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The Role of External Variables in the Chinese Economy ; Simulations from a Macroeconomic Model of China

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SUMMARY

This paper presents the structure of a macroeconometric model proposed to study the effects of the openness policy on the Chinese economic success. Through this model, this paper attempts to understand the links existing between the Chinese key-macro-variables and above all the role of external variables on the Chinese economy. Among these external variables, special care is accorded to exchange rate and foreign direct investment (FDI).

Even if this modelling does not want to supply a global view of the Chinese economy, it attempts to give the maximum of important relationships for these goals. Because it is a macroeconomic model, it excludes regional and sector-related analysis. Because it emphasises the external part of the economy, this model neglects all the internal relationships that are unconnected with the rest of the world. Error correction modelling is the general technique used for estimating this model. This technique allows the modeller to give the long run specification for the different equations while defining the short-run dynamics. The model equations are generally estimated econometrically on the period 1984-1995 ; a period particularly rich in transformations of the Chinese economic system and in structural breaks.

The external part of the model defines the foreign trade relationships (exports and imports) and the determinants of FDI. The internal part is based on the supply-side of the economy and is centred on a production function for industrial output. Some demand-side equations (households' consumption and investment) are also introduced as well as equations for money demand and domestic prices.

As the importance of the economic openness of China is emphasised, this model is introduced into a multinational model in order to determine how the world economic conditions can influence the Chinese variables. This introduction is useful, first, to evaluate how a shock on a Chinese variable can affect the world ones and, above all, to take into account the possible feedback effects on the Chinese economy. The multinational model of the NIESR (NiGEM or National Institute Global Econometric Model) has seemed perfectly adapted to such an exercise. Since it proposes a detailed modelling of the major economies and since it stresses the effects of shock transmission at an international level, NiGEM gives the world environment of the Chinese model during the simulation exercises.

Through simulations, the role of the authorities is evaluated by the effects of economic policy decisions on the economy as a whole. Two simulations are implemented: a devaluation, to assess the effect of the exchange rate policy and a reduction in the inflow of FDI, to evaluate the importance of the policies promoting FDI.

If devaluation has some effects on the Chinese economy, it is only in the short run. In the long run, due to a strong response of prices, competitiveness does not improve after a devaluation. Economic transformations have made domestic prices more sensitive to world prices. As a consequence, the devaluation is less powerful than when domestic prices were completely isolated from the rest of the world. This result indicates that the opening policy

has weaken the effect of exchange rate policy and that improvement in the Chinese competitiveness must be based on productivity gains and not on manipulation of exchange rates.

On the contrary, inflows of FDI have a positive effect on the Chinese economy in the long run, especially on output and on competitiveness. Because FDI improves technical progress, it acts directly on potential growth. By affecting positively potential growth, FDI prevents the economy from suffering from large inflationary pressures. This stabilising effect implies competitiveness gains which, in their turn, favours FDI inflows. These simulations stress a virtuous circle into which FDI favours both long run growth and the conditions to develop new long-term capital inflows. Finally, it is worth noting that FDI promotes trade but as it reinforces import dependency, the effect on external balance is negative. However, this negative effect stabilises in the long run due to an improvement in competitiveness.

Classification : JEL codes C51, C53, 011.

Keys words : macroeconometric modelling, transition economies, China.

RESUME

Ce document présente la structure d'un modèle macroéconométrique proposé pour étudier les effets de la politique d'ouverture dans le succès économique chinois. A travers ce modèle, cette étude cherche à comprendre les liens existant entre les principales variables chinoises et surtout le rôle des variables externes dans l'économie chinoise. Parmi ces variables, une attention particulière est accordée au taux de change et à l'investissement direct étranger (IDE).

Même si ce modèle ne veut pas proposer une vision globale de l'économie chinoise, il tente de donner le maximum de relations importantes pour ces objectifs. Parce que c'est un modèle macroéconomique, il exclut toute analyse sectorielle et régionale. Parce qu'il met l'accent sur la partie externe de l'économie, ce modèle néglige toutes les variables internes qui ne sont pas connectées avec le reste du monde. La modélisation repose sur l'estimation de modèles à correction d'erreurs qui permettent de donner des spécifications de long terme pour les différentes équations tout en définissant les dynamiques de court terme. Les estimations économétriques des équations du modèle se font généralement sur la période 1984-1995, une période particulièrement riche en transformations du système économique chinois et en ruptures structurelles.

La partie externe du modèle définit les relations commerciales (exportations et importations) et les déterminants de l'IDE. La partie interne est basée sur le secteur d'offre de l'économie et est centrée sur une fonction de production pour le produit industriel. Quelques équations de demande sont également introduites (consommation des ménages et investissement) ainsi que des équations pour la demande de monnaie et pour les prix internes.

Comme l'accent est mis sur l'ouverture économique de la Chine, ce modèle est introduit dans un modèle multinational afin de déterminer la manière dont les conditions économiques mondiales peuvent influencer les variables chinoises. Cette introduction est utile, premièrement, pour évaluer comment un choc sur une variable chinoise peut affecter les variables mondiales et, surtout, pour prendre en compte les possibles effets de retour sur l'économie chinoise. Le modèle multinational du NIESR (NiGEM ou National Institute Global Econometric Model) a semblé parfaitement adapté pour cet exercice. Puisqu'il propose une modélisation détaillée pour les principales économies et puisqu'il met l'accent sur la transmission des chocs à un niveau international, NiGEM donne l'environnement mondial au modèle chinois au cours des exercices de simulations.

A travers des simulations, le rôle des autorités est évalué par les effets des décisions de politique économique sur l'économie dans son ensemble. Deux simulations sont faites : une dévaluation, pour estimer l'effet de la politique de change et une réduction des entrées d'IDE, pour évaluer l'importance des politiques de promotion de l'IDE.

Si les dévaluations ont quelques effets sur l'économie, ce n'est seulement qu'à court terme. A long terme, en raison de la forte réponse des prix, la compétitivité ne s'améliore pas après une dévaluation. La libéralisation des prix a rendu les prix internes plus sensibles aux prix mondiaux. De ce fait, la dévaluation est moins efficace que lorsque les prix étaient

complètement indépendants du reste du monde. Ce résultat indique que la politique d'ouverture a affaibli la politique de change et que l'amélioration de la compétitivité chinoise doit se baser désormais sur des gains de productivité et non plus sur une manipulation des taux de change.

Au contraire, les entrées d'IDE ont un effet positif sur l'économie chinoise à long terme, notamment sur la production et sur la compétitivité. Parce que l'IDE améliore le progrès technique, il agit directement sur la croissance potentielle. En affectant positivement la croissance potentielle, l'IDE empêche l'économie de souffrir de pressions inflationnistes graves. Cet effet stabilisant implique des gains de compétitivité qui, à leur tour, incitent les entrées d'IDE. Ces simulations montrent l'existence d'un cercle vertueux dans lequel l'IDE favorise à la fois la croissance et les conditions pour accroître les entrées de capitaux de long terme. Enfin, il est important de noter que l'IDE encourage le développement du commerce extérieur mais, renforçant la dépendance à l'égard des importations, son impact sur les comptes extérieurs est négatif. Cependant, cet effet négatif se stabilise à long terme en raison de l'amélioration de la compétitivité.

Classification : JEL codes C51, C53, 011.

Mots Clés : modélisation macroéconomique, économies en transition, Chine.

The Role of External Variables In the Chinese Economy

Simulations from a macroeconometric model of China

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1. INTRODUCTION

Since the beginning of the reforms in 1978, China has known an impressive economic development (real output has grown by 8.3 per cent per annum). The progress in the Chinese economic reforms is undoubtedly the main reasons for the Chinese take off. However, explaining why reforms have led to this impressive growth requires a more attentive investigation. Reforms have aimed to achieve two main goals : the marketisation of the internal economy and the opening toward the rest of the world.

What are the channels by which the reforms have led to this economic success ? Internal restructuring or openness ? Is the Chinese miracle a 'myth' (as shown by Krugman[2] for Asia) or a reality ?

This paper, through the building of a medium-scale macroeconometric model, aims to explain what are the driving forces that have led China to move from a backward centrally planned economy to a major actor of the world trade. It emphasises the role of the openness in the Chinese success not simply by its dynamic effect on the economic activity but above all by its impact on technology transfer that narrows the technological gap between rich and poor nations. The openness of China has been realised through the growing role attached to trade and since the 1990s through the huge amounts of inward foreign direct investment (FDI) that China has attracted. China is now the tenth largest

[1] This paper was written while the author was a research officer in the National Institute of Economic and Social Research (London). The author has benefited from the help of Ray Barrell, Eric Girardin, Ian Hurst, Dirk Willem te Velde and Nigel Pain. They are in no way responsible for any errors in this paper. Comments on earlier versions by Jean-Claude Berthélemy, Agnès Benassy-Quéré, Jean-Pierre Laffargue and Simon Wren-Lewis are gratefully acknowledged. The work is part of a project financed by a European Commission grant (contract number ERBFMBICT950260).

[2] Paul Krugman (1994) in an article entitled 'The Myth of Asia's miracle' put the newly industrialising countries and the Former Soviet Union in the same category of economic inefficiency.

trading nation, and in 1998, it was beneficiary to $45.5 billion of FDI, i.e. more than 6 percent of the Chinese GDP and about 20 per cent of total world FDI (nearly 50 per cent of total FDIs in developing countries).

A macroeconometric model is likely to catch the interrelated effects that may have played in the Chinese development. To stress even more the role of world economy in China, the model presented here has been linked to a world model (NiGEM[3]) so as to take into account the feedback effects that China can receive from its major partners.

As a transforming economy, modelling China requires some precautions for the treatment of structural change, as we will see in section 2. Section 3 gives the general structure of the model and the methodology used to get the estimates of the various relationships that we have set. Section 4 presents the estimation of the model and stresses its underlying theoretical framework. Section 5 gives the results of simulations realised to show the role of external variables in the Chinese economy. Section 6 offers some concluding remarks.

2. GENERAL PRESENTATION OF THE CHINESE MEDIUM-SCALE MODEL

2.1. General structure

Before presenting its structure, it is important noting that, as this model aims to understand the effects of openness on the world economy, special care is accorded to the external part of the Chinese economy (specially external trade and foreign direct investment). The internal equations justify their presence only by the link existing between some internal variables with the external ones. This explains why we do not find models for agricultural or service activities, which seems to have weak links with the rest of the world.

The originality of this model is double. First, it is based on a quarterly database, which allows us to have more observations to make our inferences (the methodology to construct quarterly data is presented in Appendix 3). Second, its final aim is to be introduced into a world model (NIGEM). This second point is particular relevant for our purpose since we want to study the effect of the Chinese openness on the rest of the world and the multiple interactions between China and its world partners.

The model is divided into two parts : the external part and the internal part. The external part is divided into three blocs : the import and export price equations ; the exports and imports of goods and services ; the determinants of FDI. Competitiveness defined as the ratio of world to domestic prices is a central variable in this external part. The internal part consists of a supply-side group of equations (output, wages, labour demand and capacity utilisation), a demand-side group of equations (consumption and investment), a money demand equation and a domestic price equation. The government sector is present but only under the form of some trivial identities.

Three driving forces are active in this model : the wealth effects ; the competitiveness effects and the capacity utilisation effects. The link between internal and external part is supported by the concept of net wealth (defined by the sum of money, public debt[4] and net

[3] National Institute Global Econometric Model is the NIESR (National Institute of Economic and Social Research) world model.

[4] As a consequence, the model assumes a non ricardian economy.

foreign assets) playing a role in the consumption behaviour of the households. The central role given to wealth allows us to introduce stock effects into our model. Modelling the process of asset accumulation in the economy gives the understanding of the effects that private saving has played in the Chinese economic success. Competitiveness is also central in our model. Any undervaluation has a positive effect on growth through its effect on exports and on wealth (via its impact on current account). Again, the link between internal and external part is highly related and feedback effects are likely to play a crucial role in the simulation exercises. Finally, capacity utilisation (defined as the ratio of actual to desired output) has a double impact. Through its presence in the price system, it plays the role of an inflationary pressure indicators and can then influence competitiveness. Its second effect is related to its impact on investment. Investment is modelled as depending on the difference between desired and actual capital stock.

The three driving forces are highly related to each other stressing the interest to model China in such a way in order to account for these multiple interactions that can play an active role in an economy like China.

2.2. Data and estimation techniques

The model uses quarterly data and the equations are generally estimated for a period ranging between 1984 and 1995. Sources of the database and treatment of data problems are described in Appendix 2.

Concerning the estimation technique, we have used the Error-Correction Model (ECM) (Banerjee et al., 1993) to specify the general form of the equations.

The general form of an ECM for the function y = f (x) is as following :

$$\Delta y_t = c + \sum_i a_i \Delta y_{t-i} + \sum_j b_j \Delta x_{t-j} + \gamma y_{t-1} + \varphi x_{t-1} + u_t, \qquad t = 1, \ldots, n.$$

where c is a constant, Δ is the difference operator and u_t is the disturbance term. The variables y_t and x_t must be non stationary (or integrated of order one, i.e. Δy_t and Δx_t must be stationary). The error correction term, γ, must be negative and indicates the speed of adjustment between the short term desequilibrium and the long term equilibrium.

The adoption of error-correction modelling is justifiable only if the relevant variables pass the unit-root tests. Appendix 3 displays the degree of integration tests for all our variables used in an ECM in order to ensure that they have the appropriate order of integration.

To take into consideration regime shifts we have introduced some China-specific variables that could represent the transforming aspect of the economy. We will see more precisely later the specification of each equation. However, despite the use of these specific variables, some instability remained in a first estimation of the different relationships. In the estimation period, for a major part of the relationships, an instability occurs in the third quarter of 1988 suggesting the presence from this date of a regime shift. This date corresponds to a leadership change and to a serious inflationary period. Hence, this systematic instability in 1988 justifies a different methodology necessary to take this regime shift into account.

This methodology, defined in Gregory and Hansen (1992), is based on the use of a dummy-variable taking into consideration a change both in the intercept of the relationship and in the slope of the regressors.

To model the structural change we must define the following dummy variable:

$$\delta \quad \begin{cases} = 0 \text{ for } t = 0,..., k \\ = 1 \text{ for } t = b+1,..., k. \end{cases}$$

where b denotes the time of the break (in our case k = 1988:3).

We use this dummy-variable in the ECM. With δ we can not only take into account the change in the intercept (level shift) but also the change in the regressors' coefficients (regime shift). The following equation gives the general structure of our ECM with structural change :

$$\Delta y_t = c + c'\delta_t + +\pi x_{t-1} + \pi' x_{t-1}\delta_t + \gamma y_{t-1} + \sum_i a_i \Delta y_{t-i} + \sum_j b_j \Delta x_{t-j} + u_t$$

with c' and π', the change from the break, respectively in the intercept and in the slope of the exogenous variables.

3. ESTIMATION OF THE MODEL

3.1. External trade and current account

The external part is the key-part of the model. It investigates how competitiveness and foreign investment affect the Chinese external trade. Besides, it links the Chinese model with the rest of the world.

In this model trade prices are just treated as a weighted geometric average of world prices and domestic prices. Usually trade volumes are explained by a demand term and a price-competitiveness term. However, modelling external trade according to this formulation meets some problems relative to the estimations of the export and import volume equations. The statistical analysis suggests that another variable is missing and indicates that other relevant variables excluded from the conventionally specification are likely to have an impact on trade. Conventional trade equations must be augmented by measures of non-price, or technological, competitiveness. We argue here that for a country like China inward FDI is able to catch these effects both in the export equation and in the import one. FDI is taken as a measure of innovation since it embodies technology and can then improve the technological level of the Chinese industry. To close our model of foreign trade in China, we must have an equation for FDI^*. Chinese FDI is assumed to be determined by two main components : the size of the internal market (proxied in our model by Chinese real GDP) and cost advantages (summarised here by real exchange rate).

We have then a complete model for foreign trade. Equations (1) to (5) displays the specification of this model.

$$P^x = f (e.P^w , P) \qquad f_1 , f_2 > 0 \qquad (1)$$

$$P^m = f' (e.P^w , P) \qquad f'_1 , f'_2 > 0 \qquad (2)$$

$$X = g (Y^w , P^x / e.P^w , FDI) \qquad g_1 , g_3 > 0 ; g_2 < 0 \qquad (3)$$

$$M = g' (Y , P^d / P^m , FDI) \qquad g'_1 , g'_2 , g'_3 > 0 \qquad (4)$$

$$FDI = h (Y , e.P^w / P) \qquad h_1 , h_2 > 0 \qquad (5)$$

where P^x and P^m are the price of exports and imports, e is the nominal exchange rate, P^w and P are the world and domestic prices, X and M are the export and import volumes, Y^w and Y are the world and domestic demands and FDI is foreign direct investment.

Table 1 summarises the long-run estimates of our foreign trade model[5].

The model can be solved in a function of trade balance :

$$TB = P^x.X - P^m.M$$

$$\Leftrightarrow \qquad TB = k (e.P^w / P , Y^w , Y) \qquad (6)$$

The expression of trade balance (equation (6) shows that our model converges toward the conclusion of the traditional models of trade : the trade balance depends on demand factors (Y^w and Y^d) and on price-competitiveness. However, the central difference concerns the estimations of the income-elasticities. Formulated as equations (3) and (4), we should prevent the income-elasticities from exhibiting too high values since FDI must take into account the trend-effect, which usually applies with the traditional formulations. In addition to the trade balance, we have defined a current account CA, defined as the sum of the trade balance defined above and the interest payments received on net foreign assets NFA (CA = *TB + r*NFA = DNFA* where r* is the world interest rate).

Table 1 : Long-run estimates of foreign trade model (1984-1995)

Dependant variables	Regressors							
	eP^w	P	Y^w	Y	$\frac{P^x}{eP^w}$	$\frac{eP}{P^m}$	$\frac{P}{eP^w}$	FDI
P^x	0.72[a]	0.28[a]						
P^m	0.87[a]	0.13[a]						
X^{goods}			1.13		-0.68			0.11
M^{goods}				0.62		0.95		0.24
X^{serv}			1.00[b]				-0.92[c]	0.28
M^{serv}				1.00[b]			0.80[c]	0.57
FDI				1.47			-0.25	

Notes : [a] The sum of the coefficient is constrained to unity.
[b] Demand elasticities of trade of services are assumed to be equal to one.
[c] Real exchange rate is the competitiveness indicator of trade of services.

For a complete description of the data, see Appendix 2 and for the unit roots tests, see Appendix 3.

* Following a previous study (Dées, 1998).

5 Estimation results and tests are available in Appendix 1.

3.2. The supply-side

The supply-side of the model is centred on an industrial production[6] function built according to the following CES form in which technical progress is only labour augmenting:

$$Q^* = g\left[s(K)^{-r} + (1-s)\left(Le^{lt}\right)^{-r}\right]^{-1/r} \qquad (7)$$

where Q*, K and L denote industrial output[7], capital and industrial labour force.

This production function allows us to study the sources of technical progress in China. We investigate two different kinds of technical progress sources :

- an external source which affects the productivity of the production factors ;

- an internal source which affects the organisation of the production as a whole.

The factors affecting factor productivity (in our case labour productivity since we have assumed a labour augmenting technology) are assumed to come from abroad. Following Barrell and Pain (1997), we endogenise technical change by assuming that technical progress is a function of the stock of FDI in real terms, together with an exogenous element proxied by a linear time trend and the imports over GDP. This specification for technical change seems more satisfactory than the traditional time trend (λt) as written in equation (7). Technical progress is then affected by technological transfer from abroad via FDI and imports of capital and machinery. The term λt in equation (7) must be replaced by :

$$lt = l_{TIME}\,TIME + l_{FDI}\ln(FDI) + l_{M}\ln(M/GDP) \qquad (8)$$

The model allows us to investigate a second source of progress influencing not the factor productivity but the organisation of the production as a whole. This internal source of progress is a specificity of a transitional economy. The organisation of production is able to improve relative to the degree of liberalisation of the economy. To introduce this internal source, we assume that the scale parameter (γ), constant in a market economy, is a varying parameter in a transitional economy. This scale parameter is assumed to be a function of the liberalisation degree. Let :

$$\gamma = \gamma(Q^s / Q) \qquad (9)$$

where Q^s is the non-state sector production.

The scale parameter is then assumed to be a negative function of the share of the state-owned enterprises in the total industrial production. The more this share diminishes, the more efficient is the utilisation of the production factors and the larger is the quantity produced in the economy. A better organisation of the production should improve the total production in the economy. The introduction of this variable allows us to take into account the specificity of the Chinese economy in which the role of the state sector is still important. A more precise modelling should have distinguished the state sector of the non-state sector

[6] Industrial production represented 38.5 percent of total product in 1978 and 53 percent in 1995.

[7] The star indicates that this function specifies the supply-side equation.

in order to take account of the redistribution effects between the two sectors. However, this distinction would have had few advantages, explaining its presence only in the definition of the production function.

The estimattion of the production function (7) with the two specifications of the technical progress (8) and (9) is realised in two steps.

In the first step, we obtain estimates of the elasticity of substitution ($\sigma = 1 / 1+\rho$) and the coefficient of total factor productivity (λ) by using the labour demand equation implied by the marginal productivity condition that the marginal product of labour should equal its (mark-up adjusted) real wage[8].

$$\partial Q^* / \partial L = \gamma^{-\rho} (1-\delta) Q^{*(1+\rho)} \left(L e^{\lambda t}\right)^{-(1+\rho)} e^{\lambda t} = \beta (W / P) \qquad (10)$$

where β denotes the mark-up and W and P denote money wage and domestic prices. Rearranging (10) we obtain the log-linear labour demand equation.

$$\ln(L / Q^*) = -\sigma \ln \beta - \sigma \ln(W / P) + (\sigma - 1) \ln(\gamma) + \sigma \ln(1-\delta) + (\sigma - 1) \lambda t \qquad (11)$$

Equation (8) with the specification of technical progress written in equation (8) gives the form of the equation that has been estimated :

$$\begin{aligned} \ln(L / Q^*) &= -\sigma \ln \beta + (\sigma - 1) \ln(\gamma) + \sigma \ln(1-\delta) - \sigma \ln(W / P) \\ &+ (\sigma - 1)(\lambda_{TIME} TIME + \lambda_{FDI} \ln(FDI) + \lambda_M \ln(M / GDP) \end{aligned} \qquad (11')$$

This equation allows us to estimate the elasticity of substitution (σ is just the coefficient attached to the real wage term), the substitution parameter (ρ) and the coefficient of technical progress (λ). Results are displayed in table 2. The constant of this estimated equation corresponds to ($-\sigma \ln \beta + (\sigma - 1) \ln(\gamma) + \sigma \ln(1-\delta)$). The distribution parameter (δ) is calculated from wage bill divided by the value of output.

The role of FDI in the technical progress is significant only in the 1990s, which is easily explained by the large-scale expansion of FDI since 1990. Openness (proxied by M / GDP) is significant throughout the period, meaning that technology transfer via imports has played an active role in the Chinese technical progress.

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[8] This method depends to the assumption that technical progress is labour augmenting. A different form of technical progress would have required the estimation of an equation for the demand of capital defined in a similar way to the labour demand equation. Capital demand equation would have been defined by the marginal productivity conditions that the marginal product of capital should equal its mark-up adjusted real user cost. We have not chosen this alternative route because of the weak significativity of interest rates in China. Our assumption of labour augmenting technical change is not unrealistic nevertheless. Theoretical analysis supports this from of technical change (see e.g. Barro and Sala-i-Martin, 1995, for a presentation and a demonstration of the necessity of technical progress to be labour augmenting in the neoclassical theory).

The second step aims at integrating the specification of the scale parameter (γ) according to the function set in (9). All the other parameters of equation (7) have been determined during the first step. This second step is a mix between estimation and calibration. The function for γ is obtained by estimating equation (7) after replacing all the parameters by their values derived from the estimation of the labour demand equation.

Table 2 : Labour demand : long-term coefficients (1984Q2-1994Q4)

Variables	Long-run Coefficients	Corresponding production function parameters
ln(Q*)	1[a]	
ln(W/P)	-0.304	$-\sigma$
Time	0.026	λ_{TIME}
ln(FDIS)	0.016[b]	λ_{FDI}
ln(M/GDP)	0.206	λ_{M}

a : imposed by the theoretical structure of the model
b : from 1990Q1 to 1994Q4.

The results of this second step can be summarised by the following long run equation (T-statistics into parentheses):

$$Q^* = (0.46\text{-}0.15*Q^s/Q\text{-}0.01*D88\_4).\left(0.8(K)^{-1.007} + 0.2(L*e^{lt})^{-1.007}\right)^{-0.993}$$

(41.02) (-17.79) (-5.12)

NLLS estimation Period : 1985Q2-1994Q2 $R^2 = 0.99768$

The dummy variable accounts for the shock implied by the strong inflationary episode in the late 1988.

Only the scale parameter is estimated. It depends on share of state-owned enterprises in total industrial output (Q^s/Q) and on the dummy indicated a regime shift from 1988Q4. The result is quite sensible since it indicates that the output scale increases when the share of public sector diminishes. Thanks to a better organisation of the production, China has been able to obtain scale gains showing that economic liberalisation brings efficiency gains which have significant effects on economic activity. This production function defines the industrial production determined by the supply side conditions. We call the production determined here **desired output** (equivalent to an output trend). We will see later that the production determined by demand factors (noted Q) is called **actual output**. The gap between the two outputs will determine the capacity utilisation factor, which will be central in the price determination system.

These two steps are sufficient to determine the supply side of our model. The labour demand is determined by the first step. The second step determines the production function. Finally, the real wage equation is obtained once computed the last parameter (the mark-up β). It is calculated with data for the wage level since it is the sole unknown of equation (11). We assume that the mark-up is constant throughout the period. This assumption could be highly questionable in a country in transition. However, the

transforming aspect of the Chinese economy has already been took into account through the scale parameter of the production function.

3.3. The demand-side

a) Households' consumption

The demand-side of the model is theoretically inspired by the works linking consumption and non-human wealth. We assume that each household determines its consumption level as a function of disposable income and financial wealth :

$$C_t = f(Y_t, N_t) \qquad (12)$$

where C is consumption, Y is disposable income and N net financial wealth.

This is the classical representation of the real balance effect, which states that the value of net financial wealth affects consumers' expenditures. We would expect that in the long-run the ratio of net wealth to disposable income should stabilise. Barrell and in't Veld (1992) note that this can arise for several reasons, including a marginal rate of substitution between consumption and net wealth that depends only upon the wealth consumption ratio and not upon time or the level of wealth. As Barrell and in't Veld, we assume then that in the long-run the wealth and income elasticities sum to one, and that they are independent of time and the level of net financial wealth. This implies that both the consumption income ratio and the wealth income ratio are constant in the long-run. Considering this assumption, estimates of the consumption function for China give a share for after-tax income equal to 84 percent (the share of net wealth is then equal to 16 percent).

b) Investment

Domestic investment is split into two components : investment in capital (I^K) and miscellaneous investment.

Investment in capital can be defined as the difference between capital and its previous period value (adjusted for depreciation) net of foreign investment. This investment is assumed to be a function of the adjustment between desired and actual stock of capital.

Actual stock of capital (K) is just defined as the accumulation of investment adjusted for depreciation according to the perpetual-inventory method[9] (the constant depreciation rate is assumed to be equal to 10 percent per annum). Desired capital stock (K*) is defined as the stock required to match exactly the production capacity with the demand for industrial products. We solve then the production function for capital by using actual output Q instead of desired output Q* (see Appendix 1 for the detailed writing of this equation).

The long-run equation for investment in capital (I^K) is given by the following relation[10]:

$$\ln (I^K / P) = 0.33 * \ln(K^* / K) \qquad (13)$$

[9] see e.g. Barro and Sala-i-Martin (1995).

[10] Note that this equation cannot really be interpreted as an error-correction mechanism because of the difference between the log of investment and the change in the log in capital. This indicates nevertheless the positive link between investment decisions and the adjustment required to close the gap between the desired and the actual stock of capital.

The investment equation is equally central in the model since it constitutes a mechanism to transfer the effect of capacity utilisation into the rest of the model.

c) Total final expenditures and the actual industrial output

To finish the presentation of our demand equations, we must emphasise a point that is crucial in any model : the reconciliation between supply and demand. Tsang and Ma (1997) reconcile supply and demand just by a stock variation. We proceed here in a different way.

The difference between supply and output creates price tensions that have a significant influence on the domestic prices. This difference must then be calculated in order to introduce it in the inflation model. Hence, we define a capacity utilisation term, which has to capture inflationary pressures emerging from the difference between supply and demand. This term is traditionally calculated by dividing output by its trend. We have made in fact the same thing. The output trend is called here the desired output (Q*) and the current output is called the actual output (Q). The desired output is the output that prevails under the supply condition given by the production function. The actual output is in contrast the output given by the demand conditions.

The desired industrial output has already been defined by our production function. We must now define the actual industrial output, which takes into account demand terms. The actual output is defined just as an error correction between output and expenditures. We introduce here a term of *Total Final Expenditures* (TFP) that is defined as the sum of GDP and imports in domestic currency. The demand for industrial products is simply estimated as follows (T-statistics into parentheses):

$$\Delta \ln(Q) = 0.43 - 0.12 * (\ln(Q_{-1}) - \ln(TFE_{-1}/P_{-1})) + 0.55 * \Delta \ln(TFE_{-1}/P_{-1})$$

(3.11) (-3.04) (8.89)

OLS estimation Period : 1980Q2-1992Q1 $R^2 = 0.68771$

where TFE is Chinese Total Final Expenditures.

Having two industrial outputs allowed then to reconcile supply and demand and to compute our inflationary pressures indicator (CU for Capacity Utilisation) :

$$CU = Q / Q^* \qquad (14)$$

This variable will be central to the model's price system. It constitutes one of the main driving force of the model since it transfers any excess of output relative to its trend to the price equation and then to real exchange rate. This latter can imply feedback effects on output trough its effects on demand (via exports and wealth).

3.4. Inflation

We assume that pricing behaviour of industrial enterprises in transition economies can be characterised by a mark-up model (as for instance in Qin and Vanags, 1996), where domestic prices depend on world prices and on unit labour costs.

To take into account the importance of controlled prices in price level, we add the capacity utilisation term. The greater the preponderance of controlled prices in total prices, the

weaker the link between price changes and capacity levels (Commander and Corricelli, 1991). One would therefore expect a classical planned economy to lack any equilibrating mechanism. Following Commander and Corricelli (1991), we have also introduced an indicator of excess purchasing power in consumer markets to account for demand-side pressure for relative price adjustment on the part of the planner. The inclusion of both an output gap and an explicit purchasing power variable is an attempt to pin down the particular excess demand features of a centrally planned economy when controlled and market-prices co-exist and when the planners monitor their relative price (a characteristic of the two-track pricing system in China).

To take into account the structural change after the inflation episode of 1988, we have added a second intercept (equal to 1 only from 1988Q4). Concerning the import prices, their influence on the Chinese inflation are significant only from 1988Q4. Before 1988, we can reasonably assume that world prices did not influence the Chinese price system. The excess purchasing power variable is proxied by the change in money stock relative to the change in nominal GDP. Two dummies are also added (equal to 1, respectively, in 1984Q1 and 1988Q4). They correspond to the inflationary episodes of 1984 and 1988. This gives the following results (T statistics into parentheses) :

$$\Delta\ln(P) = \underset{(-0.76)}{-0.003} + \underset{(5.96)}{0.03}*\delta + \underset{(4.34)}{0.12}*\ln(ULC_{-1}/P_{-1}) + \underset{(3.06)}{0.08}*\ln(P^{m}_{-1}/P_{-1})*\delta$$

$$+ \underset{(3.75)}{0.46}*\ln(CU_{-1}) + \underset{(3.01)}{0.09}*\Delta\ln(M1_{-1}/GDP_{-1}) + \underset{(2.67)}{0.04}*D84\_1 + \underset{(3.25)}{0.03}*D88\_4$$

OLS estimation Period : 1984Q1 – 1994Q4 $R^2 = 0.62966$

where ULC, P^m and M1, denote unit labour costs, import prices and narrow money. δ is a dummy variable equal to 0 before 1988Q4 and 1 afterwards.

In the long run the Chinese domestic prices were only influenced by unit labour costs until the end of 1988. From 1989, they have been influenced both by unit labour costs (for 60 percent) and by import prices (for 40 percent). The effect of inflationary pressures is significant (see Appendix 1 for tests) and the coefficient of capacity utilisation is quite high. This allows capacity utilisation to have a strong role in the model reacting to any overheating of the Chinese economy. This will be central in the convergence toward the model's long run equilibrium since any excess of output relative to its trend will be cancelled over time by increases in prices. This also indicates that the internal restructuring of the Chinese economy is quite successful since the significativity of capacity utilisation indicates the presence of equilibrating mechanism that should be absent in purely planned economy. Finally, the excess purchasing power in consumer markets has a significant effect on inflation reflecting the coexistence of administered and market prices in the Chinese price system.

3.5. Money demand

Following Cagan (1956), we use the following log-linear type demand for money :

$$\ln(M1/P)_t = a_0 + a_1 \ln(Q_t) + a_2 \Delta\ln(P_t) \qquad (15)$$

where M1 is the nominal balances of the Chinese narrow money aggregate ; P the general retail price index ; Q is real income proxied by real industrial production and $\Delta\ln(P)$ is the annual inflation rate in log.

Following the previous studies on money demand in China (e.g. Qin, 1994 ; Girardin, 1996), we have estimated the money demand only from 1989. Prior to this date the estimation of the money demand function displays some inconsistent results suggesting that the behaviour of Chinese agents follows other specifications (e.g. the long-run income elasticity exhibits high values). However, from 1989, the conventional money demand function as studied in our theoretical presentation seems to be consistent with the Chinese series. Consequently, our results seems to be relevant regarding the usual outputs found in such an exercise :

$$\ln(M1/P)_t = -3.17 - 0.16\delta_t + 0.97\ln(Q)_t - 0.71\Delta\ln(P)_t$$

where $\delta_t = 0$ before 1993Q1 and 1 afterwards.

These results shows that the inflationary episode of 1993-94 has implied a change in the intercept of the money demand function. Only the constant value has changed ; the long-run structure staying stable between 1989 and 1997. The coefficients found are consistent with both the theoretical apriorism and the previous results of similar studies on the Chinese money demand.

3.6. Government sector

The aim of this model is not to provide a model of government's behaviour. First, it is too complicated. Second, it is not central in the building of the model since the government is present there only to link some relationships (fiscal debt is one of the component of net wealth, fiscal expenditures and tax feed the domestic demand). Then, some basic fiscal rules are defined. Fiscal expenditures and tax are assumed to grow in line with nominal GDP. Government debt is defined by the accumulation of fiscal deficits reduced by a part of the debt, which has been monetized[11].

3.7. Introduction into a world model (NiGEM)

NiGEM (National Institute Global Econometric Model) is a 1000 equation macro-econometric model covering the whole of the world economy, but focusing particularly on the major industrial countries. However, it is regularly updated to take into consideration some important new industrialised economies. The link between the Chinese model and the rest of the world is set through the Chinese trade variables. One of the channels is the definition of export markets. An export market variable is computed for every country (or group of countries; e.g. Far Eastern countries or Developing countries) as the Chinese import demand in the country's export markets. In this export market variable, the Chinese import in volume is present and can then influence the world demand term of each Chinese trade partner (if Chinese imports go up, then the export markets of other countries go up, and their exports go up as well). The second link is established through the presence of Chinese export prices into the import prices of each of its partners (if Chinese export prices

[11] We impose this part to 5 percent; a reasonable percentage if we refer to the Chinese recent economic history.

go up then the import prices of other countries go up which influences not only the import in value but also the imports in volume through the relative price effect).

4. SIMULATIONS

To assess the role of competitiveness and FDI in the Chinese economic development, we simulate two different shocks by linking the Chinese model to NiGEM. The first simulation studies the impact of a devaluation of the yuan on the main domestic variables and on the activity of the major economies. The second shock that is simulated concerns the effects of a reduction in FDI on the Chinese economy.

4.1. The effects of a Chinese currency devaluation

The first simulation studies the implications of a Chinese devaluation both on the internal economy and on the world economy. The simulation has been realised with a devaluation of 20 percent of the yuan (the Chinese currency).

As shown by Table 3, the response of the domestic variables to a devaluation is fast. The impact on real GDP is positive in the short run (a 20 percent change of the nominal exchange rate in t=0 would imply an increase of 4.1 percent in real GDP during the next quarter reaching a maximum of 5.3 percent in t=3). After two years, this effect would become negative and would be almost absorbed after 30 quarters. A similar pattern is found for domestic prices, which converge rapidly toward the initial 20 percent devaluation.

Concerning the effects of the Chinese devaluation on the world economy, we can remark first their weak magnitude. However, it is worth noting that the US economy would be less sensitive to a Chinese devaluation than the Japanese and above all the European economies[12]. These effects are very limited but do not take into account the psychological effects of such a devaluation on financial variables that would be likely to worsen these impacts on the world economic variables.

Table 3 : The effects of a 20 percent devaluation of the yuan
(Percentage changes from the base)

	Initial	1 trim	2 trim	3 trim	1 year	2 years	5 years	10 years
Yuan / dollar	+20	+20	+20	+20	+20	+20	+20	+20
Real output-China	+2.7	+4.1	+4.9	+5.3	+4.9	+2.4	+1.7	0
Prices - China	0	+1.4	+5.6	+11.6	+17.4	+24.8	+21.5	+20
Real exch. rate	+20	+18.4	+13.6	+7.6	+2.2	+1.6	+0.9	0
Real GDP-USA	-0.02	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	0
Real GDP-Europe	-0.09	-0.13	-0.11	-0.06	-0.05	-0.04	-0.02	0

[12] As the European economies are more opened, the effect of a Chinese devaluation on the European real GDP is larger than for the other economies.

Real GDP-Japan	-0.04	-0.09	-0.10	-0.08	-0.04	-0.03	-0.01	0

This simulation indicates the limited role that the authorities could play on competitiveness via a devaluation. Devaluation has an effect on output but only in the short-run. In the long-run, due to the response of prices, competitiveness remains at the same level and output is not affected by the change in currency value. This kind of response is present in every market economy. This simulation suggests then that the transformation of the Chinese economy does not allow it to use the exchange rate as a tool to durably influence price competitiveness, but only as a short term stabilisation variable.

4.2. The impact of a permanent reduction in FDI

This simulation aims at assessing the impact of a reduction in the inflow of FDI on the main Chinese economic variables. The model presented here, by taking into account the effect of FDI on trade, domestic capital and technical progress, is likely to understand the different channels through which FDI can affect the Chinese economy.

We simulate a 50 percent reduction permanent in FDI and we look at the long-run effect of such a reduction on the other Chinese variables. This simulation tells us the positive role FDI has played on the Chinese economy and indicates which are the key variables that are transmitted FDI effects on the economy as a whole.

Table 4 presents first the effect of FDI reduction on output (actual and potential) and on price level. A 50 percent reduction in FDI inflows has a negative effect on the long run output (around 25 percent for potential output and around 20 percent for actual output after 10 years[13]). As the effects on actual output are much more limited compared to those on potential output, the capacity utilisation rises and hence the domestic prices increase (around 20 percent deviation from the base level).

Table 4 shows also the effects of FDI reduction on trade variables and on competitiveness. All the trade variables suffer from the reduction in FDI. The main result is that imports are more sensible to this reduction than exports. FDI would imply a reinforcing of import dependency leading to a stronger response on the import side compared to the export side. The effect of FDI reduction on external balance is then positive but are limited by a deterioration of price competitiveness. Through the price effect, the Real Exchange Rate[14], appreciates in the long run in reaction to the FDI cut, which is contrary to what would be implied by the traditional Balassa effect. After 10 years, external balance converges toward

[13] In the very long run, the effects on potential and actual outputs should be equal. After 10 years the reduction in the **flow** of FDI is not completely reflected in the **stock** of FDI. This explains why some variables does not return to the baseline after 10 years.

[14] An increase in the Real Exchange Rate means an improvement of competitiveness (it is calculated as a ratio of world prices in US dollar to domestic prices).

one point increase in the current account as a percentage of GDP. Note that in the very long run, because of wealth effects, the current account should return to the baseline[15].

[15] The difference between the long run and the very long run are the same as those explained in footnote 13.

Table 4: The effects of a 50 percent reduction in FDI inflows
(Percentage changes from the base, except for current account: difference from the base)

	Initial	1 trim	2 trim	3 trim	1 year	2 years	5 years	10 years
FDI	-50	-50	-50	-50	-50	-50	-50	-50
Real output	-1.4	-3.1	-4.4	-5.2	-5.7	-6.0	-14.4	-19.8
Real output trend	-1.3	-2.6	-3.7	-4.7	-5.7	-9.1	-19.3	-24.4
Prices	0	0	-0.5	-1.1	-1.8	0	+15.3	+22.1
Exports	0	-5.0	-7.0	-8.0	-8.5	-9.1	-9.2	-9.3
Imports	0	-7.6	-12.0	-14.6	-16.2	-17.0	-12.2	-11.3
Real exchange rate	0	-0.01	+0.5	+1.2	+1.8	-0.1	-13.3	-18.1
Current account (% of GDP)	-0.3	+0.9	+1.8	+2.5	+3.0	+3.2	+1.3	+1.0

Three main conclusions emerge from this simulation. First, FDI has a long run effect on output, especially on the supply side by improving the production process and hence the potential output. The second conclusion concerns the effect of FDI on price levels. FDI would have helped to prevent China from the "Big-Bang"-style inflationary crisis. By improving the potential output, FDI plays a role in the price system, limiting excess of capacity utilisation. Third, if FDI promotes Chinese trade, its effect on imports is larger than on exports. The effect on balance of payments is then negative. It is however limited in the long run since FDI, on the other side, have a positive effect on competitiveness. By limiting domestic prices, FDI has played a positive role on Chinese competitiveness.

The global conclusion of the two simulations is that the authorities can play a positive role on external competitiveness and then on growth but not by devaluating the Chinese currency but by attracting inward FDI. A devaluation has a positive effect on output only in the short-run whereas the FDI effect is positive even in the long run on output and also on competitiveness.

5. CONCLUDING REMARKS

The aim of this macro-model is to understand the last twenty years of the reforming Chinese economy. It emphasises the role of external factors promoted by the Open-Door policy implemented in 1979 by Deng Xiaoping. The opening of China is one of the main phenomenon studied by this model and a special care is accorded to the impact of the dramatic increase in FDI that have occurred since the beginning of the 1990s. Being introduced into a world model (NiGEM), the model has allowed us to implement some relevant simulations to support our general analysis.

If devaluations have some effects on the Chinese economy, it is only in the short run. In the long-run, due to a strong response of prices, competitiveness remains stable after a devaluation. On the contrary, inflows of FDI have a positive effect on the Chinese economy in the long run, especially on output and on competitiveness. FDI promotes trade but as it enhances import dependency, the effect on external balance is negative. This negative effect stabilises in the long run due to an improvement in competitiveness.

These simulations bring evidence that by attracting FDI, China has found a successful way to sustain growth, to limit inflation and to improve competitiveness. Thanks to the effects of competitiveness on FDI, a virtuous circle seems to have played a positive role on the Chinese economic success.

APPENDIX 1 : MODEL SPECIFICATION AND ESTIMATES

Note :

$\Delta\ln(X) = \ln(X) - \ln(X(-1))$;
$\Delta 4\ln(X) = \ln(X) - \ln(X(-4))$;
t-values are below the estimated coefficients.

Diagnostic Tests :

Serial Correlation : Lagrange multiplier test of residual serial correlation (F Version) ;
Functional Form : Ramsey's RESET test using the square of the fitted values (F Version) ;
Normality : Based on a test of skewness and kurtosis of residuals (LM Version) ;
Heteroscedasticity : Based on the regression of squared residuals on squared fitted values.

External equations :

EQ.1. Export Prices

$$\begin{aligned}\Delta\ln(CHPX) = {} & -0.67 \\ & (-3.79) \\ & +0.53*\ln(WDPXG(-1)*CHRX(-1)/CHPX(-1)) \\ & (3.83) \\ & +0.21*\ln(CHCED(-1)/CHPX(-1)) \\ & (2.69) \\ & +0.44*\Delta\ln(CHPX(-1)) \\ & (3.63) \\ & +0.25*\Delta\ln(WDPXG*CHRX) \\ & (1.93) \\ & +(1-0.44-0.25)*\Delta\ln(CHCED(-1)) \\ & -0.20*D89Q1 \\ & (-2.62) \\ & +0.21*D94Q1 \\ & (2.47)\end{aligned}$$

Estimation period : 1984Q4-1994Q4 (41 obs.)
NLLS Estimation
$R^2 = 0.75413$
se = 0.072725
RSS = 0.17982
F-Stat F(6,34) = 17.3811 [.000]

Serial correlation :	F(4,30) = 1.5965	[.201]
Functional Form :	F(1,34) = 1.4910	[.231]
Normality :	$\chi^2(2)$ = 2.04765	[.359]
Heteroscedasticity :	F(1,39) = 0.0209	[.886]

EQ.2. Export prices in USD

CHPXA = CHPX/CHRX

EQ.3. Import Prices

$\Delta\ln(CHPM) = -1.03 + 0.78*\ln(WDPXG(-1)*CHRX(-1)/CHPM(-1))$
$(-5.09)\ (5.03)$
$+ 0.12*\ln(CHCED(-1)/CHPM(-1))$
(1.97)
$+ 0.40*\Delta\ln(CHPM(-1)) + 0.30*\Delta\ln(WDPXG*CHRX)$
$(3.66)\qquad (2.19)$
$+ (1-0.40-0.30)*\Delta\ln(CHCED(-1))$

$+ 0.16*D94Q1$
(2.01)

Estimation period : 1984Q1-1994Q1 (41 obs.)
NLLS Estimation
$R^2 = 0.76366$
se = 0.066424
RSS = 0.15442
F-Stat F(5,35) = 22.6186 [.000]

Serial correlation :	F(4,31) = 1.1298	[.361]
Functional Form :	F(1,34) = 4.3266	[.045]
Normality :	$\chi^2(2)$ = 1.8254	[.401]
Heteroscedasticity :	F(1,39) = 0.01447	[.905]

EQ.4. Import prices in USD

CHPMA = CHPM/CHRX

EQ.5. Export of goods, volume

$\Delta\ln(CHXGI) = -2.57 \quad -0.63*\ln(CHXGI(-1)) + 0.71*\ln(CHS(-1))$
$(-3.38)\ (-4.31)\qquad (4.12)$
$- 0.43*\ln(CHPX(-1)/CHRX(-1)/WDPXG(-1))$
$(- 3.30)$
$+ 0.07*\ln(CHFDI(-1)*CHRX(-1)/CHCED(-1))$
(2.79)
$+ 0.40*\Delta\ln(WDPXG*CHRX/CHCED)$
(3.83)
$- 0.18*D85Q1 + 0.23*D89Q1 - 0.28*D90Q1$
$(- 3.51)\qquad (4.10)\qquad (-5.17)$

Estimation period : 1985Q1-1994Q4 (40 obs.)
OLS Estimation
R^2 = 0.81247
se = 0.048907
RSS = 0.074149
F-Stat F(8,31) = 16.7883 [.000]

Serial correlation :	F(4,27) = 1.8403	[.150]
Functional Form :	F(1,30) = 3.7544	[.062]
Normality :	$\chi^2(2)$ = 0.41264	[.814]
Heteroscedasticity :	F(1,38) = 1.3484	[.253]

EQ.6. Export of goods, value in USD Mill

CHXGV = CHXGI*CHPXA

EQ.7. Import of goods, volume

Δln(CHMGI) = 2.69 -0.42*ln(CHMGI(-1)) +0.26*ln(CHRGDP(-1))
(2.67) (-4.86) (2.63)
- 0.40*ln(CHPM(-1)/CHCED(-1))
(- 3.51)
+ 0.10*ln(CHFDI(-1)*CHRX(-1)/CHCED(-1))
(2.49)
-0.22*Δln(CHPM/CHCED)
(-2.77)
+ 0.20*D89Q1 -0.18*D89Q1 -0.25*D90Q1
(3.70) (-3.36) (-4.96)

Estimation period : 1985Q2-1994Q4 (39 obs.)
OLS Estimation
R^2 = 0.82030
se = 0.046912
RSS = 0.066023
F-Stat F(8,30) = 17.1180 [.000]

Serial correlation :	F(4,26) = 0.45409	[.769]
Functional Form :	F(1,30) = 0.0998	[.754]
Normality :	$\chi^2(2)$ = 0.33059	[.848]
Heteroscedasticity :	F(1,37) = 1.5370	[.223]

EQ.8. Import of goods, value in USD Mill

CHMGV = CHMGI*CHPMA

EQ.9. Export of services, value in USD Mill

Δln(CHXSER*CHRX/CHCED) =
[-0.73 - 0.25*[ln(CHXSER(-1)*CHRX(-1)/CHCED(-1))-ln(CHS(-1))]
(-2.64) (- 2.21)
+0.23*ln(WDPXG(-1)/CHRX(-1)/CHCED(-1))
(1.93)
+0.07*ln(CHFDI(-1)*CHRX(-1)/CHCED(-1))
(2.21)
+1.14*Δln(WDPXG*CHRX/CHCED)
(6.38)
- 0.22*D89Q4]
(- 2.49)

Estimation period : 1985Q1-1995Q1 (41 obs.)
OLS Estimation
R^2 = 0.63217
se = 0.086049
RSS = 0.25915
F-Stat F(5,35) = 12.0306 [.000]

Serial correlation :	F(4,31) = 2.6805	[.050]
Functional Form :	F(1,34) = 0.0049	[.945]
Normality :	$\chi^2(2)$ = 3.4136	[.181]
Heteroscedasticity :	F(1,39) = 0.1198	[.731]

EQ.10. Import of services, value in USD Mill

Δln(CHMSER*CHRX/CHCED) =
[-1.06 - 0.30*[ln(CHMSER(-1)*CHRX(-1)/CHCED(-1))-ln(CHRGDP(-1))]
(-3.35) (- 3.11)
- 0.24*ln(WDPXG(-1)/CHRX(-1)/CHCED(-1))
(- 2.17)
+0.17*ln(CHFDI(-1)*CHRX(-1)/CHCED(-1))
(3.54)
+0.48*Δln(WDPXG(-4)*CHRX(-4)/CHCED(-4))
(3.06)
- 0.19*D89Q4 +0.65*D92Q1]
(- 2.03) (6.75)

Estimation period : 1983Q2-1995Q2 (49 obs.)
OLS Estimation
R^2 = 0.77726
se = 0.093288

RSS = 0.35681
F-Stat F(7,42) = 20.4389 [.000]

Serial correlation :	F(4,38) = 1.3628	[.266]
Functional Form :	F(1,41) = 9.8599	[.003]
Normality :	$\chi^2(2)$ = 3.2723	[.195]
Heteroscedasticity :	F(1,39) = 0.50416	[.481]

EQ.11. Foreign Direct Investment

$$\begin{aligned}\Delta\ln(CHFDI*CHRX/CHCED) = [&-4.30 - \ln(CHFDI(-1)*CHRX(-1)/CHCED(-1)) \\ &(-6.44) \\ &- 0.75*\ln(CHFDI(-1)*CHRX(-1)/CHCED(-1)) \\ &(-12.60) \\ &+1.10*\ln(CHRGDP(-1)) \\ &(7.85) \\ &+0.19*\ln(WDPXG(-1)*CHRX(-1)/CHCED(-1)) \\ &(2.05) \\ &-0.96*\Delta\ln(CHER/CHCED) \\ &(-1.82) \\ &- 0.50*D92 +1.14*D9295] \\ &(- 7.73) \quad (12.80)\end{aligned}$$

Estimation period : 1984Q1-1994Q4 (44 obs.)
OLS Estimation
R^2 = 0.86270
se = 0.064503
RSS = 0.15394
F-Stat F(6,37) = 38.7462 [.000]

Serial correlation :	F(4,33) = 1.0421	[.400]
Functional Form :	F(1,36) = 6.8251	[.013]
Normality :	$\chi^2(2)$ = 1.5918	[.451]
Heteroscedasticity :	F(1,42) = 1.4343	[.238]

EQ.12. Stock of Foreign Direct Investment

CHFDIS = CHFDIS(-1)+(CHFDI*CHRX/CHCED)

EQ.13. Invisibles

CHIVA = CHXSER -CHMSER + CHNPI

EQ.14. Net Property Incomes

CHNPI = WM4IR*CHNFA(-1)

EQ.15. World Interest Rates

WM4IR = (0.3612*USR3M + 0.1929*JPR3M + 0.088*GER3M + 0.0704*FRR3M) / (0.712*400)

EQ.16. Trade Balance

CHTB = CHXGV + CHXSER - CHMGV - CHMSER

EQ.17. Current Account

CHCBV = CHTB + CHNPI

EQ.18. Net Foreign Assets

CHNFA = CHNFA(-1) + CHCBV

Internal equations :

EQ.19. Labour Demand

Δln(CHL/CHIP) = 0.45 - 0.53*ln(CHL(-1)/CHIP(-1))
(2.89) (- 3.96)
- 0.16*ln(CHER(-1)/CHCED(-1))
(-1.90)
+ (0.16-0.53)*ln(0.026*TIME+0.016*ln(CHFDIS(-1))*DFDI
(3.683) (2.361)
+ 0.206*ln((CHMGV(-1)*CHRX(-1)/CHPM(-1))/CHRGDP(-1)))
(2.754)
- 0.60*Δln(CHIP(-4)/CHIP(-5)) - 0.09*DUM94)
(-3.78) (-6.17)

Estimation period : 1984Q2-1994Q4 (43 obs.)
NLLS Estimation
R^2 = 0.51637
se = 0.020216
RSS = 0.015122
F-Stat F(7,35) = 6.5841 [.000]

Serial correlation :	F(4,31) = 1.3186	[.284]
Functional Form :	F(1,34) = 2.8715	[.099]
Normality :	$\chi^2(2)$ = 0.50191	[.778]
Heteroscedasticity :	F(1,42) = 0.27586	[.602]

EQ.20. Desired Industrial Output

CHIPTR = (0.45 -0.29*CHSY -0.01*DELTA89)
(41.02) (-17.79) (-5.12)

(0.8(CHK)^(-2.292)+0.2*(CHL*EXP(0.026*TIME

+ 0.016*ln(CHFDIS(-1))*DFDI

+ 0.20*ln(CHMGV(-1)*CHRX(-1)/CHPM(-1))/CHRGDP(-1))))^(-2.292))^(-0.436)

Estimation period : 1985Q2-1994Q2 (37 obs.)
NLLS Estimation
R^2 = 0.99768
se = 2.9311
RSS = 248.4737
F-Stat F(2,35) = 2670.8 [.000]

Serial correlation :	F(4,30) = 0.79175	[.541]
Functional Form :	F(1,33) = 0.79612	[.379]
Normality :	$\chi^2(2)$ = 2.4709	[.291]
Heteroscedasticity :	F(1,38) = 0.71939	[.402]

EQ.21. Actual Industrial Output

Δln(CHIP) = 0.43 -0.12*(ln(CHIP(-1))-ln(CHTFE(-1)/CHCED(-1)))
(3.11) (-3.04)
+ 0.55*Δln(CHTFE(-1)/CHCED(-1))
(8.89)
+ 0.03*DELTA89 + 0.08*D88Q1
(3.19) (5.29)

Estimation period : 1980Q2-1992Q1 (48 obs.)
OLS Estimation
R^2 = 0.68771
se = 0.013989
RSS = 0.0084145
F-Stat F(4,43) = 23.673 [.000]

Serial correlation :	F(4,39) = 1.0832	[.378]
Functional Form :	F(1,42) = 1.7629	[.191]
Normality :	$\chi^2(2)$ = 1.4564	[.483]
Heteroscedasticity :	F(1,46) = 1.3619	[.249]

EQ.22. Capacity Utilisation

CHCU = CHIP/CHIPTR

EQ.23. Wages

CHER =(1/CHMARKUP)*(((0.46-0.29*CHSY-0.01*DELTA89)^(-2.292))

(0.2)((CHIP/CHL)^(3.292))*(EXP(-2.292*(0.03*TIME

+0.016*ln(CHFDIS(-1))*DFDI

+0.20*ln(CHMGV(-1)*CHRX(-1)/CHPM(-1))/CHRGDP(-1))))*CHCED

Coefficients taken from the Labour Demand function (EQ.1.)

EQ.24. Unit Labour Costs

CHULC = CHER*CHL/CHIPTR

EQ.25. Consumption

Δln(CHC/CHCED) = - 1.83 + 0.32*(ln(CHRGDP(-1)-(CHTAX(-1)/CHCED(-1))
(-2.87) (2.82)
- ln(CHC(-1)-CHCED(-1))

+ 0.06*ln(CHNW(-1)/CHC(-1))
(2.66)
- 0.68*Δln(CHRGDP(-4))
(-2.04)
- 0.23*D93Q1 -0.07*D94Q1 - 0.05*DELTA89
(-7.77) (-4.78) (-3.56)

Estimation period : 1982Q3-1994Q1 (47 obs.)
OLS Estimation
R^2 = 0.80295
se = 0.027344
RSS = 0.029161
F-Stat F(7,40) = 22.7022 [.000]

Serial correlation :	F(4,36) = 0.56554	[.689]
Functional Form :	F(1,39) = 1.7775	[.190]
Normality :	$\chi^2(2)$ = 0.40438	[.817]
Heteroscedasticity :	F(1,51) = 1.8152	[.185]

EQ.26. Domestic Investment in Capital

$$\Delta\ln(CHIC/CHCED) = -0.32 - \underset{(-3.88)}{0.18}*\ln(CHIC(-1)/CHCED(-1)) + \underset{(2.56)}{0.06}*\ln(CHKTR(-1)/CHK(-1)) + \underset{(5.53)}{0.02}*\Delta\ln(CHIP) - \underset{(-2.84)}{0.15}*D90Q2$$

Estimation period : 1985Q2-1994Q1 (36 obs.)
OLS Estimation
$R^2 = 0.56784$
se = 0.050671
RSS = 0.082163
F-Stat F(7,31) = 14.0155 [.000]

Serial correlation :	F(4,27) = 0.59877	[.667]
Functional Form :	F(1,35) = 0.00797	[.929]
Normality :	$\chi^2(2)$ = 4.0934	[.129]
Heteroscedasticity :	F(1,42) = 0.1876E-4	[.997]

EQ.27. Other Domestic Investments

CHIM = CHIM(-1)*CHNGDP/CHNGDP(-1)

EQ.28. Domestic Demand

CHDD = CHC + CHIC + CHIM + (CHFDI*CHRX/1000) +CHGV

EQ.29. Actual Capital

CHK = 0.974*CHK(-1) + CHIC + (CHFDI*CHRX/1000)

EQ.30. Desired Capital

CHKTR = (1.25*((CHIPTR/ (0.46 - 0.29*CHSY - 0.045*DELTA89))^(-2.292)

- 0.2*(CHK*EXP(0.03*TIME+0.016*ln(CHFDIS(-1))*DFDI

+0.20*ln((CHMGDP(-1)*CHRX(-1)/CHPM(-1))/CHRGDP(-1)))^(-2.292)))^(-0.436)

Coefficients taken from the desired output (EQ.2)

EQ.31. Total Final Expenditures

CHTFE = CHNGDP + CHMGV*CHRX/1000

EQ.32. Net Wealth

CHNW = CHM1 + CHDEBT + CHNFA*CHRX/1000

EQ.33. Domestic Prices

Δln(CHCED) = -0.003 + 0.03*DELTA89 + 0.12*ln(CHULC(-1)/CHCED(-1))
(-0.76) (5.96) (4.34)
+ 0.08*ln(CHPM(-1)/CHCED(-1))*DELTA89
(3.06)
+ 0.46*ln(CHCU(-1)) + 0.09*Δln(CHM1(-1)/CHNGDP(-1))
(3.75) (3.01)
+ 0.04*D84Q1 + 0.03*D88Q4
(2.67) (3.25)

Estimation period : 1984Q1-1994Q4 (44 obs.)
OLS Estimation
R^2 = 0.62966
se = 0.014706
RSS = 0.0077853
F-Stat F(7,36) = 8.7438 [.000]

Serial correlation :	F(4,32) = 1.5671	[.207]
Functional Form :	F(1,35) = 0.96509	[.333]
Normality :	$\chi^2(2)$ = 3.54265	[.170]
Heteroscedasticity :	F(1,42) = 0.02927	[.865]

EQ.34. Money Demand

Δln(CHM1/CHCED) = -1.11 -0.35*ln(CHM1(-1)/CHCED(-1))
(-4.26) (-4.86)
+ 0.34*ln(CHIP(-1)) - 0.25*Δ4ln(CHCED(-1))
(4.90) (-2.83)
+ 0.72*Δln(CHIP) + 0.63*$\Delta\Delta$4ln(CHCED(-1))
(2.98) (2.74)
- 0.11*D90Q4 +0.18*D93Q1 -0.06*DELTA93
(-3.69) (5.68)

Estimation period : 1989Q1-1996Q4 (32 obs.)
OLS Estimation
R^2 = 0.81555
se = 0.027282
RSS = 0.017119
F-Stat F(8,23) = 12.7117 [.000]

Serial correlation :	F(4,19) = 0.1561	[.958]
Functional Form :	F(1,36) = 1.1765	[.290]
Normality :	$\chi^2(2)$ = 0.16720	[.920]
Heteroscedasticity :	F(1,42) = 0.8344	[.368]

EQ.35. Government Consumption

CHGV = CHGV(-1)*(CHNGDP/CHNGDP(-1))

EQ.36. Government Revenue

CHTAX = CHTAX(-1)*(CHNGDP/CHNGDP(-1))

EQ.37. Government Debt

CHDEBT(-1)+CHGV-CHTAX-0.05*(CHM1-CHM1(-1))

EQ.38. Nominal GDP

CHNGDP = CHDD+CHTB*CHRX/1000

EQ.39. Real GDP

CHRGDP = CHNGDP*100/CHCED

APPENDIX 2 : DESCRIPTIONS OF VARIABLES AND DATA COMPILATION

The label of each variable presented here is that used in NiGEM. All the variables begin by CH to denote China. The name attributed to each variable is generally the same used for the other country similar NiGEM's variables.

The model uses quarterly data from the early eighties to 1995. Generally data come from the IMF International Financial Statistics (hereafter referred to as IMF IFS). Some data are from the China Monthly Statistics and the Chinese Statistical Yearbook published by the State Statistical Bureau in China (hereafter referred to as CMS and CSY). NIESR's database gave some specific data which was previously used in its Chinese model. This Appendix gives the source of all variables used in this model and presents the methodology applied to transform some annual data into quarterly one.

Variable name	Description	Source
	World variables	
WDPXG	World prices in USD	NIESR
WM4IR	World interest rate	NIESR
	Trade variables	
CHIVA	Invisibles	NIESR
CHS	Export Markets, 1994=100	NIESR
CHXGI	Exports of goods, volume 1990=100	NIESR
CHXGV	Exports of goods, value in USD Mill	NIESR
CHPXA	Export prices in USD, 1994=100	EQ.2
CHPX	Export prices in Yuan	CSY[a]
CHMGI	Imports of goods, volume 1990=100	NIESR
CHMGV	Imports of goods, volume in USD Mill	IMF
CHPMA	Import prices, 1994=100	EQ.4
CHPM	Import prices in Yuan	CSY[a]
CHXSER	Exports of services in USD Mill	IMF[a]
CHMSER	Imports of services in USD Mill	IMF[a]
CHCBV	Current balance in USD Mill	IMF
CHTB	Trade balance in USD Mill	EQ.16
CHNFA	Net foreign assets in USD Mill	EQ.18[b]
CHRX	Nominal exchange rate	IMF
CHFDI	Foreign direct investment in USD Mill	CSY[a]
CHFDIS	Stock of foreign direct investment in real terms in Yuan	EQ.12
CHNPI	Net property incomes in USD Mill	EQ.14
	Domestic variables	
CHC	Household consumption	CSY[a]
CHI	Total investment in Yuan Bn	CSY[a]
CHIC	Domestic investment in capital	CSY[a]
CHIM	Other domestic investment	EQ.27
CHDD	Domestic demand	EQ.28
CHCU	Capacity utilisation	EQ.22

CHCED	Consumer price index	IMF
CHULC	Unit labour costs	EQ.24
CHRGDP	Real GDP in Yuan Bn	EQ.39
CHNGDP	Nominal GDP in Yuan Bn	CSY[a]
CHGV	Government consumption	CSY[a]
CHTAX	Government revenue	CSY[a]
CHNW	Net wealth	EQ.32
CHDEBT	Government debt	EQ.37
CHM1	Money (narrow money)	IMF
CHL	Industrial employment	CMS
CHK	Real capital stock in Yuan Bn	EQ.29
CHKTR	Desired capital stock in Yuan Bn	EQ.30
CHMARKUP	Wage markup	EQ.23
CHIP	Industrial production in real terms in Yuan (1990=100)	CMS
CHIPTR	Trend of industrial production in real terms in Yuan (1990=100)	EQ.20[c]
CHSY	Share of state-owned enterprises in total industrial output	CMS
CHER	Average annual earnings (1987=100)	CMS
CHTFE	Total final expenditures (in Bn of Yuan)	EQ.31
CHDS	Variation of stocks	CSY[a]

Notes : [a] Annual data

[b] Initial value in 1982 from IMF IFS.

[c] underlying series computations : Hodrick-Prescott filter.

Several raw data series are in an annual base. As our model is based on quarterly data, we have had to transform these raw series into quarterly data by interpolation. To interpolate series we have first searched for similar series and assumed that the quarterly movements of both series were the same. We have four groups of annual series : the national accounts' data (CHNGDP, CHC, CHI, CHIC, CHDS, CHGV and CHTAX), the trade prices (CHPX and CHPM), the trade of services (CHXSER and CHMSER) and Foreign Direct Investment (CHFDI).

The data of the first group (national accounts' variables) have been interpolated by assuming that the quarterly movements of these series were the same of those of the industrial output in nominal terms (CHIP times CHCED).

The data of the second group (trade prices) have been interpolated from the Far East trade of goods in constant prices (raw data are from IMF IFS export unit value page, Asia).

The trade of services data have been transformed by assuming that their intra-annual behaviours were similar to those of the trade of goods.

Finally, the quarterly movements of the flows of foreign direct investment are from Li (1994). Instead of taking the Li's quarterly variables (that are slightly different from the CSY's data when they are compiled on an annual basis), we have just assumed that these series were useful to indicate the quarterly behaviour of FDI inflows.

APPENDIX 3 : UNIT-ROOT TESTS (ADF Tests)

Equation Number	Variable	H0 : I(1) level	H0 : I(0) 1st difference	I(0) / I(1)
EQ.1.	ln(CHPX)	-0.20 (1)	-3.64* (3)	I(1)
	ln(WDPXG*CHRX)	-1.04 (1)	-2.99* (2)	I(1)
	ln(CHCED)	0.46 (3)	-3.10* (2)	I(1)
EQ.3	ln(CHPM)	-1.27 (3)	-3.09* (3)	I(1)
	ln(WDPXG*CHRX)	-1.47 (2)	-3.66* (1)	I(1)
	ln(CHCED)	0.19 (1)	-3.19* (2)	I(1)
EQ.5.	ln(CHXGI)	0.46 (3)	-6.12* (2)	I(1)
	ln(CHS)	1.13 (2)	-3.57* (1)	I(1)
	ln(CHPX/CHRX/WDPXG)	-1.93 (4)	-5.66* (3)	I(1)
	ln(CHFDI*CHRX/CHCED)	0.31 (4)	-4.02* (1)	I(1)
	Δln(WDPXG*CHRX/CHCED)	-5.65* (1)		I(0)
EQ.7.	ln(CHMGI)	-0.74 (1)	-4.43* (1)	I(1)
	ln(CHRGDP)	0.45 (4)	-2.96* (4)	I(1)
	ln(CHPM/CHCED)	-1.60 (1)	-3.93* (1)	I(1)
	ln(CHFDI*CHRX/CHCED)	0.11 (4)	-3.79* (1)	I(1)
EQ.9.	ln(CHXSER*CHRX/CHCED)	0.90 (4)	-3.07* (3)	I(1)
	ln(CHS)	1.04 (1)	-3.82* (1)	I(1)
	ln(WDPXG*CHRX/CHCED)	-2.37 (4)	-3.40* (4)	I(1)
	ln(CHFDI*CHRX/CHCED)	-0.76 (4)	-3.79* (1)	I(1)
EQ.10.	ln(CHMSER*CHRX/CHCED)	0.59 (2)	-6.21* (1)	I(1)
	ln(CHRGDP)	-0.31 (4)	-2.94* (3)	I(1)
	ln(WDPXG*CHRX/CHCED)	-2.08 (2)	-6.41* (1)	I(1)
	ln(CHFDI*CHRX/CHCED)	-0.55 (4)	-3.79* (1)	I(1)
EQ.11.	ln(CHFDI*CHRX/CHCED)	1.01 (1)	-4.72* (1)	I(1)
	ln(CHRGDP)	-0.59 (4)	-2.96* (4)	I(1)
	ln(WDPXG*CHRX/CHCED)	-2.85 (4)	-3.47* (4)	I(1)
	Δln(CHER/CHCED)	-4.24* (1)		I(0)
EQ.16.	ln(CHM1/CHCED)	-0.68 (1)	-5.14* (1)	I(1)

	ln(CHIP)	0.77 (2)	-5.09* (0)	I(1)
	Δ4ln(CHCED)	-1.99 (4)	-3.82* (3)	I(1)
EQ. 19.	ln(CHL/CHIP)	2.28 (1)	-2.83* (1)	I(1)
	ln(CHER/CHCED)	-2.69 (1)	-3.30* (1)	I(1)
	ln(CHFDIS)*DFDI	-0.61 (1)	-4.39* (1)	I(1)
	ln(CHMGV*CHRX/CHPM)/ CHRGDP	-2.38 (1)	-5.03* (1)	I(1)
	Δln(CHIP)	-3.02* (2)		I(0)
EQ.21.	ln(CHIP)	-0.20 (2)	-3.87* (2)	I(1)
	ln(CHTFE/CHCED)	-1.72 (1)	-4.14* (1)	I(1)
EQ.25.	ln(CHC/CHCED)	-1.83 (1)	-5.65* (1)	I(1)
	ln(CHNW)	-0.51 (1)	-5.22* (1)	I(1)
	ln(CHRGDP-(CHTAX/CHCED))	-0.53 (1)	-5.43* (1)	I(1)
EQ.26.	ln(CHIC/CHCED)	-2.33 (4)	-3.08* (1)	I(1)
	ln(CHK)	1.15 (4)	-2.95* (4)	I(1)
	ln(CHKTR)	1.16 (4)	-2.95* (4)	I(1)
	Δln(CHIP)	-4.97* (0)		I(0)
EQ.33.	ln(CHCED)	0.38 (3)	-4.49* (0)	I(1)
	ln(CHULC)	0.99 (2)	-4.58* (0)	I(1)
	ln(CHPM)	-0.82 (1)	-3.07* (3)	I(1)
	ln(CHCU)	-4.58* (3)		I(0)
	Δln(CHM1/CHNGDP)	-7.40* (1)		I(0)

Note : * The null hypothesis is rejected at the 5% significance level.
The value of k is in parentheses. It is chosen from information criteria. k=0 means simply that a DF test is run instead of an ADF test.

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