consumption taxes, capital income taxes, labour

[9]In the Rees-Tyers model, it is assumed that we have a certain amount of output, from which we use some mathematical trick and derive the total factor productivity coefficient. However, this trick can not be used in the derivation of TFP for the three-sector macroeconomic model, because we have three factors and three sectors here, and some terms can not be cancelled out, which happen during our calculation for the two-sector model. On the other hand, we also attempted another approach. Assume that total factor productivity coefficient starts at 1 in each industry sector, and see how the TFP departs from the initial equilibrium, if the economy faces some productivity growth shocks. However, this approach was unsuccessful. So we use our current approach, which is detailed in Appendix 4.2 in Dai (2006).

[10]See Appendix 4.1 in Dai (2006) for the solution to the firm's cost minimisation problem.

[11]See Appendix 4.2 in Dai (2006) for the derivation of the total factor productivity coefficient.

income taxes, import tariffs and export taxes.

2.2 Model Detail

The Supply Side

In the Rees-Tyers model, the supply side of the model follows the standard Heckscher-Ohlin-Samuelson two-factor, two-sector structure with perfect competition in both product and factor markets. In this three-sector macroeconomic model, we extend the Rees-Tyers macroeconomic model by adding one more factor and one sector. The remainder of this section follows Rees and Tyers (2004b), except where departures are required for the extensions and modifications in the three-sector macroeconomic model and for the fit of the model to the Chinese economy.

The production levels Y_1, Y_2 and Y_3 are all Cobb-Douglas in the three primary factors:
Land-intensive agriculture:

$$Y_1 = \beta_1 (L_1)^{\beta_{11}} (K_1)^{\beta_{21}} (A_1)^{\beta_{31}} \tag{1}$$

Labour-intensive industry[12] :

$$Y_2 = \beta_2 (L_2)^{\beta_{12}} (K_2)^{\beta_{22}} (A_2)^{\beta_{32}} \tag{2}$$

Capital-intensive services:

$$Y_3 = \beta_3 (L_3)^{\beta_{13}} (K_3)^{\beta_{23}} (A_3)^{\beta_{33}} \tag{3}$$

Total primary factor demands are therefore

$$\bar{L} = L_1 + L_2 + L_3$$

$$\bar{K} = K_1 + K_2 + K_3$$

$$\bar{A} = A_1 + A_2 + A_3$$

Given perfectly competitive profit maximisation[13] , the unit factor rewards in each sector j are the respective H$ values of the marginal products at

[12]The industry sector includes both manufacture and mining.

[13]The solution to a firm's profit maximisation problem also minimises the cost in the production.

producer prices.

Because labour is mobile between sectors, we have

$$W_1 = p_{H_1} MP_{L_1} = W_2 = p_{H_2} MP_{L_2} = W_3 = p_{H_3} MP_{L_3}$$

both in the short run and in the long run.

Correspondingly, the H$ values of rental rates per unit of physical capital is

$$R_{KG_j} = p_{H_j} MP_{K_j}$$

which only equates across sectors in the long run.

The H$ values of land rates per unit of land is

$$Z_1 = p_{H_1} MP_{A_1} = Z_2 = p_{H_2} MP_{A_2} = Z_3 = p_{H_3} MP_{A_3}$$

which equates across the three sectors both in the short run and in the lone run.

So in the long run, we have the same optimisation problem as that of the three-sector microeconomic model in Dai(2006).

But in the short run, unit factor demands stem from the technology, via the firms' cost minimisation problem.[14] These are:

$$L_j = \frac{1}{\beta_j} \frac{\beta_{1j}}{W} (\frac{W}{\beta_{1j}})^{\beta_{1j}} (\frac{R_j}{\beta_{2j}})^{\beta_{2j}} (\frac{Z}{\beta_{3j}})^{\beta_{3j}} \tag{4}$$

$$K_j = \frac{1}{\beta_j} \frac{\beta_{2j}}{R_j} (\frac{W}{\beta_{1j}})^{\beta_{1j}} (\frac{R_j}{\beta_{2j}})^{\beta_{2j}} (\frac{Z}{\beta_{3j}})^{\beta_{3j}} \tag{5}$$

$$A_j = \frac{1}{\beta_j} \frac{\beta_{3j}}{Z} (\frac{W}{\beta_{1j}})^{\beta_{1j}} (\frac{R_j}{\beta_{2j}})^{\beta_{2j}} (\frac{Z}{\beta_{3j}})^{\beta_{3j}} \tag{6}$$

Producer prices follow as

$$p_{Hj} = WL_j + R_j K_j + ZA_j \tag{7}$$

[14] Minimise factor cost, $WL_j + R_j K_j + ZA_j$, subject to $1 = \beta_j L_j^{\beta_{1i}} K_j^{\beta_{2i}} A_j^{\beta_{3i}}$.

The GDP price, P_Y, is a constant weighted index of the producer prices p_{Hj}:

$$\frac{P_Y}{P_Y^0} = (\frac{1}{Y_1^0 p_{H_1}^0 + Y_2^0 p_{H_2}^0 + Y_3^0 p_{H_3}^0})(Y_1^0 p_{H1} + Y_2^0 p_{H2} + Y_3^0 p_{H3}) \tag{8}$$

In the absence of intermediate inputs, our aggregate measure of economic activity is real GDP at producers' prices:

$$Y = \frac{1}{P_Y} \sum_{j=1}^{3} p_{H_j} Y_j \tag{9}$$

which is linked to the demand side of the model by the volume accounting relation:

$$Y_j = C_{H_j} + I_{S_j} + (I_{V_j} - I_{V_j}^0) + G_{S_j} + X_j \tag{10}$$

which sums the sectoral product demands for the consumption of home products, investment (including inventory adjustments applying in the short run only), government consumption and exports.

The Demand Side

Consumption volumes are derived in three stages. First, an aggregate volume of consumption is determined, along with corresponding savings, in an intertemporal optimisation. For this purpose, the utility of the collective household is assumed to be concave in this aggregate of current consumption. Second, this aggregate is assumed to be CES in the consumption of the two goods. To achieve the differentiation of home from foreign products, however, the third stage is needed. Aggregate consumption of each product type is then assumed to be CES in the volumes consumed of the home produced and imported varieties.

In the first stage, the collective private household is forward-looking, consuming volume C_1 in the current year and C_F in *every* subsequent year. They observe their current nominal disposable income, which includes net income flows from abroad, N and excludes direct taxes, $T_Y (Y_D = P_Y Y - T_Y + N)$. They also observe the current aggregate consumer price level P_C, and the current real interest rate net of capital income tax $r_N = \frac{r}{1+\tau_K}$. Correspondingly, they form expectations about the future consumer price level P_C^F , the future level of their nominal disposable income Y_D^F, and the future real interest rate net of capital income tax r_N^F , all of which are presumed to prevail in every subsequent year. The optimal current consumption volume is derived

as follows.[15]

$$C_1 = \frac{y_D + R_2(T)y_D^F - \Delta W(1+r_N)}{[\frac{R_2(T)}{R_1(T)}]^{\frac{1}{1-\omega}} + R_2(T)}[\frac{R_2(T)}{R_1(T)}]^{\frac{1}{1-\omega}} \tag{11}$$

where

$$\begin{aligned} R_1(T) &= \frac{1-(\frac{1}{1+\nu})^{T_1}}{\nu} \\ R_2(T) &= \frac{1-(\frac{1}{1+r_N^F})^{T-2}}{r_N^F} \end{aligned}$$

Here ΔW is the real change in wealth present value over a finite horizon T, ν is the rate of time preference, and ω is the elasticity of utility to current consumption. To calibrate these equations, we first choose ν and T for an initially stable consumption path, which is consistent with the assumed underlying steady state. We then obtain ΔW from initial conditions and equation (11).

Since consumption C is a CES composite of the three goods, the collective household is assumed to select the three volumes C_{s_1}, C_{s_2} and C_{s_3} to minimise the cost of the aggregate.

$$C_{s_1} = s_1 C(\frac{p_1}{P_C})^{-\sigma} \tag{12}$$

$$C_{s_2} = s_2 C(\frac{p_2}{P_C})^{-\sigma} \tag{13}$$

$$C_{s_3} = s_3 C(\frac{p_3}{P_C})^{-\sigma} \tag{14}$$

where σ is the elasticity of substitution between the three goods. s_1 is the initial expenditure share on good 1, s_2 is the initial expenditure share on good 2, and s_3 is the initial expenditure share on good 3.

The composite consumer price is:

$$P_C = (\sum_{j=1}^{3} s_j p_j^{1-\sigma})^{\frac{1}{1-\sigma}} \tag{15}$$

[15]See Appendix 4.3 in Dai (2006) for the derivation of the optimal current consumption volume.

In the third stage, the consumption of each product is divided between the home and imported varieties. A similar cost minimisation takes place for each j but this time the expenditure minimised is:

$$p_j C_{s_j} = p_{H_j}(1+\tau_c)C_{H_j} + \frac{p_j}{E}(1+\tau_{M_j})(1+\tau_C)M_j \tag{16}$$

where E is the exchange rate in F$/H$, τ_C is the consumption tax rate, τ_M is the import tariff rate and M is the volume of imports. The optimal volumes are then:

$$C_{H_j} = s_{H_j} C_{S_j} [\frac{p_{H_j}(1+\tau_C)}{p_j}]^{-\sigma_s} \tag{17}$$

$$M_j = (1-s_{H_j})C_{s_j} [\frac{\frac{p_j^*}{E}(1+\tau_{M_j})(1+\tau_C)}{p_j}]^{-\sigma_s} \tag{18}$$

and the composite price of good j is:

$$p_j = \{s_{H_j}[p_{H_j}(1+\tau_C)]^{1-\sigma_s} + (1-s_{H_j})[\frac{p_j^*}{E}(1+\tau_{M_j})(1+\tau_C)]^{1-\sigma_s}\}^{\frac{1}{1-\sigma_s}} \tag{19}$$

Private saving is the residual after consumption (gross of consumption tax) is deducted from disposable income

$$Y_D = P_Y Y - T_Y + N$$

Direct tax applies to labour income and capital income net of depreciation (at a common depreciation rate, δ).

$$T_Y = \tau_w W \bar{L} + \tau_K [\frac{\beta^* i^*}{E} + \sum_{j=1}^{3} (R_{KG_j} - \delta P_K) K_j] \tag{20}$$

where B^* is the domestic holdings of foreign bonds and P_K is the price of capital goods, behaviour for both of which is introduced later.

Nominal private saving is then:

$$S = Y_D - P_C C = Y_D - \sum_{j=1}^{3} [p_{H_j}(1+\tau_C)C_{H_j} + \frac{p_j^*}{E}(1+\tau_{M_j})(1+\tau_C)M_j] \tag{21}$$

Indirect tax revenue stems from both import and export taxes:

$$T_M = \sum_{j=1}^{3} \tau_{M_j} \frac{p_j^*}{E} M_j \tag{22}$$

$$T_X = \sum_{j=1}^{3} \tau_{X_j} p_{H_j} X_j \tag{23}$$

as well as from consumption tax, which is levied at rate τ_C on both home goods and imports,

$$T_C = \tau_C \sum_{j=1}^{3} [p_{H_j} C_{H_j} + (1 + \tau_{M_j}) \frac{p_j^*}{E} M_j] \tag{24}$$

Government saving is defined as the surplus of current revenue over current expenditure:[16]

$$S_G = T_Y + T_C + T_M + T_X - P_G G$$

Real government expenditure G is split between the three goods, once again, by CES disaggregation, yielding:

$$G_{s_j} = s_{G_j} G (\frac{p_{H_j}}{P_G})^{-\sigma_G} \tag{25}$$

for all j, where σ_G is the elasticity of substitution in government demand between the three home goods and the composite price is:

$$P_G = (\sum_{j=1}^{3} s_{G_j} p_{H_j}^{1-\sigma_G})^{\frac{1}{1-\sigma_G}} \tag{26}$$

The final two sources of demand are investment and exports. On the open capital account, net inflow is the difference between investment and total domestic saving, $S_D = S + S_G$. The balance of payments, here measured in H$, then requires that:

$$KA = I - SD = \frac{S_N F - \Delta R}{E} = -CA = -(NX + N) \tag{27}$$

where I is investment, ΔR is the annual addition to official foreign reserves in F$, and S_{NF} is the private component of the net inflow of financial capital (net foreign saving), also in F$. More specifically, net foreign saving is the annual inflow associated with acquisitions of home bonds by foreigners net of the outflow associated with acquisitions of foreign bonds by home residents.

[16]The outstanding stock of government bonds and the associated debt services burden, when included, causes little change in short run solutions and so is omitted from the model discussed here for parsimony.

On the current account CA, the net inflow associated with merchandise trade is NX, and N is net factor income (both derived below).

Financial capital is assumed to be less than perfectly mobile internationally, so that interest parity does not hold in general. Financial investors world wide are assumed to manage a portfolio comprising the national bonds of each country, the base period composition of which accounts for risk factors that are unaltered by the shocks considered here. Other things equal, then, a rise in the after tax home (nominal) bond yield induces a rebalancing of this portfolio that, in turn, causes a corresponding rise in net private inflows on the home capital account. Such a rise might also be caused by an expected exchange rate appreciation. We therefore make these net inflows in F$ depend on a "parity ratio"[17]:

$$S_{NF} = a_{FS} + b_{FS}[\frac{\frac{i}{1+\tau_K} + \hat{E}^{\varepsilon}}{i^*}] \tag{28}$$

where $\hat{E}^{\varepsilon}$ is the expected annual proportional change (appreciation positive) in the exchange rate. They yield on foreign bonds i^* is net of capital income tax, the rate of which is considered to be determined abroad. Interest parity, at least in proportional change terms, can be approximated by making the slope parameter b_{FS} or the elasticity from which it stems ε_{FS} arbitrarily large.

The investment financed by these domestic and foreign savings is comprised, conventionally, of depreciation replacement $\delta\bar{K}$, and net investment; the latter motivated by the ratio of the expected future real net return on physical capital to the current real financing cost[18]:

$$I = I_N + \delta_K = K[\gamma(\frac{r^e_{KN}}{r})^{\varepsilon_I} + \delta] \tag{29}$$

To obtain the real net return on physical capital, we first take an economy-wide average of the gross H$ rental per unit of capital R_{KG}.

$$R_{KG} = \sum_{j=1}^{3}(\frac{K_j}{\bar{K}})R_{KG_j} \tag{30}$$

[17]This relationship is made linear to facilitate changes of direction following large shocks. The key parameter read in, however, is the elasticity of net foreign saving to the interest parity ratio ε_{FS}, from which the coefficient b_{FS} is derived. When this is made arbitrarily large, interest parity is approximated, at least in proportional changes.

[18]For long run simulations, the rate of return on installed capital is made endogenous (the expected future value is forced into equality with the endogenous value). In the short run, it is exogenous and shocked by the proportion emerging from the long run simulation. Also, in long run solutions, net investment increments the total stock of physical capital in annual increments over the period T_{LR}.

The corresponding gross *rate of return* on physical capital investment is then the quotient of this with the price of capital goods P_K (derived subsequently). This raw quotient is the rate of return on investments in physical capital. We then net out the rate of depreciation and, to obtain a *real* net rate of return, we express this rate as a growth rate in purchasing power over consumption goods by also netting out expected inflation:

$$r^e_{KN} = \frac{1 + \frac{R^\varepsilon_{KG}}{P^\varepsilon_K}}{(1+\delta)(1+\hat{P}^\varepsilon_C)} - 1 \approx \frac{R^\varepsilon_{KG}}{P^\varepsilon_K} - \delta - \hat{P}^\varepsilon_C \tag{31}$$

To construct this real net rate of return in the model, expectations are formed via the long run solution over the gross rental rate R_{KG} , the price of capital goods P_K, and the consumer price level P_C.[19]

Aggregate investment makes demands on a capital good industry that uses the three home goods as inputs, via the CES production function:

$$I = (\sum_{j=1}^{3} \psi_j I_{s_j}^{-\zeta})^{\frac{1}{1-\zeta}} \tag{32}$$

Minimising investment expenditure, $P_K I = \sum_{j=1}^{3} p_{H_j} I_{s_j}$, yields:

$$I_{s_j} = s_{I_j} I (\frac{p_{H_j}}{P_K})^{-\sigma_I} \tag{33}$$

and the capital good price:

$$P_K = (\sum_{j=1}^{3} s_{I_j} P_{H_j}^{1-\sigma_I})^{\frac{1}{1-\sigma_I}} \tag{34}$$

Related to investment is the accumulation of inventories. These are incorporated to capture product price sluggishness and are active only in the short run. They respond simply to changes in producer prices:

$$I_{V_j} = I^0_{V_j} (\frac{p_{H_j}}{p^0_{H_j}})^{-\varepsilon_v} \tag{35}$$

[19]There are two key determinants of investment in an economy. One is the anticipated rate of return on installed capital net of depreciation, which has a positive effect on the volume of investment. The other is the real cost of funds, that is, the real borrowing rate, which has a negative effect on the volume of investment. These two rates might be expected to converge on common values in a steady state, but this is rare in practise (Tyers and Golley, 2006). In a steady state such as the one applying at the outset, in which there is no population or productivity growth and therefore no net investment, the quotient in (31) is unity: the net real rate of return on installed physical capital is the same as the real yield on bonds r . Following our economic growth shocks, however, the departures from the initial equilibrium are also departures form the steady state, so in general $r_{KN} \neq r$.

Returning to the external sector, the real exchange rate is defined as the value of a home production bundle in terms of the corresponding foreign bundle. It can therefore be measured as the ratio of the home currency price of home output to the (before import tax) home currency price of foreign output:

$$e_R = \frac{P_Y}{\frac{P^*}{E}} = E\frac{P_Y}{P^*} \tag{36}$$

where E is in F\$/H\$.

Exports represent the demand for home output by foreigners. In keeping with the "almost small" character of the economy, foreign consumption of each good j is comparatively large and constant, denoted by Q_j. Foreigners aggregate home exports with their products according to:

$$Q_j = (\lambda_j X_j^{\rho_j^*} + \lambda^* C_j^{*\rho_j^*})^{\frac{1}{\rho_j^*}} \tag{37}$$

where $\rho_j^* = \frac{\sigma_j^* - 1}{\sigma_j^*}$.

Foreign expenditure on good j is given by:

$$P_j^F Q_j = (1 + \tau_{X_j}) E p_{H_j} X_j + p_j^* C_j^*$$

where C_j^* denotes foreign supply from all other sources.

Optimisation for each good yields:

$$X_j = \lambda_j^{\sigma_j^*} Q_j [\frac{(1 + \tau_{X_j}) p_{H_j}}{P_j^F}]^{-\sigma_j^*} \tag{38}$$

The composite foreign price of foreign consumption for good j is:

$$P_j^F = [\lambda_j^{\sigma_j^*} E(1 + \tau_{X_j}) p_{H_j}^{1-\sigma_j^*} + \lambda_j^{*\sigma_j^*} p_j^{*(1-\sigma_j^*]^{\frac{1}{1-\sigma_j^*}}} \tag{39}$$

With exports thus defined, H\$ net inflows on the current account of the balance of payments is associated with merchandise trade are:

$$NX = \sum_{j=1}^{3} [(1 + \tau_{X_j}) p_{H_j} X_j - \frac{p_j^*}{E} M_j] \tag{40}$$

The remaining component of the current account, net factor income, depends on base period holdings of domestic debt by foreigners B_H^* in H\$, and of

foreign debt by domestic residents B^* in F\$. These sums are fixed in the short run[20] , when current net factor income, measured in H\$, takes the form

$$N = \frac{i^* B^*}{E} - \frac{i B_H^*}{(1+\tau_K)E} \tag{41}$$

Finally, the home money market is given a textbook characterisation, with transactions demand for home money driven by GDP while the opportunity cost of holding home money is the nominal yield on home bonds. Real money balances are measured in terms of purchasing power as indexed by the consumer price level:

$$m_D = a_M Y^{\varepsilon_{MY}} i^{\varepsilon_{Mi}} = m_S = \frac{M_S}{P_C} \tag{42}$$

Expectation formation:
Expectations are formed by consumers over their future nominal disposable income Y_D^e, and the future consumer price level P_C^e. Consumers decide on the levels of current consumption C and future consumption C_F, which is considered constant in all future periods. Since values for Y_D^e and P_C^e emerge directly from the long run simulation, these form expected future values in the short run. Expectations are also formed by investors over the average domestic real return on installed capital r_{KN}^e. This also emerges directly from the long run solution.

The formation of expectations by domestic and foreign financial investors is less straight forward. Their net acquisition of domestic bonds S_{NF} contributes to the financing of domestic investment and appears as the private component of net inflows on the capital account of the balance of payments. With imperfect international mobility of financial capital, these are determined by the "interest parity ratio" $\frac{\frac{i}{1+\tau_K}+\hat{E}^\varepsilon}{i^*}$, where the nominal bond yield is: $i = (1+r)(1+\pi^\varepsilon) - 1$ and $\pi^\varepsilon = \hat{P}_C^\varepsilon$. In forming $\hat{E}^\varepsilon$ and $\hat{P}_C^\varepsilon$, a key issue is the information available to financial agents. One assumption is that these agents only know the long run equilibrium. They therefore form their expectations *ex ante*, before any short run behaviour is revealed. An alternative is to assume these expectations are formed *ex post*, once the economy's short run behaviour has been revealed, or that they also account fully for short

[20]In the long run, B^* and B_H^* are each adjusted to include half of the accumulated private flows (S_{NF}) over the interval T_{LR}. Note that foreign-held debt of home residents is assumed to be denominated in F\$. This avoids the non-neutrality of domestic money in the long run.

run behaviour.

Because these agents are generally the best informed of decision makers, we assume that they also have perfect foresight about short run behaviour and so might be thought of as forming their expectations *ex post*. The expected annual rates of inflation and appreciate are then:

$$\hat{P}_C^{\varepsilon} = (\frac{P_C^{\varepsilon}}{P_C})^{\frac{1}{T_{LR}}} - 1 \tag{43}$$

$$\hat{E}^{\varepsilon} = (\frac{E^{\varepsilon}}{E})^{\frac{1}{T_{LR}}} - 1 \tag{44}$$

where T_{LR} is the number of years beyond which the long run equilibrium prevails, and both P_C and E are the endogenous short run values of the consumer price level and the exchange rate, respectively.

2.3 Model Feature

There are five main features of this three-sector macroeconomic model, which are described as follows.

The "Almost Small" Open Economy

In our model, the Chinese economy is modelled as an "almost small" economy, which is common in single country CGE[21] work, following Dixon, Parmenter, Sutton and Vincent (1982)[22] , and Harris (1984). There are many economic studies on China, which also make this assumption, such as Roberts and Tyers (2003). What "almost small" means is that an economy does not have the power to influence the world market but to take the world prices as given. Corden (2002) assumes that the country is a "small" one, with respect to its influence on the international capital market, that is, it does not have a significant impact on world price and interest rates. He emphasises that except for United States, Japan and Germany, all the countries are "small", even including Britain, France and China. Hence, our project also follows this assumption on China.

Dynamic Behaviour

[21]CGE stands for computable general equilibrium.

[22]This is on the second version the ORANI model, which is a multi-sectoral model of the Australian economy. See Dixon, et al. (1982) for more information on the ORANI model. See also Dixon and Rimmer (2002) for further development of the model.

The intertemporal behaviour is achieved without explicit dynamics by solving the model in two different lengths of run. The long-run results are used to form expectations in the short run analysis of economic growth shocks. In the short run with myopic agents, the growth shocks are not expected by those agents. But the policy response is expected in the short run with forward-looking agents.

Long Run and Short Run

There are four distinct features of the long run version of the model. First, agents form the expectation that simulated changes in prices and rates are permanent. Second, there are no nominal rigidities and the labour market clears in the long run, but in the short run, the labour market does not clear and nominal wages are rigid. Third, there is no inventory adjustment. Fourth, physical capital is mobile intersectorally.[23] These assumptions collectively make money neutral in the long run.

Intertemporal Choice

In the three-sector macroeconomic model, we have inter-temporal choice, which uses the method of Rees and Tyers (2004b) to solve the optimisation problem on the optimal current and future consumption[24] . In this optimisation problem, consumers have a rate of time preference. They choose consumption in the current year and a consumption level, which we assume to be constant in all future years, in order to maximise their utilities over a finite time horizon

Chinese Feature

In late 2005, a wide-ranging economic census in China revealed that the agriculture, industry and service sectors contributed 13.1 percent, 46.2 percent and 40.7 percent to GDP respectively in the Year 2004 (EIU, 2006a). In our economic model, we include these three sectors, that is, the agriculture, industry and service sectors.[25] The industry sector includes mining, semi-processing, manufacturing and construction. Manufactured exports become more important in recent years. By 2004, manufactured products accounted for over 93 percent of exports from China. Primary products accounted for

[23]There exists a common assumption that production and consumption decisions are driven by larger elasticities in the long run (Pitchford, 1988; Rees and Tyers, 2004a). Like Rees and Tyers (2004b), we also do not apply this here in order to simplify interpretation.

[24]See Appendix 4.3 in Dai (2006) for the derivation of optimal current and future consumption, which is a three-sector version of the solution of Rees and Tyers (2004b).

[25]The agriculture, industry and service sectors are also called the primary, secondary and tertiary industries in China.

21 percent of imports to China in 2004 (EIU, 2006a). The agriculture sector is modelled as a net importing sector, industry is a net exporter, and services are non-traded.

In addition, China's current account surplus was US$ 161 billion in the Year 2005, or 7.2 percent of GDP (World Bank, 2006b). This current account surplus corresponds to a capital account deficit. Hence, we construct the model economy to have a current account surplus and a capital account deficit, in order to represent the Chinese economy in the present.

2.4 Database and Parameters

Like other computable general equilibrium models, most components in this model are not econometric in origin. They are calibrated from national accounts and international trade data, which are combined with input-output tables. In general, we collect our data from the China Statistical Yearbook 2005 and our parameters from GTAP base. The numerical structure of this three-sector macroeconomic model is detailed in Table 1 through Table 7. As can be shown from these reference tables, we make the agriculture sector a net importing sector, the industry sector a net exporting one, and the service sector a near autarkic one. On top of that, the variables and parameters are intended to represent the Chinese economy in the Year 2004. The database and parameters are consistent with those constructed for the microeconomic model in Dai (2006).

3. Growth Shocks

In this section, we conduct economic experiments and apply the macroeconomic model to analyse both the short run and the long run responses of several domestic and external growth shocks to the model economy, in particular, we focus on growth shocks which enhance the rate of GDP growth in the Chinese economy. These growth shocks include a productivity gain among three sectors in the domestic economy; a reduction in the risk premium on investment in China; a trade liberalisation in the agriculture sector; a consumption tax reform as a fiscal instrument to correct the distortion from the trade reform in the agriculture sector; and an increase in the private saving rates in the Chinese economy. The reason why we choose these four distinct growth shocks is that they appear important during the current economic reform period in China. In each experiment, we run a new simulation in which the determinant in question is shocked once-and-for-all, as of the Year

2005, which is the year we calibrate our model by using the yearly data. We then compare the economy's responses to those growth shocks, and the focus is mainly on the proportionate change in the GDP level, the price level, and the real exchange rate to make the comparisons between the two alternative macroeconomic policy regimes. In Table 8 and 9, we provide a summary of our findings from the analyses of these growth shocks in our experiments.

From Table 8, we can see that when the central bank adopts a fixed exchange rate regime with low financial capital mobility, the price level moves in the same direction as the real exchange rate, for example, if there is a real depreciation, then there is a deflation in the price level. This is due to the fact that the nominal exchange rate is the monetary target in this macroeconomic environment, so the price level makes the adjustment in order to defend the fixed nominal exchange rate, and the change in the real exchange rate is completely born by the producer price level in the home economy. That is to say, the monetary policy is enslaved by the exchange rate target. So the central bank is not able to implement monetary policy independently under this macroeconomic policy regime. However, the correspondence between the price level and real exchange rate does not appear under the second macroeconomic policy regime, where the central bank adopts a floating exchange rate regime with high financial capital mobility, as can be seen in Table 9. So the central bank is able to practice at least some degree of independent monetary policy under this macroeconomic environment. On a different note, it can be shown from the simulation results that in the macroeconomic regime with high financial capital mobility, there are larger variations in the net flows on the capital account, current account, and net foreign savings, and therefore the economy is more open than before.

Take the tax reform as an example. In our experiment, we use consumption tax reform as a fiscal instrument to correct the distortion from the trade reform in the agriculture sector. If the economy is under a fixed exchange rate regime with low financial capital mobility, then there will be a deflation in the price level and a depreciation in the real exchange rate only in the short run. But if the economy adopts a floating exchange rate regime with high financial capital mobility, then there will be a deflation and a real depreciation throughout both lengths of run. So the fiscal correction, combined with the monetary policy, is more effective under the second macroeconomic policy regime.

However, when we assess the economic performance under these two alternative macroeconomic policy regimes, we also have to take into account the

origin of the shock - whether it is a domestic shock or an external shock; the nature of the shock - whether it is a supply side shock or a demand side shock; and the magnitude of the shock - whether it is a positive shock or a negative shock, and how large it is. From Table 8 and 9, it can be shown that there is no one macroeconomic policy regime which performs better than the other across all growth shocks. Another concern is the stability of economic performance across a broad range of growth shocks, that is, when the economy faces a few domestic and external shocks at the same time.

Overall, we find from these economic experiments that great flexibility in exchange rate regime allows the central bank to conduct independent monetary policy in the Chinese economy, which is beneficial to China. The benefit will increase as its financial capital becomes more internationally mobile. This is due to the expansionary effects on the net flows on the capital account and net foreign savings as capital becomes more mobile.

In addition, most of the growth shocks have expansionary effects on the Chinese economy, which are represented by the increase in the real GDP level. When the economy adopts a floating exchange rate regime with high financial capital mobility, most growth shocks will cause deflation in the price level and real depreciation in the Chinese economy. This will further boost exports and improve trade balance. So these expansionary consequences have a positive impact on the Chinese economy as a whole.

To conclude, our experiment results show that the Chinese economy performs better and grows faster under the macroeconomic environment of a floating exchange rate with high financial capital mobility. Hence, this macroeconomic policy regime is the way towards becoming a more open and competitive economy that China is aiming for.

4. Conclusion

As stated from the outset of this paper, we are adopting a holistic approach to investigating the impact of macroeconomic policy regime on economic growth performance in China. This holistic approach is achieved by developing an open economy macroeconomic model. Under the general equilibrium framework of this model, this paper seeks to establish the importance of macroeconomic regime choice in explaining the performance of economic growth in the Chinese economy. In focusing on the exchange rate regime and financial capital mobility, and on a fixed exchange rate regime with low finan-

cial capital mobility and a floating exchange rate regime with high financial capital mobility in particular, this paper conducts economic experiments to analyse both domestic and external growth shocks under the two alternative macroeconomic policy regimes in the Chinese economy.

Although we may not know about the economy-wide consequences under the managed-floating exchange rate regime in China, especially when China is also in a gradual process of liberalising its capital account, we can know enough from our economic modelling work to identify cases of different domestic and external shocks under the two alternative macroeconomic policy regimes. The first macroeconomic policy regime, which includes a fixed exchange rate with low financial capital mobility, is what China operated in reality. The second macroeconomic policy regime, including a floating exchange rate with high financial capital mobility is a possible macroeconomic regime that China will implement in the foreseeable future. This is due to the fact that China is becoming more open than before, its exchange rate is being reformed to be more flexible, and China is in the transition to open up its capital account. On the other hand, China's financial market has also become more liberalised during recent years, which is part of its commitment for entry into the World Trade Organisation (WTO). The financial reform, together with the exchange rate reform and capital account liberalisation will further open up the Chinese economy.

Hence, it is rational for us to examine the four domestic and external growth shocks to the Chinese economy under the two alternative macroeconomic policy regimes. The impact of various growth shocks for different macroeconomic regimes is our interest and the topic of this paper. From our economic experiments, the simulation results show that greater flexibility in the exchange rate regime allows the central bank to conduct independent monetary policy in the Chinese economy, the benefit from which increases as financial capital becomes more internationally mobile. We also found that most growth shocks would cause an expansion in the real GDP level, and there is a deflation in the price level and depreciation in the real exchange when the economy operates a floating exchange rate regime with high financial capital mobility. Overall, the expansionary effect in this macroeconomic environment will be beneficial to the Chinese economy.

When we ask what economic growth might have been with alternative macroeconomic policy regimes in China, the question is just hypothetical. If the answer from the modelling is that economic growth would have been faster, then this says that all the policy changes, which are needed before the reform

of macroeconomic policy regime is possible, are a high priority, because their absence is constraining economic growth in China. Hence, our investigation of economic growth shock under alternative macroeconomic policy regimes will help us to understand what a good macroeconomic management is, and it will give us sound warning signals, and implications for further macroeconomic policy in China.

The subjection of the models, separately, to shocks associated with economic growth, to productivity, financial openness, the saving rate and trade liberalisation is an idea not developed in the growth literature. Moreover, in this paper these shocks are repeated under different assumptions about the macroeconomic policy regime, the idea being to find out which regime would be most growth-promoting. This is the contribution to existing research on macroeconomics and economic growth in China.

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	Economy	Agriculture	Industry	Service
Product volume accounts (H)				
Aggregate output, Y	1800	270	954	576
Consumption at home C_H	558.16	79.47	246.23	232.46
Use for investment at home I_S	500	100	212.50	187.50
Government consumption (H), G_S	213.33	19.20	38.40	155.73
Exports, X_S	528.51	71.33	456.87	0.31
Starting inventories, I_V	180	27	95.40	57.60
Volumes including F varieties:				
Aggregate home consumption, C_S	777.16	239.52	304.29	233.34
Imports, M	155.55	85.55	69.30	0.70

Table 1: Macroeconomic Model - Initial Equilibrium Volumes 1

	Economy
Aggregate output:	
Real GDP at producers' prices (factor cost), Y	1800
Real GDP (including indirect tax revenue)	1918.97
Stocks:	
Physical capita, K	8211.60
Home holdings of foreign bonds, B^*	164.88
Foreign holdings of home bonds, B_H^*	410.58

Table 2: Macroeconomic Model - Initial Equilibrium Volumes 2

	Agriculture	Industry	Service
Individual product prices:			
Home (producer), p_H, H$/unit	1.0	1.0	1.0
Foreign (trading), p^*, F$/unit	1.0	1.0	1.0
Aggregate consumption, p_S, F$/unit	0.81	1.22	1.15
Imports (after tariffs and exchange), p_M, H$/unit	1.04	1.10	1.00

Table 3: Macroeconomic Model - Initial Prices 1

	Economy wide
Aggregate prices:	
GDP price, P_Y, H$/unit	1.0
Capital goods (investment) price, P_I, H$/unit	1.0
Government service price, P_G, H$/unit	1.0
Consumer price, P_C, H$/unit	1.09
Nominal exchange rate, E, F$/H$	1.0
Yields and rates:	
Home bond yield, i	0.0486
Foreign bond yield, i^*	0.0427
Gross rental per unit of home physical capital, R_K	0.1
Net real rate of return on home physical capital, r_{KN}	0.04
Real home bond yield net of capital income tax, r_N	0.0423
Depreciation rate, δ	0.06
Rate of time preference, ν	0.06454

Table 4: Macroeconomic Model - Initial Prices 2

	H$ value
Capital market identity:	
Investment, $P_I I$	446.99
Private saving, S	819.96
Tax revenue, T	213.33
Government spending, $P_G G$	213.33
Net foreign saving (private net capital account inflows), S_{NF}	2.03
Annual increment to official foreign reserves, ΔR	375
Balance of payments:	
Current account net inflows, CA	372.97
Capital account net inflows, KA	-372.97
Tax revenue:	
Total tax, T	213.33
Income tax (labour and capital), T_Y	94.37
Consumption tax, T_C	108.61
Import tariff, T_M	10.35
Export tax, T_X	0.01

Table 5: Macroeconomic Model - Accounting Identities - Initial Values

	Agriculture	**Industry**	**Service**
Sectoral shares:			
Labour expenditure, β_{11}, β_{12}, β_{13}	0.54	0.55	0.33
Inputs to capital goods production	0.22	0.40	0.66
Inputs to government services	0.24	0.05	0.01

Table 6: Macroeconomic Model - Key Parameters 1

	Economy wide
Elasticities:	
Money demand to GDP, ε_{MY}	0.5
Money demand to the nominal interest rate, ε_{Mi}	0.1
Net foreign saving the interest parity ratio, ε_{SF}	5.0
Real net investment to real capital return/real interest rate ratio, ε_I	1.0
Inventories to producer price, ε_V	0
Utility to aggregate consumption volume, ω	0.4
Elasticities of substitution:	
In consumption, among each good, σ	1.5
In consumption, between home and imported varieties, σ_S	2.5
In capital goods production, among each good, σ_I	0.5
In government consumption, among each good, σ_G	0.5
In foreign consumption, between home and foreign goods, σ^*	2.5
Tax rates:	
Labour income, τ_L	0.05
Capital income, τ_K	0.15
Consumption, τ_C	0.15
Imports, τ_M, good 1	0.04
Imports, τ_M, good 2	0.1
Imports, τ_M, good 3	0
Exports, τ_X, good 1	0
Exports, τ_X, good 2	0
Exports, τ_X, good 3	0

Table 7: Macroeconomic Model - Key Parameters 2

	Real GDP	**Price**	**Real Exchange Rate**
Productivity Gain	Increase	*Deflation*	*Depreciation*
Risk Premium Reduction	Increase-LR	Deflation-LR	Depreciation-LR
Agriculture Trade Reform	Decrease	Inflation-LR	Appreciation-LR
+ Consumption Tax Reform	Increase-LR	Inflation-LR	Appreciation-LR
Saving Rate Increase	Increase	Deflation-LR	Depreciation-LR

Table 8: Macroeconomic Model - Experiment Summary - Macro Regime 1

	Real GDP	**Price**	**Real Exchange Rate**
Productivity Gain	Increase	Inflation	Appreciation
Risk Premium Reduction	Increase	Inflation	Appreciation
Agriculture Trade Reform	Decrease	Inflation-LR	*Depreciation*
+ Consumption Tax Reform	Increase-LR	*Deflation*	*Depreciation*
Saving Rate Increase	Increase	*Deflation*	*Depreciation*

Table 9: Macroeconomic Model - Experiment Summary - Macro Regime 2