Trade Liberalizations and Global Current Account Imbalances

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Abstract

A wave of trade liberalizations take place in both developing and developed countries, including China's WTO accession and the end of import quotas on textile and garment in the United States and Europe. At the same time, both China's current account surplus and the US deficit have risen to an unprecedented level. Are these developments related? We study how trade reforms affect current accounts by embedding a modified Heckscher-Ohlin structure and an endogenous discount factor into an intertemporal model of current account. We show that trade liberalizations in a developing country would generally lead to capital outflow. In contrast, trade liberalizations in a developed country would result in capital inflow. Thus, trade reforms can contribute to global imbalances.

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1 Introduction

A wave of trade liberalizations have taken place in both developing and developed countries in the last two decades. Global capital flows and global imbalances have also risen to an unprecedented level. Starting in 1991 the U.S. current account deficit worsened continuously, reaching 6.4 percent of U.S. GDP in the fourth quarter of 2005, then falling back to 5 percent of GDP by early 2008. The current account surpluses that were the counterpart of the U.S. deficits initially emerged in Japan and Western Europe were bolstered by surpluses in emerging Asia and the commodity-producing countries after 1997.[1] World trade, measured as the ratio of imports plus exports over GDP, has grown five times in real terms since 1980. All groups of emerging market and developing countries, when aggregated by income group, have been catching up with or surpassing high-income countries in their trade openness. In particular, the ratio of imports and exports to GDP in low income countries has increased from about 20% in 1990 to more than 40%, and the average tariff rate in low income countries has declined from about 60% to 15%.[2]

Figure 1 reports balances of current account in China since 1982. It is particularly interesting to note that China joined the WTO in 2001; the average current account balance was 7.5 billion dollars from 1982-2001, but jumped 28 times to 214.3 billion dollars from 2002-2010. Does China's WTO entrance contribute to this jump in its current account surplus?

One's first reaction may be no. The WTO accession requires China to reduce its import barriers without corresponding changes in its trade partners' import barriers. Shouldn't that lead to a rise in China's imports and therefore a fall in China's trade surplus? However, that reaction represents a partial equilibrium effect. The general equilibrium effect could be very different. It is important to note that China's import competing sectors are likely to be more capital intensive than its export sectors. When China is forced to cut down its import barriers, the increase in imports should lead to a contraction of the import-competing

[1] The data are from Caballero, Farhi, and Gourinchas (2008).

[2] The data are from Jaumotte, Lall, and Papageorgiou (2008).

sectors. In general equilibrium (and ignoring the non-tradable sector for simplicity), the export sectors would expand in response. Since the export sectors use less capital per unit of labor, full employment of labor would imply that China would have an "excess" of capital, for a given level of savings, as a result of its trade liberalization. When the "excess" capital is exported abroad, China's current account surplus increases. This heuristic explanation takes savings as given. Of course, savings would be endogenous in a dynamic model. The first key objective of this paper is to clarify when this general equilibrium effect can happen in a dynamic model.

It is important to note that trade liberalizations would generally induce an opposite current account response in a high-income (or capital abundant) country. Reductions in trade barriers in a capital-abundant country tends to be concentrated in the labor-intensive sector, causing a contraction of the labor-intensive sector and an expansion of the capital-intensive sector. At a given savings rate, the country would experience a shortage of capital and a rise in the return to capital. This would attract a capital inflow, i.e., creating a current account deficit.

Figure 2 and Table A1 report trade liberalizations and balances of current account in China since 1995. There were two phases of tariff reductions. In Phase I from 1995 to 2000, the weighted tariff rate decreased by about 14% while current account/GDP increased by 1.5%. In Phase II (WTO accession) from 2001 to 2010, however, the weighted tariff rate decreased by about 10% and current account/GDP increased by more than 4%. Why is current account response in Phase II much larger than that in Phase I?

Factor market frictions could affect the current account response to trade reforms by blocking or slowing down structural transformations. The second key objective of the paper is to study interactions between trade reforms and factor market frictions. We focus on credit constraints and follow the modeling choice of Antras and Caballero (2009). We find that with credit constraints, trade reforms in a developing country tend to produce a current account surplus, but with a magnitude that is smaller than without credit constraints. This suggests that trade reforms that are also accompanied by factor market reforms are likely to produce greater current account responses.

In the last part of the paper, we offer an interpretation of the Chinese experience with trade reforms and current account in the recent years. First, the trade reforms embedded in China's WTO accession are much deeper and wider than those that took place before the accession. Trade reforms take the form of dismantling a slew of non-tariff barriers as well as reductions in tariff rates. The accession also brought about a significant reduction in trade costs for exporting firms. Most notably, before the accession, a separate license was required for any producer to engage in exports and imports, and only a small fraction of firms had the right to engage in international trade. As part of the reform commitments in the accession protocol, all producers automatically acquire the right to engage in trade. According to our theory, such reductions in trading cost should lead China to export capital or run a current account surplus.

By coincidence, the MFA quotas were phased out by the end of 2004, and the Chinese textiles and garment producers turned out to be one of the largest producers. This would generate a surplus in China's current account. Given China's size, the rest of the world has to have a matching current account deficit. Moreover, the end of MFA also represents one of the most significant trade liberalizations for the United States (and to a less extent, the European Union) in the recent years. This, by itself, could generate a current account effect for these countries. If the United States has a more flexible labor market than the European Union, our theory would predict that the effect is stronger for the United States.

The Chinese WTO accession also accelerated financial sector reforms in the country. In particular, as part of the accession obligations, China opened up the investment banking business over a three-year period, and commercial banking business over a five-year period. By the end of 2006, the share of lending that was conducted by banks outside the traditional top-4 state-owned banks had gone up substantially. The stock market listing criteria were reformed so that more non-state-owned firms obtained a chance to be listed on the stock market. Both venture capital and private equity markets have developed. Overall, the access to finance by private firms, while still less than perfect, has nonetheless improved measurably. According to our theory, this financial sector reform should complement the trade reforms and help produce an even bigger current account surplus than otherwise would have been the case.

This paper is related to several papers on the cause of global current account imbalances. Caballero, Farhi, and Gourinchas (2008) and Mendoza Quadrini, and Rios-Rull (2009) highlight the role of difference in financial development. Countries with a relatively low financial development (e.g., China) cannot produce enough financial assets at home to absorb all the savings. As a result, they have exported part of their savings to countries with better financial development (e.g., the United States). As a result, countries like China run a current account surplus, and countries like the United States run a deficit. Song, Storesletten and Zilibotti (2011) also feature the role of financial imperfections in China in generating its current account surplus. It stresses the inability by productive domestic private firms to borrow from the formal financial sector as the key financial sector frictions. As the share of these firms grow in the economy, so does the country's current account surplus. In both papers, when China's financial market develops (including improvement in the access to finance by private firms), the country's current account surplus should decline rather than increase. This appears to be the opposite of what one observes in the data. A different theory about the rise of current account imbalances is given by Du and Wei (2010), which suggests that a rise in the relative surplus of men in China since 2002 may have triggered a competitive race to raise household savings by families with a son. As the sex ratio deteriorates progressively, the faster rise of the savings rate than investment rate produces a progressively larger current account surplus since 2002. Wei and Zhang (2011) provide empirical evidence that suggests that higher sex ratios may explain about 50-60% of the increase in Chinese household savings from 1990 to 2007. While this paper also examines the cause of the Chinese current account surplus (and the global current account imbalances in general), the underlying mechanism is very different. Logically, these explanations (financial development, sex ratio imbalance, and trade reforms) can be compatible with each other, and collectively generate the type of current account imbalances that we see in the data.

A few papers have examined the empirical relationship between trade reforms and current account such as Ostry and Rose (1992) and Ju, Wu, and Zeng (2010). They generally find that the relationship is ambiguous. Our model provides a natural explanation: the effect of the current account response to trade reforms depends on whether the country is capital abundant or labor abundant, and also on the nature of domestic factor market frictions. When one mixes different types of countries in a sample, and disregards factor market features, it is not surprising to find an ambiguous effect.

In terms of modeling methodology, our paper is related to a small but growing literature that considers multiple tradable sectors with different factor intensities in a general equilibrium framework. These papers include Cunat and Maffezzoli (2004), Ju and Wei (2007), Jin (2011), Jin and Li (2011), and Ju, Shi and Wei (2011). None of the existing papers in this literature explicitly studies the effect of trade liberalizations and therefore do not link the patterns of global current account imbalances to China's WTO accession, the end of MFA quotas and other trade reforms.

2 The Basic Model

Our model marries a Heckscher-Ohlin structure (with two tradable sectors of different factor intensities) and a small open economy dynamic general equilibrium framework. It has two additional twists. First, we incorporate a version of an endogenous discount factor following Uzawa (1968), Obstfeld (1982), Mendoza (1991), Uribe (1997), Schmitt-Grohe (1998), Choi, Mark, and Sul (2008), among others. Second, we follow Neumeyer and Perri (2005) and Schmitt-Grohe and Uribe (2003) to assume convex costs of adjusting the international asset position.

The usual motivation for an endogenous discount factor in a dynamic open-economy model is either to make the steady state different from initial conditions or to make the current account adjustment more persistent. We assume an endogenous discount factor primarily to solve the challenge of over-determination of the interest rate. In the standard intertemporal model of current account, the interest rate in the steady state is determined by the time discount factor from the demand side. In the HO model, the interest rate is determined by the zero profit conditions from the supply side. With a permanent shock such as trade liberalization hits the economy, the steady states before and after shocks differ. As a result, the two interest rates as determined by the discount factor and as determined by the zero profit conditions are not equal except by coincidence. This problem was raised by Stiglitz (1970) when he shows that unless two countries have identical discount factors one country must specialize in a dynamic HO model. Once we introduce an endogenous discount factor, the interest rate is determined by the zero profit conditions in the HO model. For any given interest rate, through endogenous discount factor, the total consumption in the steady state is then determined.

Convex adjustment costs for international asset position can also make the steady state independent of initial conditions. In our context, this assumption helps to address another technical challenge that has to do with the inherent multiplicity of equilibria in the standard HO model when both goods trade and capital flows are considered. As Mundell (1957) pointed out, goods trade and capital flow are perfect substitutes in the frictionless HO model. Because an infinite number of combinations of goods trade and capital flow can constitute an equilibrium, the exact amount of capital flows (or current account) is indeterminate. With linear costs of trade in goods and/or capital, corner solutions occur: either goods trade or capital flow takes place, but goods trade and capital flow do not coexist.[3] Once we assume convex costs of adjusting international asset position, we can pin down equilibrium capital flows and current account. In the extension of the model when we introduce costs of adjustment of labor and capital between sectors, the multiple equilibria problem is resolved as well.

[3] For more detail discussions, readers are guided to Ju and Wei (2007).

2.1 Household

The economy is inhabited by a continuum of identical and infinitely lived households that can be aggregated into a representative household. The representative household's preference over consumption flows is summarized by the following time-separable utility function

$$U = \sum_{s=t}^{\infty} \theta_s U(C_s)$$

where C_s is the household's consumption of a final good at date s, and θ_s is the discount factor between period 0 and t as given by

$$\theta_{s+1} = \beta(\tilde{C}_s, \widetilde{Y}_s)\theta_s, \;\; s \geq 0 \tag{2.1}$$

where $\theta_0 = 1$ and $\frac{\partial \beta(\tilde{C}_s)}{\partial \tilde{C}_s} < 0$ and $\frac{\partial \beta(\widetilde{Y}_s)}{\partial \widetilde{Y}_s} > 0$. We assume that the endogenous discount factor does not depend on the household's own consumption and income, but rather on the economy-wide average per capita consumption $\tilde{C}_s$ and income $\widetilde{Y}_s$, which the representative household takes as given.[4] The exact functional form of $\beta(\tilde{C}_s, \widetilde{Y}_s)$ will be presented later. The household owns both factors of production, capital K and labor L. For simplicity, we assume a fixed labor supply.

The final good is produced by combining two intermediate goods. Each intermediate good is produced by combining capital and labor. The household supplies labor to both intermediate good sectors through a competitive spot market. In the benchmark model, both labor and capital are assumed to be freely mobile across sectors. Factor market frictions will be discussed later. The household can hold foreign asset B_t to smooth consumption. Following Neumeyer and Perri (2005), we assume that trade in foreign bonds is subject to a small and convex portfolio adjustment costs. If the household holds an amount B_{t+1}, then these portfolio adjustment costs, denominated in units of the final good, are $\frac{\psi_b}{2}(B_{t+1} - \bar{B})^2$,[5]

[4] This preference specification was pioneered by Uzawa (1968) and applied to the small open economy literature by Obstfeld (1982) and Mendoza (1991).

[5] As in Schmitt-Grohé and Uribe (2003), these portfolio adjustment costs eliminate the unit root in the economy's net foreign assets.

where $\bar{B}$ is an exogenous capacity level of foreign asset management. For simplicity, we assume $\bar{B} = 0$.

Therefore, the budget constraint and the capital accumulation equation faced by the representative household are given, respectively, by

$$\begin{aligned} & P_t[C_t + \frac{\psi_b}{2}(B_{t+1} - \bar{B})^2] + B_{t+1} + I_t \\ = \quad & w_t L + r_t K_t + (1 + r^*)B_t + TR_t \end{aligned} \tag{2.2}$$

$$K_{t+1} = (1 - \delta)K_t + I_t - \frac{1}{2}\psi_k(\frac{I_t}{K_t} - \delta)^2 K_t \tag{2.3}$$

where I_t is investment in period t, and w_t and r_t are the wage and the domestic return to capital, while r^* being the world interest rate. δ is the capital appreciation rate and ψ_k is the aggregate capital adjustment cost coefficient. The tariff revenue, TR_t is rebated in a lump sum to the representative consumer, which is taken as exogenous by the consumer.[6]

The first order conditions with respect to C_t, I_t, K_{t+1}, and B_{t+1}, give intertemporal and intra-temporal optimization conditions

$$\frac{U_c'(C_t)}{P_t} = \Omega_t \tag{2.4}$$

$$\Lambda_t(1 - \psi_k(\frac{I_t}{K_t} - \delta)) = \Omega_t \tag{2.5}$$

$$\Lambda_t = \beta(\tilde{C}_t, \widetilde{Y}_t) \left[\Lambda_{t+1}\left(1 - \delta + \frac{\psi_k}{2}(\frac{I_t}{K_t} - \delta)(\frac{I_t}{K_t} + \delta)\right) + \Omega_{t+1}r_{t+1}\right] \tag{2.6}$$

$$\Omega_t \left[1 + \psi_b P_t(B_{t+1} - \bar{B})\right] = \beta(\tilde{C}_t, \widetilde{Y}_t)[\Omega_{t+1}(1 + r^*)] \tag{2.7}$$

where Ω_t and Λ_t are Lagrange multipliers for the budget constraint, the law of motion for capital, respectively.

[6]See Devereux and Lee (1999) for a similar assumption.

2.2 Production

The production function for the final good is $Y_t = G(D_{1t}, D_{2t})$, where D_{it} is the usage of intermediate good i by the final good producer. The production function for the intermediate good $i(=1,2)$ is $X_{it} = f_i(A_t L_{it}, K_{it})$ where A_{it} measures labor productivity. $H_{it} = A_{it} L_{it}$ can be understood as units of *effective labor.* All production functions are assumed to be homogeneous of degree one. D_{it} and X_{it} can differ due to international trade.

The unit cost function for X_{it} is $\phi_i(\frac{w_t}{A_t}, r_t)$. Let P_i be the domestic price of intermediate good i. We assume that the country's endowment is always within the diversification cone so that both intermediate goods are produced. In each period t, free entry and zero profits in both the intermediate good and the final good markets imply that

$$P_{1t} = \phi_1(\frac{w_t}{A_{1t}}, r_t), P_{2t} = \phi_2(\frac{w_t}{A_{2t}}, r_t) \tag{2.8}$$

$$P_t D_t = P_t G(D_{1t}, D_{2t}) = P_{1t} D_{1t} + P_{2t} D_{2t} \tag{2.9}$$

2.3 Equilibrium

In equilibrium, trade in intermediate goods equalizes (tariff-inclusive) good prices across all countries in every period. Without loss of generality, we assume that sector 1 is labor intensive while sector 2 is capital intensive. Considering a labor abundant country which exports labor intensive good 1, we have:

$$P_{1t} = P_1^*,\ P_{2t} = (1+\tau) P_2^*, \tag{2.10}$$

where P_i^* denotes the world price and is exogenously given, and τ is the import tariff. Following the standard assumptions in the Heckscher-Ohlin model, we assume that production functions (and the unit cost functions) in all countries are the same (although the labor-augmenting productivity can be different). Therefore, in the foreign country we also have:

$$P_1^* = \phi_1(\frac{w^*}{A_1^*}, r^*),\ P_2^* = \phi_2(\frac{w^*}{A_2^*}, r^*) \tag{2.11}$$

where r^* is the return to capital in the rest of the world. For simplicity, we assume that the foreign economy is in its steady state. We have the following market clearing conditions in the home country

$$K_t = K_{1t} + K_{2t} \tag{2.12}$$

$$L_t = L_{1t} + L_{2t} \tag{2.13}$$

$$D_t = C_t + \frac{I_t}{P_t} + \frac{\psi_b}{2}(B_{t+1} - \bar{B})^2 \tag{2.14}$$

Equation (2.14) implies that the final good is used not only for consumption and investment, but also for covering the costs of adjusting the international asset position. The current account balance over period t is defined as $CA_t = B_{t+1} - B_t$; thus, noting that $P_{it} = w_t L_{it} + r_t K_{it}$ and using equations (2.9) and (2.14)), we can rewrite the budget constraint as

$$CA_t = P^*_{1t}(X_{1t} - D_{1t}) + P^*_{2t}(X_{2t} - D_{2t}) + r^* B_t \tag{2.15}$$

That is, the current account balance is equal to the trade balance (evaluated at the world prices) plus the interest income from the net foreign asset position. For future reference, we define the domestic gross product as $Y_t = \frac{P_1 X_{1t} + P_2 X_{2t}}{P_t}$.

3 Equilibrium Analysis

To study the equilibrium explicitly, we adopt the following standard functional forms for preference and technology. The utility function is $U(C_t) = \frac{{C_t}^{1-\gamma}}{1-\gamma}$, where γ is the inverse of the elasticity of intertemporal substitution. The production function for the final good is $G(D_{1t}, D_{2t}) = \frac{1}{\omega^\omega (1-\omega)^{1-\omega}} D_{1t}^{\omega} D_{2t}^{1-\omega}$, where ω is the share of intermediate good D_1 in the final good production. The production function for intermediate good i is $f_i(A_{it}Lit, K_{it}) = \frac{1}{\alpha_i^{\alpha_i}(1-\alpha_i)^{1-\alpha_i}} K_{it}^{\alpha_i}(A_{it}L_{it})^{1-\alpha_i}$, where a_i is the capital share in producing intermediate good i. We let $\alpha_1 < \alpha_2$ so that sector 1 is labor intensive. The endogenous discount factor takes the following function form:

$$\beta(\tilde{C}_t) = \beta(\frac{\tilde{C}_t}{\bar{C}})^{-\psi_1}(\frac{\widetilde{Y}_t}{\overline{Y}})^{\psi_2} \tag{3.16}$$

where $\psi_1 > 0$ and $\psi_2 > 0$. $\bar{C}$ and $\overline{Y}$ are, respectively, the consumption and output levels in the initial steady state with tariff τ_0. This form is a variant of Choi, Mark and Sul (2008). It implies that in the steady state after tariff reforms, the endogenous discounted factor would deviate from the constant β. To make the model parsimonious, we assume $\psi_1 = \psi_2 = \psi$.

3.1 The Effect of Trade Liberalizations in the Steady State

For simplicity, we assume that $A_1^* = A_2^* = 1$. In equilibrium, given the production functions, from Equation (2.8), we have

$$(\frac{w}{A_1})^{1-\alpha_1} r^{\alpha_1} = P_1^*,\ (\frac{w}{A_2})^{1-\alpha_2} r^{\alpha_2} = (1+\tau)P_2^* \tag{3.17}$$

which give

$$r = r^*[(\frac{A_1}{A_2})^{(1-\alpha_1)(1-\alpha_2)} \frac{1}{(1+\tau)^{(1-\alpha_1)}}]^{\frac{1}{\alpha_1-\alpha_2}} \tag{3.18}$$

$$w = w^*[\frac{A_1^{(1-\alpha_1)\alpha_2}}{A_2^{\alpha_1(1-\alpha_2)}} \frac{1}{(1+\tau)^{\alpha_1}}]^{\frac{1}{\alpha_2-\alpha_1}} \tag{3.19}$$

Three comparative statics can be immediately seen: (a) $\frac{\partial r}{\partial \tau} > 0$, (b) $\frac{\partial r}{\partial A_1} < 0$, and (c) $\frac{\partial r}{\partial A_2} > 0$. By inequality (a), trade liberalization in a labor abundant country (a reduction in τ) reduces the return to capital. Inequalities (b) and (c) pertain to sector-biased productivity shocks. While a technological progress in the labor intensive sector reduces the return to capital, the same change in the capital intensive sector produces the opposite effect. It can be verified that, as long as there is a faster technology progress in the labor intensive sector relative to the capital intensive sector ($\frac{A_1}{A_2}$ increases), the return to capital declines.

These results (in a dynamic setting) are consistent with the Stolper-Samuelson theorem in a static HO model. That is, an increase in the price of a good will increase the return to the factor used more intensively in that good, and reduce the return to the other factor. A tariff reduction in the capital intensive sector implies a decrease in the price of capital intensive goods, therefore, r decreases but w increases.

It is worth emphasizing that the discussion points to a natural asymmetry between developed (capital abundant) and developing (labor abundant) countries. Trade liberalizations tend to reduce the domestic return to capital for a developing country, but to raise it for a developed country.

We now solve for the foreign asset holding in the steady state. Using first order conditions (2.6) and (2.7), we obtain:

$$B = \frac{1}{\psi_b P} \frac{r^* - r + \delta}{1 + r - \delta} \tag{3.20}$$

The holding of foreign bond B is a function of r and $\frac{\partial B}{\partial r} < 0$. That is, when the return to capital in the country decreases, capital flows out in the steady state. We summarize our discussion by the following proposition:

Proposition 1 *A trade liberalization, or a reduction in trade costs, in a labor abundant country leads to a decrease in the return to capital in the country, which results in an increase in the position of net foreign asset holding in the steady state. A technological progress in favor of the comparative advantage sector in a labor abundant country also reduces the return to capital and produces an increase in the net foreign asset position. An opposite set of results holds when a trade liberalization, a reduction in trade costs, or a productivity increase in favor of the comparative advantage sector, take places in a capital abundant country.*[7]

[7] Let t_c be the iceberg trade cost, we will have: $P_{1t} = \frac{P_1^*}{1+t_c}$ and $P_{2t} = (1 + t_c + \tau)P_2^*$. It is immediately seen that a reduction in trade cost will increase the price of the labor intensive good, P_{1t}, but reduce P_{2t}. Similar to the analysis of the tariff reduction, a reduction in trade cost will result in a decrease in r. On the other hand, if the home country were a capital abundant country and exporting good 2, we would have $P_{2t} = \frac{P_2^*}{1+t_c}$ and $P_{1t} = (1 + t_c + \tau)P_1^*$. Now a reduction in tariff or trade cost would reduce the price of the labor intensive good, P_{1t}, but increase P_{2t}, which would increase r.

Using the Euler equation in the steady state (2.6) and the function of endogenous discount factor (3.16), we solve for the ratio of consumption to income.

$$c_y = \frac{\overline{C}}{\overline{Y}}[\beta(1+r-\delta)]^{\frac{1}{\psi}} \tag{3.21}$$

where $c_y = \frac{C}{Y}$ and $\overline{C}$ and $\overline{Y}$ are the consumption and income level in initial steady state, respectively. Clearly, $\frac{\partial c_y}{\partial r} > 0$. Now the interest rate is determined by the production side (along the demand curve of capital). A decrease in the interest rate implies that the capital stock in the new steady state is larger, which requires that the household becomes more patient and consumes less relative to income.

The return to factors (r, w) and the holding of foreign asset (B) are given by equations (3.18), (3.19) and (3.20). Given that, we can solve for the demand for the final good, D, consumption, C, investment I and Gross Domestic Product, Y and sectoral outputs X_1 and X_2 from the set of equations listed in Appendix 7.1. We can write the sectoral outputs as below

$$P_1X_1 = \frac{wL - (1-\alpha_2)(1+\tau)(\zeta PD - r^*B)}{(1-\alpha_1)-(1+\tau)(1-\alpha_2)} \tag{3.22}$$

$$P_2X_2 = \frac{(1-\alpha_1)(1+\tau)(\zeta PD - r^*B) - (1+\tau)wL}{(1-\alpha_1)-(1+\tau)(1-\alpha_2)} \tag{3.23}$$

where $\zeta = \omega + \omega/(1+\tau)$. The optimization conditions for the final good producer yield $P_1D_1 = \omega PD$. Thus the exports of intermediate good 1 are given by

$$NX_1 = P_1(X_1 - D_1) = P_1X_1 - \omega PD \tag{3.24}$$

Finally, the factor usages and capital intensities in sector i are given by

$$K_i = \alpha_i \frac{P_iX_i}{r},\ L_i = (1-\alpha_i)\frac{P_iX_i}{w}, \text{ and} \tag{3.25}$$

$$\frac{K_i}{L_i} = \frac{\alpha_i}{1-\alpha_i}\frac{w}{r} \tag{3.26}$$

A tariff cut in the capital intensive sector will lead an expansion of the labor intensive sector, and a contraction of the capital intensive sector. As a result, labor and capital flow from the capital intensive sector to the labor intensive sector, and both exports and imports go up.

In the initial steady state, we assume the values of the parameters to make $r = r^*$ so that $B = 0$. We cannot use the Euler equation to determine the level of aggregate consumption $\bar{C}$ and output $\overline{Y}$ as there are multiple equilibria. As long as the country's capital-labor ratio K/L is between $\frac{K_1}{L_1}$ and $\frac{K_2}{L_2}$, any level of capital stock K could be an equilibrium. A smaller K simply implies that the country would export more labor intensive good and import more capital intensive good. We use the country's export share, therefore, to select the equilibrium in the initial steady state. The mathematical derivations are relegated in Appendix 7.2.

3.2 Calibrations in the Basic Model

To calibrate the basic model, we follow the standard approach (as in Backus, Kehoe, and Kydland, 1992, 1994; and Kehoe and Peri, 2002) as much as possible. The parameter values are summarized in Table 1. We set the inverse of the elasticity of intertemporal substitution $\gamma = 2$, the steady state discount factor $\beta = 0.99$, which implies a 4 percent annual world interest rate. We assume an equal share of the intermediate goods in the final good production, so $\omega = 0.5$. We choose $\alpha_1 = 0.33$ and $\alpha_2 = 0.7$ so that the average labor share and the dispersion of labor share in two sectors are the same as the estimation from China's input-output Table in 2002. We set capital adjustment cost $\psi_k = 4$ so the elasticity of Tobin's Q with respect to the investment capital ratio is 0.1, which is within the range reported in the literature. We set the annual depreciation rate of capital as 10%, which implies $\delta = 0.025$. Following Schmitt-Grohe and Uribe (2003), the coefficient for bond adjustment costs, ψ_b, is set at 0.0007. We set $\psi = 0.1$, which is close to the value chosen by Choi, Mark and Sul (2008). In Section 5, we will use Chinese data to calibrate ψ_b and ψ.

Table 1: Parameter Values in the Calibrations

β	discount factor in steady state	0.99
γ	inverse of the elasticity of intertemporal substitution	2
α_1	capital share in sector 1	0.33
α_2	capital share in sector 2	0.7
ω	share of goods 1 in final good	0.5
ψ_b	coefficient for convex bond adjustment costs	0.0007
δ	capital depreciation rate	0.025
ψ	parameter of endogenous discount factor	0.1
ψ_k	coefficient of capital adjustment cost	4
A_1	productivity in sector 1	0.8
A_2	productivity in sector 2	0.50207

We assume that in the initial steady state, the economy imposes a 15% of tariff on imports of the capital intensive good, while the rest of the world has no tariff. For the initial productivity, we set $A_1 = 0.8$ and $A_2 = 0.50207$ so that in the initial steady state, given the tariff, the return to capital across countries is equalized and the wage in the domestic economy is lower than that in the rest of the world. We consider a policy experiment of reducing the import tariff by 5 percentage points to 10%. In columns 2, 3 and 4 of Table 2, we report the values for both the initial and the new steady states. The numerical results confirm Proposition 1 : 1) the return to capital declines while the wage rate arises; 2) the labor intensive sector expands while the capital intensive sector shrinks; the labor intensive sector exports more while the capital intensive sector imports more, and 3) capital flows out of the country. A moderate tariff reduction (by 5%) results in a significant capital outflow, so that the increase in the foreign asset holding is about 27% of the domestic GDP; a 10% tariff reduction leads to an increase in foreign asset holding to more than 50% of GDP; 4) The domestic capital stock, K, increases; the consumption to GDP ratio declines while the investment to GDP ratio increases. These are consistent with theoretical results discussed in equation (3.21).

In Figures 3, we report the dynamic path of the economy from the initial to the new steady state after a trade liberalization. We assume that the trade liberalization starts to hit the economy in period 1. We find that the structural adjustment takes place immediately. In particular, sector 1 (the labor intensive sector) expands immediately with an increase in K_1, L_1, and X_1, while sector 2 contracts immediately, with a decline in K_2, L_2, and X_2. As a result, both the export share sx and import share $-sm$ increase immediately. The consumption response is somewhat non-standard. There is a decline in the first several periods; after that, consumption rises gradually to a higher new steady state level. Due to a sharp rise in output, we can find that the ratio of consumption to output declines, which implies a higher saving rate after a tariff reduction. This is because the return to domestic capital declines, which implies that the domestic capital stock is larger. Also, the household sends some of the savings abroad. Both of which require the household to consume less (as a proportion of income).

In Figure 4, we observe that the trade volume, trade surplus and current account surplus jump immediately. While the current account stays positive throughout the transition and approaches zero in the long run, the net foreign asset position B/GDP gradually increases to the steady state level. In response to the trade liberalization, the economy runs a persistent trade surplus, initially on the order of 5 percent of GDP. In the long run, however, the economy will run a trade deficit, which is balanced by the interest payment of the foreign asset.

As equation (3.20) indicates, the change in the foreign asset position from the initial to the new steady state is affected by the bond adjustment cost, ψ_b. In Figure 5, we report the transition dynamics under the assumption of two different values of ψ_b, 0.0005 and 0.0010, in addition to the benchmark value of 0.0007. The country still runs a current account surplus after a tariff cut with each of the two alternative bond adjustment costs. The quantitative effect, however, varies. As expected, a smaller bond adjustment cost results in a larger current account surplus in transition dynamics, and larger trade volume and net foreign asset position in both transition dynamics and the steady state. In Schmitt-

Grohe and Uribe (2003), the parameter of bond adjustment cost is chosen to match the standard deviation of the current account/GDP ratio for Canada (which is 0.015). From the corresponding annual data for China during 1982-2010, after detrending with an HP filter, we calculate that the standard deviation of the CA/GDP ratio is 0.019, which is close to the Canadian number. Separately, in calibrating an RBC model to explain the business cycles in the Chinese economy, Curtis and Mark (2010) also choose $\psi_b = 0.0007$ as the value for the bond adjustment cost. Therefore, we regard $\psi_b = 0.0007$ as the "right" benchmark value.

We also report transitional dynamics when we vary the aggregate capital adjustment costs $\psi_k = 4$, 8, and 12. Although the steady state is not affected by changes in ψ_k, the trade volume, the current account and the foreign asset position in the transition dynamics become larger when ψ_k becomes smaller.

4 Factor Market Frictions

For the current account to respond to trade reforms, a key intermediary step is the structural adjustment of the domestic economy - the contraction of the capital intensive sector and the expansion of the labor intensive sector - leads to a mismatch between the aggregate saving and the new domestic absorption of capital. This produces a current account response. Logically, factor market frictions that block and reduce the extent of the structural adjustment can also reduce the current account response to trade reforms. In this section, we study the interactions between factor market frictions and trade reforms and their implications for the current account response. We start with financial frictions in the form of credit constraints.

4.1 Financial Frictions

Following Antras and Caballero (2009), we make the simplifying assumption that financial frictions are asymmetric in the two sectors: while firms in the importing sector can employ any desired amount of capital at the equilibrium interest rate, firms in the exporting sector face credit constraints. Note that with a tariff cut on the capital intensive good, only the (labor-intensive) export sector would expand. Therefore, we essentially assume that credit constraints are more binding in the sector that needs expansion.

Credit constraints are introduced through the following (admittedly artificial) setting. Each capitalist owns one unit of capital so that the capital stock K is owned by a total K of capitalists. A proportion ξ of K are endowed with "entrepreneurial ability" and labelled "entrepreneurs". Only the "entrepreneurs" know how to operate in the exporting sector. However, each entrepreneur can borrow only up to θ amount of her own capital. Thus the total amount of capital employed in the exporting sector is given by,

$$K_{1t} \leqslant (1+\theta)\xi K_t = \mu_k K_t \tag{4.27}$$

where $\mu_k = (1+\theta)\xi$. We focus on the case in which financial frictions are binding (or μ is sufficiently small) so that $\mu_k K$ is less than the desired amount of capital that exporting firms would like to employ in the absence of financial frictions.

Let r_i be the return to capital in sector i. The financial frictions cause a wedge between the returns to capital in the two sectors, $r_{1t} > r_{2t}$. The budget constraint (2.2) now is changed to

$$\begin{aligned} & P_t[C_t + \frac{\psi_b}{2}(B_{t+1} - \bar{B})^2] + B_{t+1} + I_t \\ = \quad & w_t L + \sum_{i=1}^{2} r_{it} K_{it} + (1+r^*)B_t + TR_t \end{aligned} \tag{4.28}$$

In addition to capital accumulation equation, the representative household also faces the credit constraint (4.27) and capital market clearing condition, $K_{1t} + K_{2t} = K_t$. When the credit constraint (4.27) is binding, we have $K_{1t} = \mu_k K_t$ and $K_{2t} = (1-\mu_k) K_t$. Using these results, the budget constraint (2.2) now becomes:

$$\begin{aligned} & P_t[C_t + \frac{\psi_b}{2}(B_{t+1} - \bar{B})^2] + B_{t+1} + I_t \\ = \quad & w_t L + [\mu_k r_{1t} + (1-\mu_k)\, r_{2t}]\, K_t + (1+r^*)B_t + TR_t \end{aligned} \tag{4.29}$$

Therefore, the first order conditions with respect to C_t, K_{t+1}, B_{t+1}, and L_{it} in the consumer's maximization problem now remain the same as conditions (2.4), (2.6), and (2.7) except that we now replace r_{t+1} by

$$r^C_{t+1} = \mu_k r_{1,t+1} + (1-\mu_k)\, r_{2,t+1} \tag{4.30}$$

4.1.1 The Steady State Equilibrium

The steady sate equilibrium in the case of financial frictions is represented by 15 equations with 15 variables, and is summarized in Appendix 7.3. Similar to equation (3.20), in the steady state we have

$$B = \frac{1}{\psi_b P} \frac{r^* - r^C + \delta}{1 + r^C - \delta} \tag{4.31}$$

Thus, $r^C = \mu_k r_1 + (1-\mu_k)\, r_2$, is a key variable in determining the country's net foreign asset holding B.

Because we are not able to obtain an analytic solution, we will resort to numerical results. Here we offer some intuition for the numerical results to come. When financial frictions become tighter (μ_k declines), the capital usage in sector 1 declines. As a result, the marginal product of capital in the exporting sector, r_1, increases, but the marginal product of labor, w_1, declines. Since the wage rates are equalized in the two sectors in the steady state, $w_1 = w_2 = w$, using the zero profit condition in the import-competing sector, $P_2 = \phi_2(\frac{w_2}{A_2}, r_2)$, we infer that the marginal product of capital in the import-competing sector, r_2 must rise. Since both r_1 and r_2 are larger, therefore, r^C becomes larger as financial frictions becomes tighter. Using (4.31), that results in a smaller B. That is, a lower level of financial development (a tighter credit constraint) results in a smaller net foreign asset holding. To summarize, because financial frictions impede the expansion of the exporting sector, a given trade reform produces a smaller capital outflow.

Several recent papers (Caballero, Farhi, and Gourinchas, 2008; Mendoza, Quadrini, and Rios-Rull, 2009; and Ju and Wei, 2010; and Song, Storesletten, and Zilibotti, 2011) have showed that a low level of financial development in a developing country can produce a financial capital outflow to developed countries. Therefore, a tighter financial friction would lead to more current account surplus in a developing country. Our paper, however, suggests the opposite. When credit constraint is asymmetric across sectors, for example, when there is a credit rationing in one sector but not in another sector, similar to the setup in Antras and Caballero (2009), we show that a tighter credit constraint induces capital inflow (or a smaller current account surplus). The two parts of the literature can be reconciled when one realizes that the first set of papers emphasizes the effect of financial frictions on the supply side of capital (financial frictions reduce the return on savings and generate incentives to move savings out of the country), while the current paper and Antras and Caballero (2009) stress the demand side effect (credit constraints could increase demand for capital by firms in the unconstrained sector). Our model is different from Antras and Cabballero (2009) in that trade liberalization always leads to capital outflow (current account surplus) under credit constraints, although the amount of capital outflow could be made smaller by a tighter credit constraint.

4.2 Labor Market Frictions

We can model labor frictions in a similar fashion and obtain qualitatively similar results. Assume that labor employed in the exporting sector requires "exporting skills", and the amount of labor with "exporting skills" does not exceed a proportion of total amount of labor. In other words, when the labor-intensive sector expands, not all labor previously working in the importing sector can successfully function in the exporting sector. As an example, when the textile industry expands but the steel mills are shut down, not all former steel workers can be productive textile workers. Formally, we model the frictions by the following inequality:

$$L_{1t} \leqslant \mu_L L \tag{4.32}$$

Similarly, the budget constraint (2.2) now becomes

$$\begin{aligned} & P_t[C_t + \frac{\psi_b}{2}(B_{t+1} - \bar{B})^2] + B_{t+1} + I_t \\ = \quad & [\mu_L w_{1t} + (1 - \mu_L) w_{2t}] L + r_t K_t + (1 + r^*) B_t + TR_t \end{aligned} \tag{4.33}$$

and all the analysis in the basic model goes through except that now we replace w_t by $w_t^c = \mu_L w_{1t} + (1 - \mu_L) w_{2t}$. Labor market frictions impede the expansion of the exporting sector. Thus a given trade reform produces a smaller response in both the trade volume and the current account.

4.3 Numerical Results

We focus on the case of credit constraints, while assuming no labor market frictions. We choose the same structural parameters as in the benchmark case. For financial frictions, we set the credit constraint parameter in the initial steady state $\mu_k = 0.42$ so that the initial net export share is about 10%.

The case of a tariff reduction from 15% to 10% under financial frictions is presented in Columns 5 and 6 in Table 2. The return to capital in the importing sector, r_2, decreases, but r_1 in the exporting sector increases. The labor intensive sector expands while the capital intensive sector shrinks, and both export and imports increase. While the qualitative result is the same as the case without financial frictions, the magnitude of the changes is (much) smaller. Because the (labor-intensive) export sector cannot expand as much as before, the wage rate now declines. The ratio of the trade volume to GDP increases by 3.7 percentage points (from 21.1% to 24.8%), compared to an increase by 6.6 basis points when there is not credit constraint. The increase in the net foreign asset position, B/GDP, is on the order of 9.6% of GDP, compared to an increase by 27.3% of GDP in the absence of credit constraints.

Figures 6 and 7 present the transitional dynamics in the case with credit constraints. For comparison, Figure 7 presents the trade volume, the trade balance, the current account and the net foreign asset position in thick bold lines and the transitional dynamics for the same variables in the case without credit constraints in thin broken lines. As one can see clearly, the magnitude of the response of the current account and other variables are all significantly smaller under credit constraints.

5 An Interpretation of the Chinese Experience

The connections between current account and trade liberalizations and between current account and sector-biased technological changes are quite general. In this section, we use the insight from our theory to interpret the Chinese current account experience. This case is chosen for two reasons. First, the rapid rise of China's current account surplus since 2002 has attracted international attentions, leading to various effort by the International Monetary Fund and the U.S. government to "correct" it. Second, China has also undertaken a number of large and unilateral trade liberalizations in the context of its accession to the World Trade Organization. If one counts the number of trade reforms China has to undertake, it is more two standard deviations greater than the median value for an accession country since 1990 (Tang and Wei, 2009). This makes it interesting to see if our theory is consistent with the Chinese experience.

The trade reforms embedded in China's WTO accession are much deeper and wider than those that took place before the accession. Trade reforms take the form of dismantling non-tariff barriers as well as a reduction in tariff rates. The accession also brought about a significant reduction in trade costs for exporting firms. Most notably, before the accession, a separate license was required for any producer to engage in exports and imports, and only a small fraction of firms had the right to engage in international trade. As part of the reform commitments in the accession protocol, all producers automatically acquire the right to engage in trade. According to our theory, such reductions in trading cost should lead China to export capital or run a current account surplus.

By coincidence, the MFA quotas were phased out by the end of 2004, and the Chinese textiles and garment producers turned out to be one of the largest producers. Therefore, the end of MFA represents simultaneously a reduction for export costs for Chinese firms and a reduction in import barriers for the United States. According to our theory, this force will also generate a surplus in China's current account, and a deficit in the U.S. current account.

The Chinese WTO accession also accelerated financial sector reforms in the country. In particular, as part of the accession obligations, China opened up the investment banking business over a three-year period, and commercial banking business over a five-year period. By the end of 2006, the share of lending that was conducted by banks outside the traditional top-4 state-owned banks had gone up substantially. The stock market listing criteria were reformed so that more non-state-owned firms obtained a chance to be listed on the stock market. Both venture capital and private equity markets have developed. Overall, the access to finance by private firms, while still less than perfect, has nonetheless improved measurably. According to our theory, this financial sector reform should complement the trade reforms and help produce an even bigger current account surplus than otherwise would have been the case.

Figure 2 and Table A1 show that there were two phases of tariff cuts in China. The first phase occurred in 1995-1996. The weighted tariff was reduced about 13%, from 27.96% to 15.53%. Correspondingly, the trade volume to GDP ratio slightly increased from 38.81% to 39.01%, and the current account to GDP ratio increased from 0.22% to 3.88%. The second phase was WTO accession where weighted tariff was reduced about 10%, from 14.17% in 2000 to 4.29% in 2006. This time both trade volume and current account increased much more dramatically. The trade volume to GDP ratio increased from 44.24% in 2000 to as high as 70.57% in 2006. The current account surplus to GDP ratio increased from 1.712% in 2000 to 10.13% in the peak year of 2007.

There seem to be forces deterring the structural adjustment in the first phase. One possible reason is that there are factor market frictions which prevent the structural adjustments in a full scale. Our interpretation is that, the financial market frictions in the first phase, significantly reduces the magnitude of structural adjustments due to trade liberalizations. Our main purpose of the numerical exercise is to understand the sharp increase in current account surplus after China's WTO accession. Therefore, our calibration strategy is as follows: We assume the economy is subject to credit constraints in Phase I (from 1995-2000), selecting the parameters, endogenous discount factor parameter ψ and the bond adjustment cost ψ_b to match the data. We assume there is no credit constraint in Phase II, and use the parameters selected in Phase I to calibrate the model. We then compare the model predictions with the data. On the one hand, the assumption of no credit constraint in Phase II is too strong, which overestimates the effect of the WTO accession. On the other, we ignore trade cost reductions induced by the WTO accession and only consider the effect of tariff cuts, which underestimate the effect of WTO accession.

5.1 Phase I: Tariff Reductions in 1990s

The initial tariff is 30%. For this experiment, we consider a 15% tariff reduction in period 1. We set the credit constraint parameter $\mu_k = 0.5$ so that the initial trade pattern in the model is close to the ratio of trade volume to GDP in 1995. We set the endogenous discount factor parameter $\psi = 0.075$ so that the ratio of trade volume to GDP in the new steady state of the model is close to the data in 2000.[8] Similarly, we set the bond adjustment cost $\psi_b = 0.0007$ so that the share of foreign asset to GDP in the new steady state is close to the ratio of foreign reserve to GDP in 2000. The result in columns 2 and 3 in Table 3 show that when there is a 15% tariff reduction, the trade volume/GDP increases from 35.9% to 45.8% and the foreign asset position increases from 0 to 12.6% of GDP in the new steady state. Figure 8 reports the transition dynamics in Phase I. Immediately after the tariff reduction in 1995, the ratio of trade volume/GDP jumps from 35.9% to 44% and the ratio of current account/GDP jumps from 0 to 3.5%. Comparing with the data in Table A1 in which both

[8] To pick up the value of endogenous discount factor parameter, we also estimate the Euler equation using Chinese data. Our GMM estimation show that, when we set $\beta = 2$ and $\gamma = 2$, ψ is about 0.075.

trade volume/GDP and current account/GDP take two years to reach the peak, the model prediction happens too soon.

5.2 Phase II: WTO Accession

For the WTO accession, we do two numerical exercises. First, we consider a tariff reduction from 15% to 5%, and compare the steady state equilibria before and after the tariff cut in Columns 4 and 5 in Table 3. The ratio of trade volume/GDP increases from 43% to 55% and the foreign asset position/GDP increases by 57.6% in the new steady state.

Second, we study the transition dynamics. To better match the data, we now assume a gradual tariff reduction that the initial tariff rate in 2001 is 15%, and the tariff reduction in the first, second, third, fourth and fifth year are 5%, 2%, 1% , 1% and 1% respectively. The results are presented in Figure 9 where the solid red line is the model prediction and the dash line represents the data. The puzzle that why China's current account surplus increases sharply after WTO is qualitatively addressed: the model predicts that the ratio of current account surplus/GDP increases by 6% in the peak time, consumption/GDP declines while investment/GDP increases. Quantitatively, the model prediction of trade volume/GDP match the data well. However, the ratios of trade balance/GDP and current account balance/GDP increase in the model too soon than that in the data.

As we have discussed before, our exercises only consider tariff reductions, while ignoring trade cost reductions, technological improvements, financial development, firms' heterogeneity, and other reasons to cause high savings. Therefore, this model is too simple to match the data in transitional dynamics. Nonetheless, our exercises indicate that the WTO accession could be an important driving force for China's sharp increase in current account surplus. The tariff cut alone, may explain more than 50% of current account increases in China.

6 Concluding Remarks

A wave of trade liberalizations take place in both developing and developed countries, including China's WTO accession and the end of import quotas on textile and garment in the United States and Europe. At the same time, both China's current account surplus and the US deficit have risen to an unprecedented level. Are these developments related? We study how trade reforms affect current accounts by embedding a modified Heckscher-Ohlin structure and an endogenous discount factor into an intertemporal model of current account. There are two key results. First, trade liberalizations in a developing country would generally lead to capital outflow, while trade liberalizations in a developed country would result in capital inflow. Thus, trade reforms can contribute to global imbalances. Second, factor market frictions can reduce the current account response to trade reforms by reducing the extent of economic structural change.

We use the model to offer an interpretation of the Chinese experience with trade reforms and current account dynamics. Before China's accession to the WTO at the end of 2001, while there had been trade reforms, financial sector frictions may blunt the current account response. The WTO accession represents a watershed event in two senses. First, not only the dismantling of tariff and non-tariff barriers on imports was accelerated, there was also a dramatic reduction in trading costs faced by firms in the exporting sector. The most noteworthy change is that an expansion of firms that are legally authorized to engage in international trade. Second, the accession protocol also obligates China to engage in a series of financial sector reforms over a five-year transition period after the accession. These reforms have also greatly facilitate the economic adjustment in the direction of expanding China's comparative advantage sectors and reducing its comparative disadvantage sectors. Both changes brought out by the WTO accession, in the context of our model, have the effect of producing a positive current account response. In fact, because both trade reforms and financial reforms were conducted over a multi-year phase, the current account response can be expected to gain strength over time in the first few years after the WTO accession before it peters off.

The end of the import quotas on textile and garments by the United States and Europe in 2004 represents another important event that reduces trading costs. Since this was a reduction in trade barriers on a labor-intensive product in the United States, our theory would predict that the U.S. responds by running a current account deficit. More importantly, because textile and garments are an important comparative advantage sector for China, the end of quotas represented a big decline in the export costs for Chinese exporting firms. Therefore this event also reinforces the rise of China's current account surplus in recent years.

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7 Appendix

7.1 Equations for Steady State

Given the factor prices (w, r) and the holding of foreign asset B, the output Y, consumption C, investment I, aggregate demand D, and sectoral outputs X_1 and X_2 can be determined by the following six equations.

$$\frac{C}{Y} = \frac{\overline{C}}{\overline{Y}}[\beta(1 + r - \delta)]^{\frac{1}{\psi}} \tag{7.1}$$

$$D = C + \frac{I}{P} + \frac{\psi_b}{2} B^2 \tag{7.2}$$

$$PY = P_1 X_1 + P_2 X_2 \tag{7.3}$$

$$\alpha_1 P_1 X_1 + \alpha_2 P_2 X_2 = r \frac{I}{\delta} \tag{7.4}$$

$$(1 - \alpha_1) P_1 X_1 + (1 - \alpha_2) P_2 X_2 = wL \tag{7.5}$$

$$P_1 X_1 + P_2 X_2 / (1 + \tau) + r^* B = \zeta P D \tag{7.6}$$

where $\zeta = \omega + (1 - \omega)/(1 + \tau)$. Equation (7.6) is derived from the current account equation in the steady state, $P_1^*(X_1 - D_1) + P_2^*(X_2 - D_2) + r^* B = CA = 0$.

7.2 Equilibrium Selection in the Initial Steady State

In the initial steady state, we assume an exogenous export share, sx, and an import share, sm, to select the equilibrium. Let

$$sx = \frac{NX_1}{P_1 X_1 + P_2 X_2} > 0$$

$$sm = \frac{NX_2}{P_1 X_1 + P_2 X_2} < 0$$

Since B is initially zero, using expressions of sectoral output, we have

$$P_1 X + P_2 X_2 = \frac{(\alpha_2 - \alpha_1)(1 + \tau) \zeta P D - \tau w L}{(1 - \alpha_1) - (1 + \tau)(1 - \alpha_2)}$$

Using the expressions for X_1 and D_1, we have

$$sx = \frac{wL - PD[(1 - \alpha_2)(1 + \tau)\zeta + \omega((1 - \alpha_1) - (1 + \tau)(1 - \alpha_2))]}{(\alpha_2 - \alpha_1)(1 + \tau)\zeta P D - \tau w L}$$

This implies that given the initial share of export sx, we can determine the initial ratio of wage income to final good expenditure as below

$$\frac{wL}{PD} = \frac{sx(\alpha_2 - \alpha_1)(1 + \tau)\zeta + (1 - \alpha_2)(1 + \tau)\zeta + \omega((1 - \alpha_1) - (1 + \tau)(1 - \alpha_2))}{1 + sx\tau}$$

Let $\kappa = \frac{wL}{PD}$. We can solve for the initial output $\overline{Y}$ as

$$\overline{Y} = \frac{wL}{P}\frac{(\alpha_2 - \alpha_1)(1+\tau)\zeta\kappa^{-1} - \tau}{(1-\alpha_1) - (1+\tau)(1-\alpha_2)}$$

In the initial steady state, the consumption is given by $C = D - \frac{I}{P}$, and the investment is given by $I = \delta K = \frac{\delta}{r}(\alpha_1 P_1 X_1 + \alpha_2 P_2 X_2)$. From the determination of sectoral output, we have

$$I = \frac{\delta}{r}\frac{(1+\tau)(\alpha_2-\alpha_1)\zeta PD - (1+\tau)(\alpha_2-\alpha_1)r^* B - (\alpha_2(1+\tau)-\alpha_1)wL}{(1-\alpha_1)-(1-\alpha_2)(1+\tau)}$$

For simplicity, we rewrite it as

$$\frac{I}{P} = \phi D + \Phi$$

where

$$\begin{aligned}
\phi &= \frac{\delta}{r}\frac{(1+\tau)(\alpha_2-\alpha_1)\zeta}{(1-\alpha_1)-(1-\alpha_2)(1+\tau)} > 0 \\
\Phi &= -\frac{\delta}{rP}\frac{(1+\tau)(\alpha_2-\alpha_1)r^* B + (\alpha_2(1+\tau)-\alpha_1)wL}{(1-\alpha_1)-(1-\alpha_2)(1+\tau)}
\end{aligned}$$

Note that Φ is an investment component determined by the supply side. Therefore, substituting them into the aggregate demand equation, the initial consumption can be expressed as

$$\overline{C} = D[(1-\phi) - \frac{\Phi}{D}]$$

where

$$\frac{\Phi}{D} = -\frac{\delta}{r}\frac{\alpha_2(1+\tau)-\alpha_1}{(1-\alpha_1)-(1-\alpha_2)(1+\tau)}\frac{wL}{PD}$$

Finally, we obtain the initial consumption as below:

$$\overline{C} = \frac{wL}{P}[\frac{1-\phi}{\kappa} + \frac{\delta}{r}\frac{\alpha_2(1+\tau)-\alpha_1}{(1-\alpha_1)-(1-\alpha_2)(1+\tau)}]$$

7.3 Steady State Equilibrium with Credit Constraint

$$B = \frac{1}{\psi_b P}\frac{r^* - r^C + \delta}{1 + r^C - \delta} \tag{7.7}$$

$$(\frac{w}{A_1})^{1-\alpha_1} r_1^{\alpha_1} = P_1^* \tag{7.8}$$

$$(\frac{w}{A_2})^{1-\alpha_2} r_2^{\alpha_2} = (1+\tau)P_2^* \tag{7.9}$$

$$\frac{K_1}{K_2} = \frac{\mu}{1-\mu} \tag{7.10}$$

$$L_1 + L_2 = L \tag{7.11}$$

$$r_1 K_1 = \alpha_1 P_1 X_1 \tag{7.12}$$

$$r_2 K_2 = \alpha_2 P_2 X_2 \tag{7.13}$$

$$wL_1 = (1-\alpha_1)P_1 X_1 \tag{7.14}$$

$$wL_2 = (1-\alpha_2)P_2 X_2 \tag{7.15}$$

$$r^C = \mu K_1 + (1-\mu)K_2 \tag{7.16}$$

$$P_1 D_1 = \omega P D \tag{7.17}$$

$$P_2 D_2 = (1-\omega) P D \tag{7.18}$$

$$D = C + \frac{\delta(K_1 + K_2)}{P} + \frac{\psi_b}{2}B^2 \tag{7.19}$$

$$P_1 X_1 + P_2 X_2/(1+\tau) + r^* B = \zeta P D \tag{7.20}$$

$$\frac{C}{Y} = \frac{\overline{C}}{\overline{Y}}[\beta(1 + r^C - \delta)]^{\frac{1}{\psi}} \tag{7.21}$$

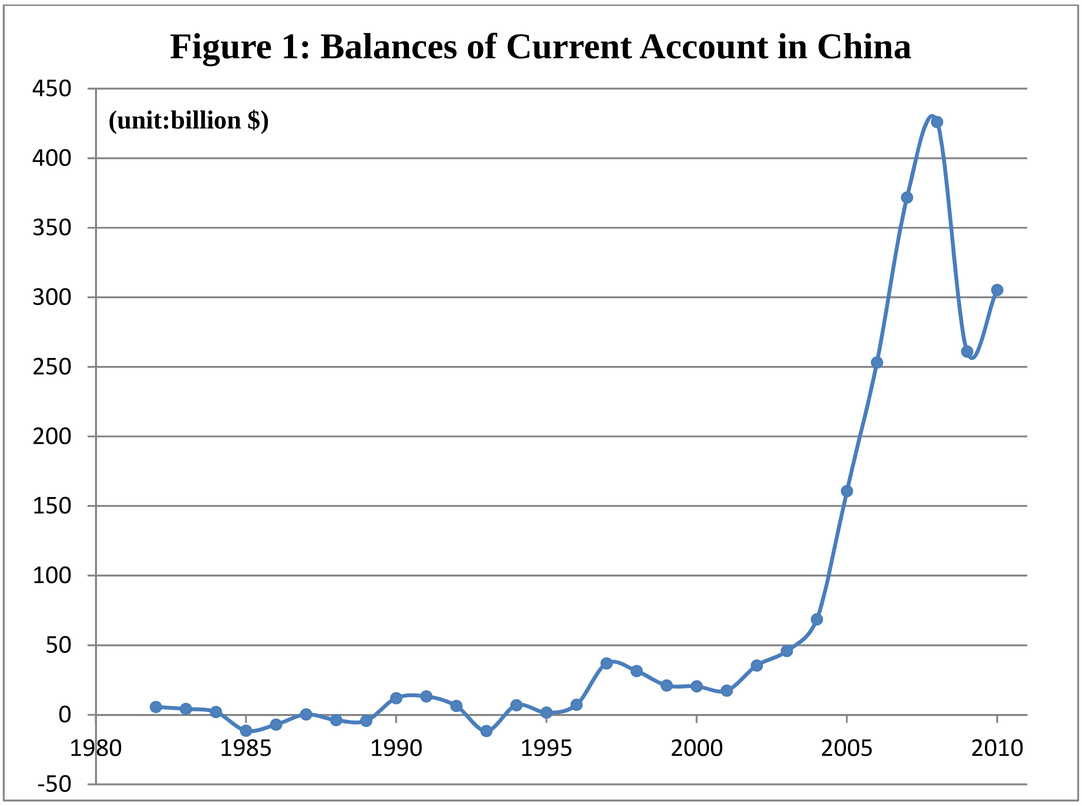

Figure 1: Balances of Current Account in China
(unit:billion $)
450
400
350
300
250
200
150
100
50
0
-50
1980
1985
1990
1995
2000
2005
2010

Figure 2: Trend of tariffs, trade balance/GDP, Current account balance/GDP for China from 1995-2010

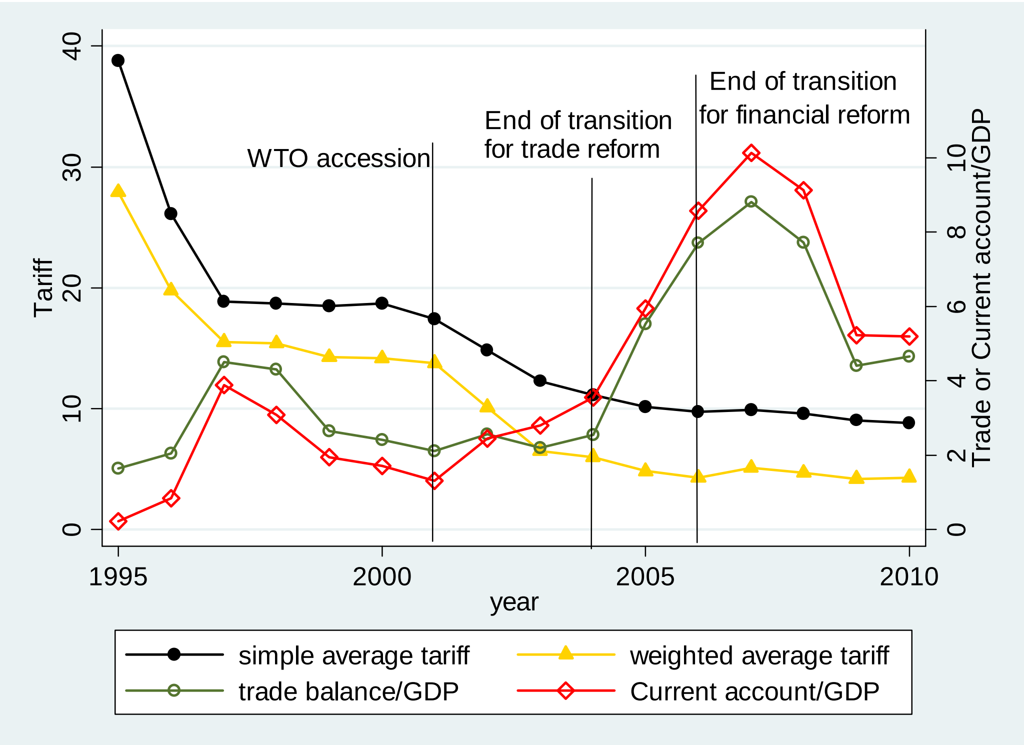

Figure 3: Transition path of the economy after a 5% tariff reduction

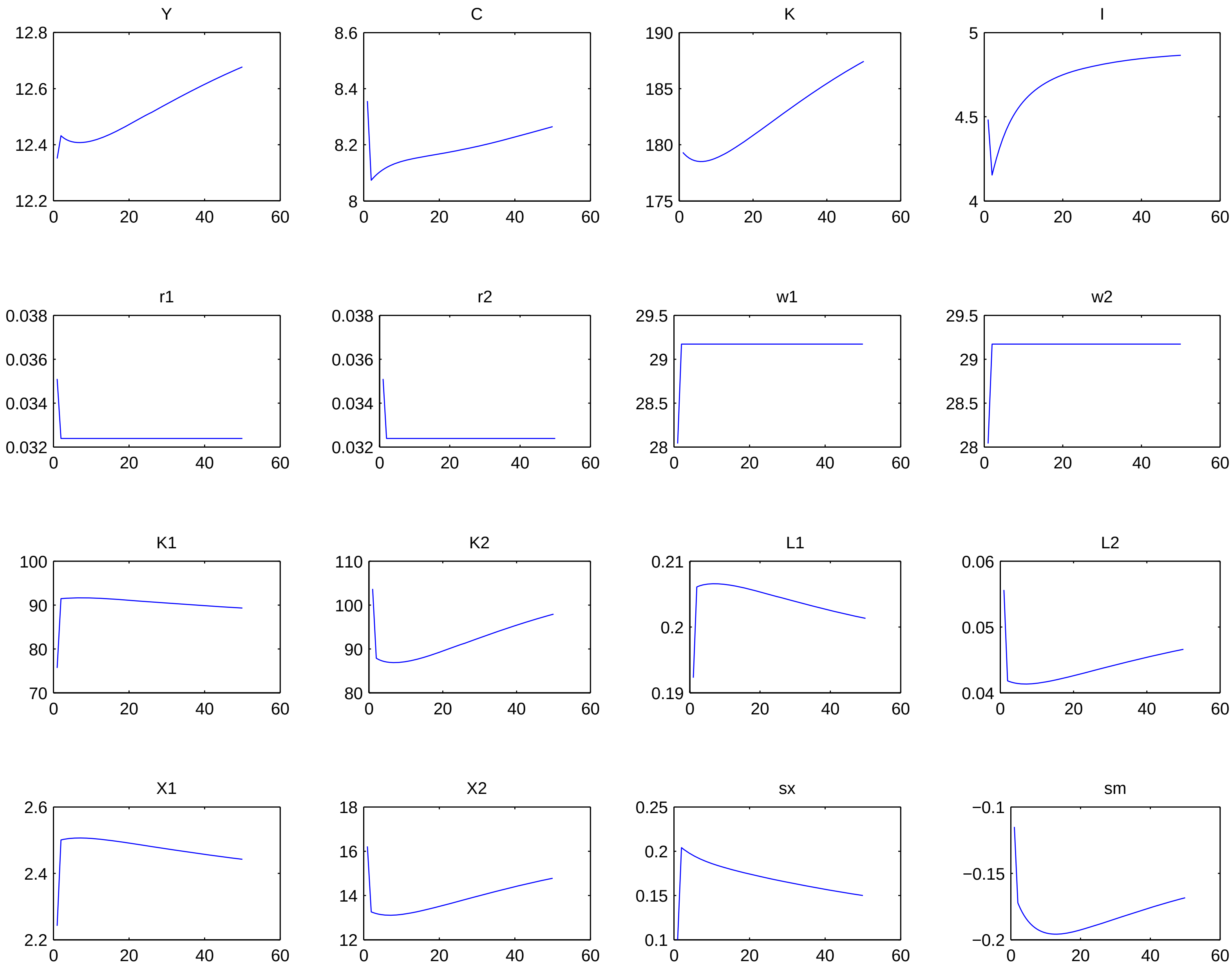

Figure 4: Response of trade and capital flow to a 5% tariff reduction

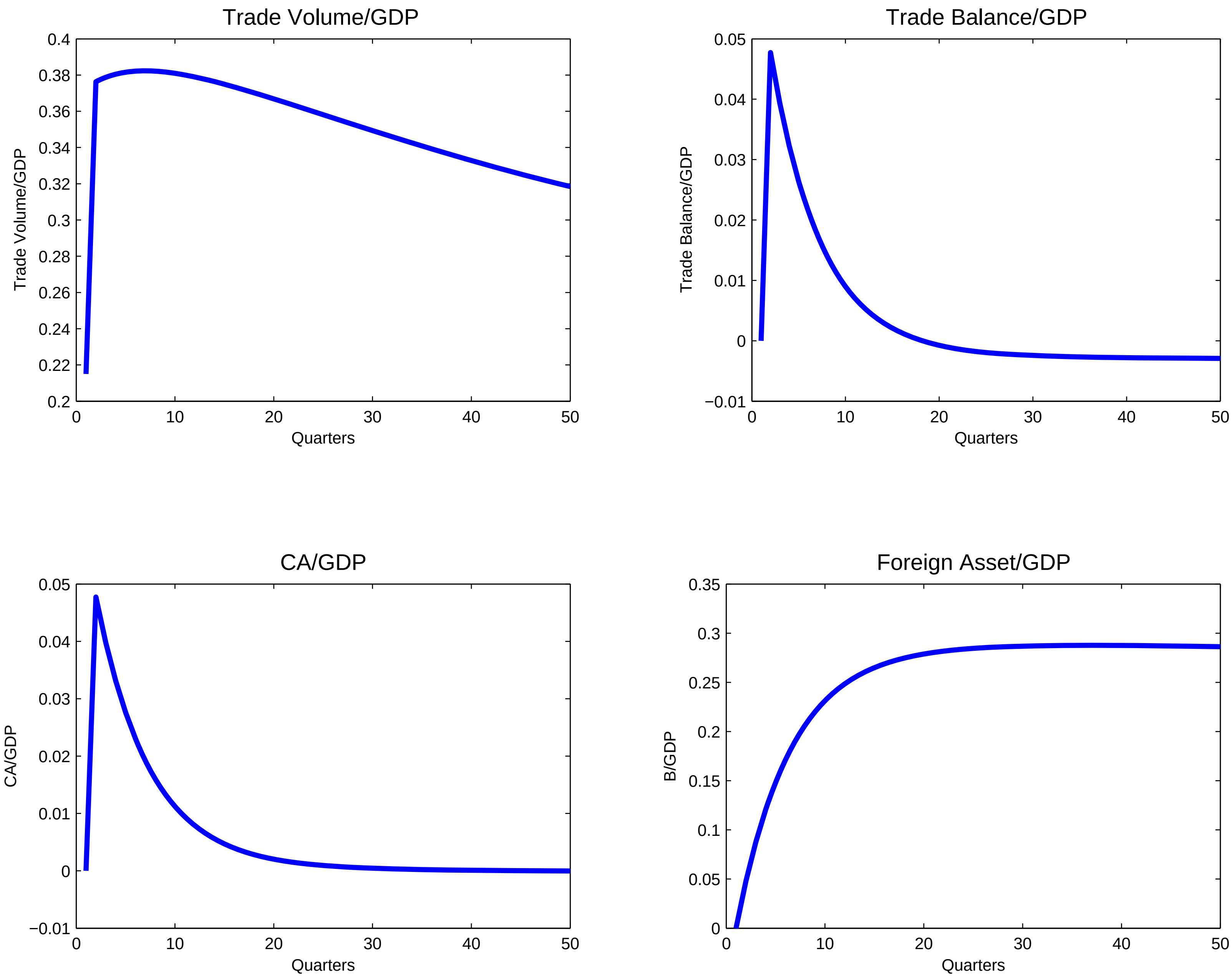

Figure 5: Transition path for different adjustment costs

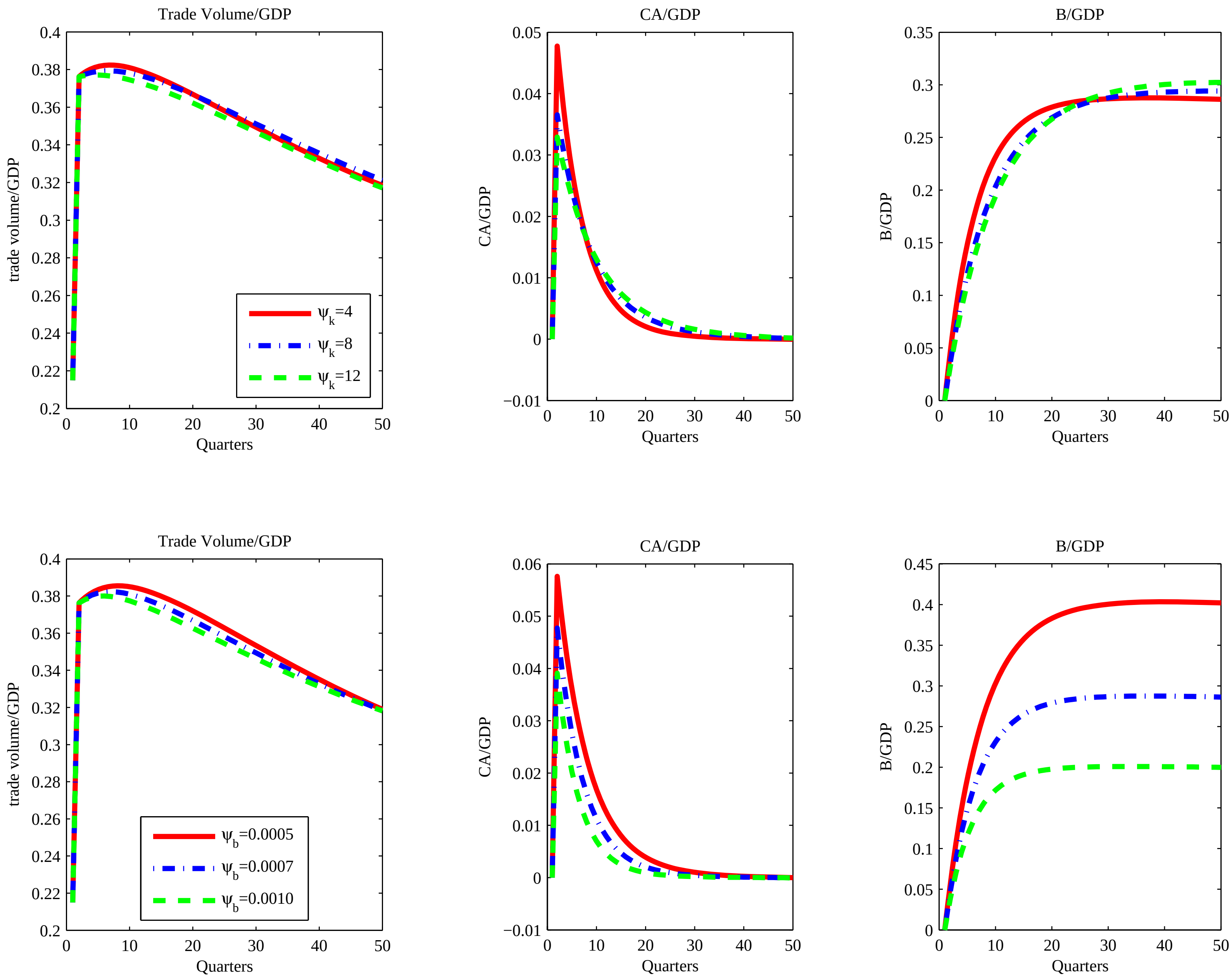

Figure 6: Transition path of the economy with credit constraints after a 5% tariff reduction

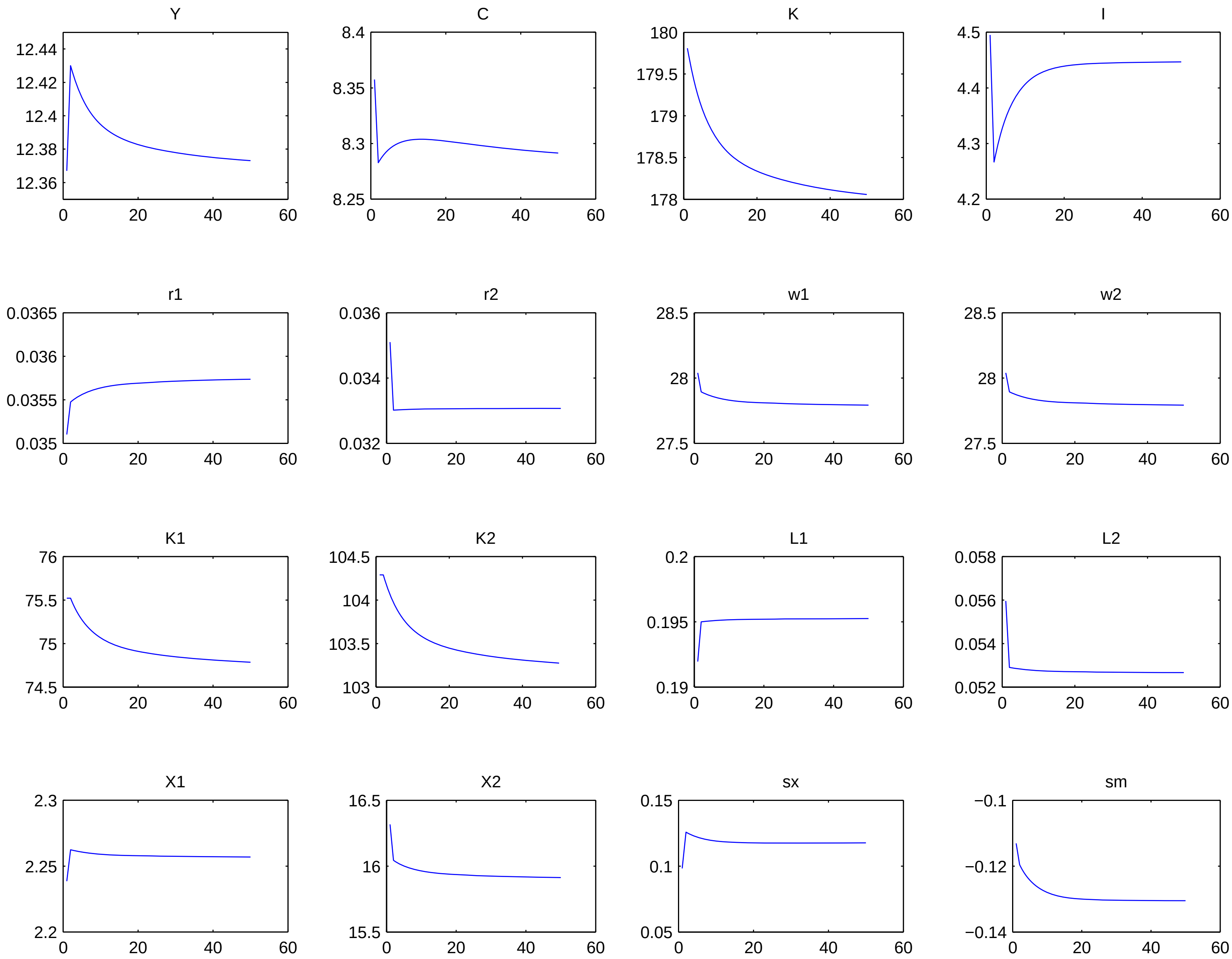

Figure 7: Responses of trade and capital flow to trade liberalizations with and without credit constraints

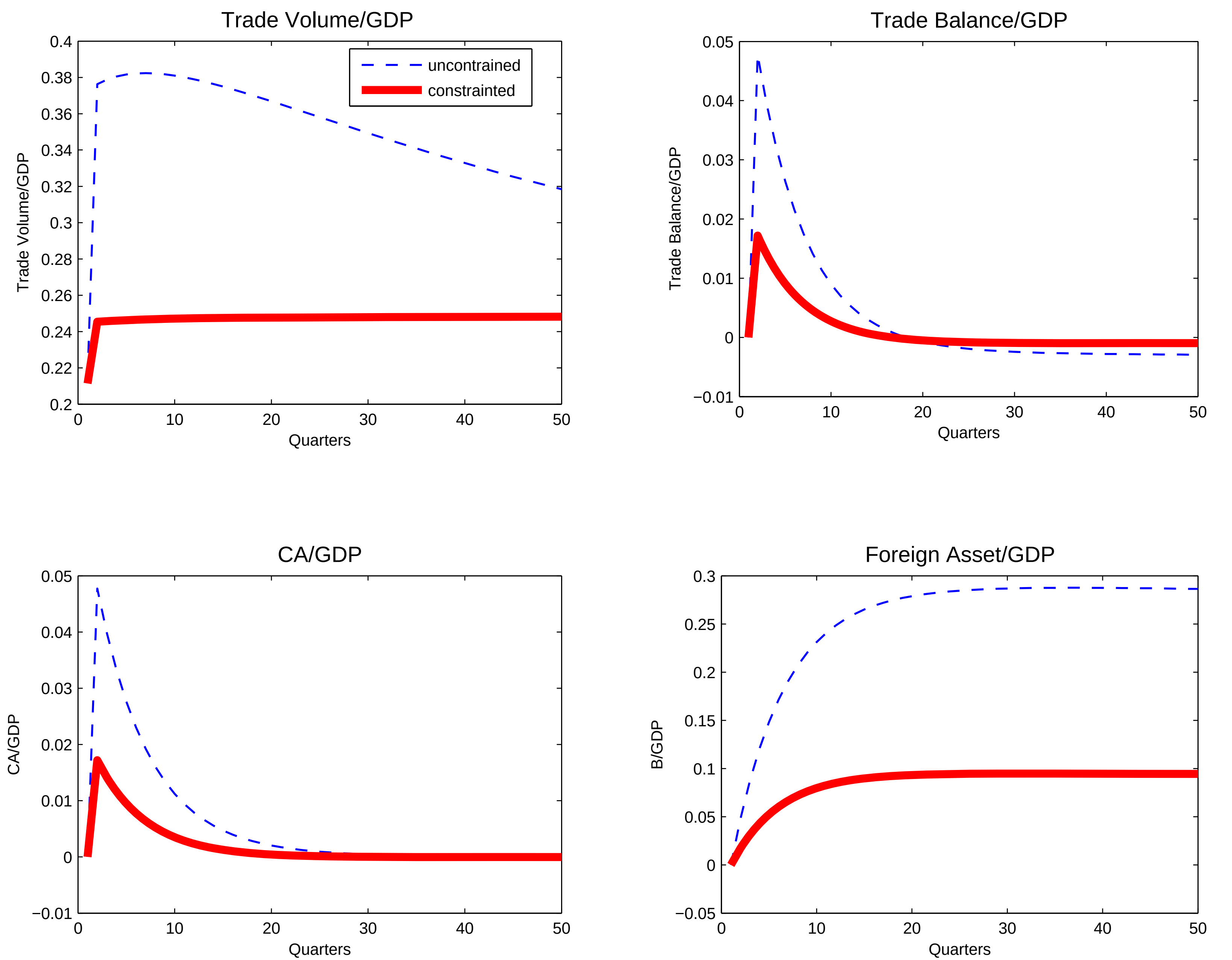

Figure 8: Responses of Chinese economy to trade liberalizations in 1995

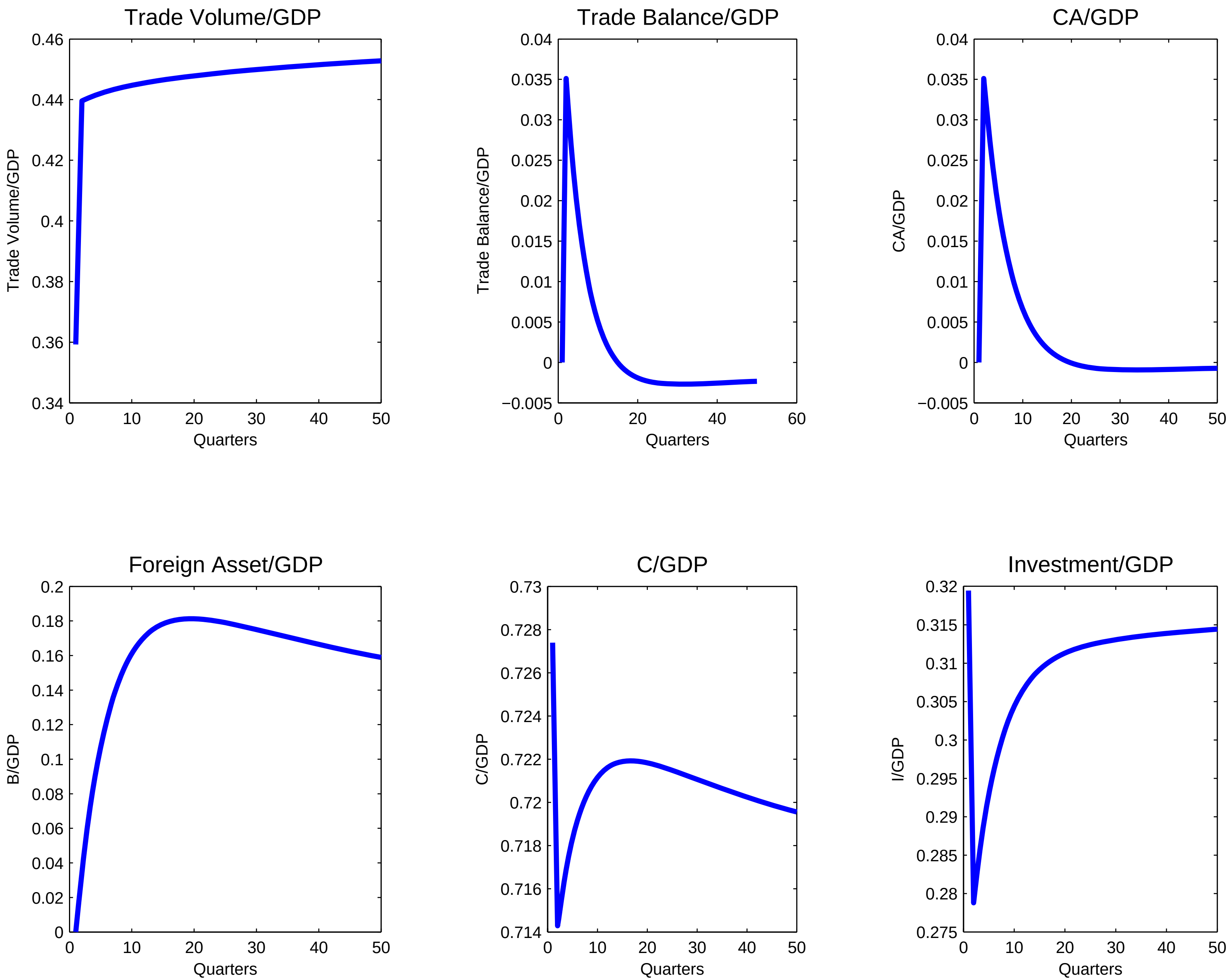

Figure 9: Comparison between model predictions and the Chinese data after WTO

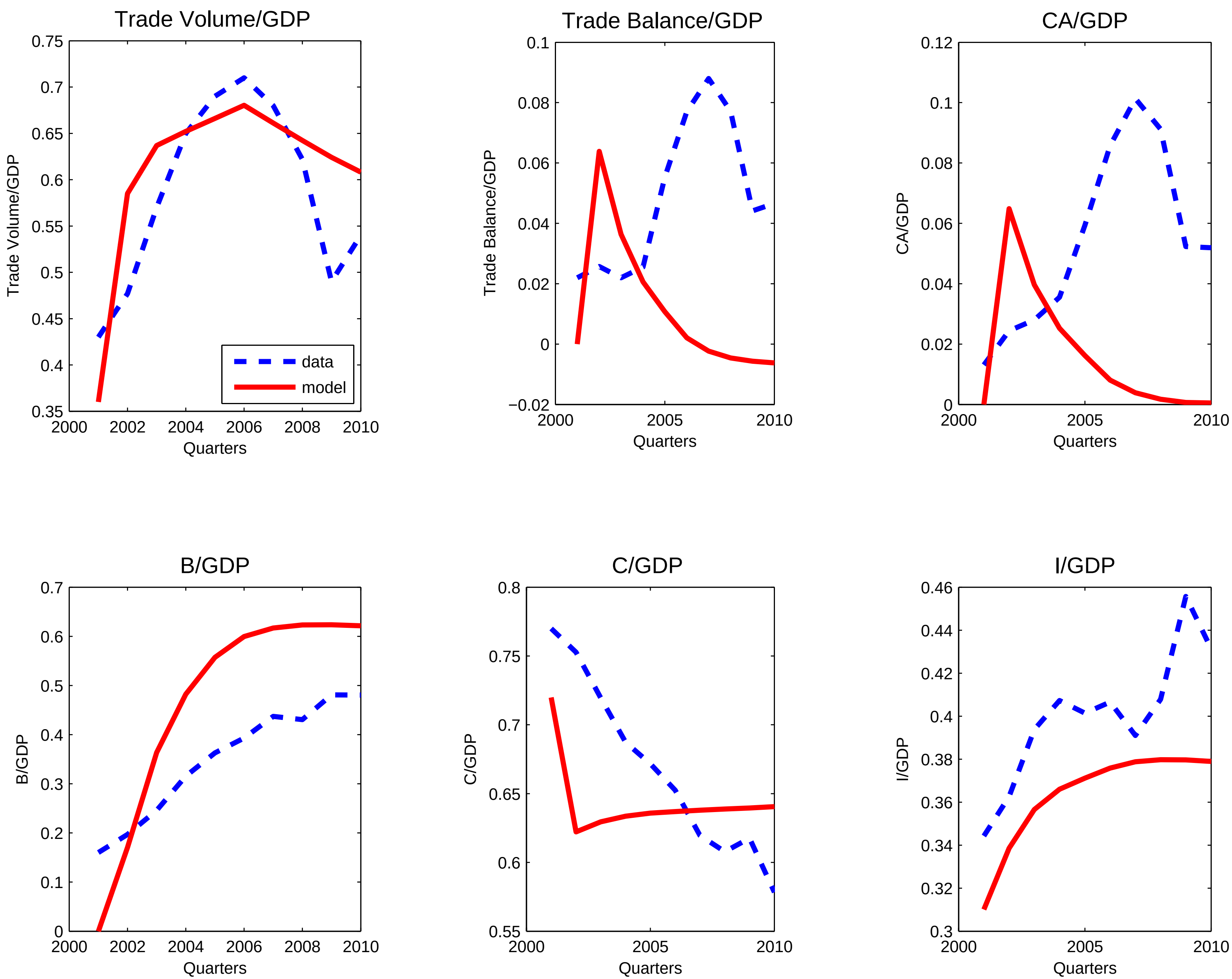

Table 1: Steady State Equilibria Before and After Tariff Reductions

variable	Benchmark (5% and 10% trariff reduction)			Credit constraint (5% and 10% tariff change)		
	tariff=0.15	tariff=0.1	tariff=0.05	tariff=0.15	tariff=0.1	tariff=0.05
rc	0.035101	0.032386	0.02977	0.035101	0.034181	0.033638
r1	0.035101	0.032386	0.02977	0.035101	0.035725	0.03704
r2	0.035101	0.032386	0.02977	0.035101	0.033064	0.031175
w1	28.038	29.172	30.408	28.038	27.796	27.306
w2	28.038	29.172	30.408	28.038	27.796	27.306
p1	3.5882	3.5882	3.5882	3.5882	3.5882	3.5882
p2	0.32049	0.30656	0.29262	0.32049	0.30656	0.29262
p	1.0724	1.0488	1.0247	1.0724	1.0488	1.0247
c	8.3559	8.4551	8.4749	8.3575	8.2875	8.1629
d	12.536	13.048	13.408	12.549	12.534	12.363
b	0	3.6705	7.3971	-5.18E-18	1.2411	2.0219
k	179.32	192.47	201.4	179.81	178.13	172.09
I	4.483	4.8118	5.0351	4.4951	4.4534	4.3023
k1	75.648	87.91	104.2	75.518	74.817	72.278
k2	103.67	104.56	97.205	104.29	103.32	99.813
l1	0.19228	0.19815	0.20712	0.19195	0.19523	0.19906
l2	0.055624	0.04975	0.040785	0.055953	0.052671	0.048839
x1	2.2424	2.4044	2.6197	2.2386	2.2572	2.2609
x2	16.221	15.781	14.127	16.317	15.919	15.191
d1	1.8733	1.9069	1.9144	1.8753	1.8318	1.7653
d2	20.973	22.32	23.475	20.995	21.441	21.646
nx1	1.3245	1.7853	2.5305	1.3038	1.5264	1.7785
nx2	-1.5232	-2.0046	-2.7355	-1.4994	-1.6928	-1.8889
ca	0	0	0	0	0	0
sx	0.1	0.13258	0.18697	0.098313	0.1176	0.14162
sm	-0.115	-0.14887	-0.20212	-0.11306	-0.13042	-0.15041
debt/gdp ratio	0.0%	27.3%	54.7%	0.0%	9.6%	16.1%
trade volume/GDP	21.5%	28.1%	38.9%	21.1%	24.8%	29.2%
GDP	12.35066017	12.83875995	13.20762202	12.36663544	12.37548978	12.25505202
consumption	8.3559	8.4551	8.4749	8.3575	8.2875	8.1629
c/y	67.7%	65.9%	64.2%	67.6%	67.0%	66.6%
i/py	33.8%	35.7%	37.2%	33.9%	34.3%	34.3%

Table 2: Steady State Equilibria Before and After Tariff Reductions in China

variable	15% tariff reduction in 1990s China		10% trariff reduction in 2001	
	tariff=0.30	tariff=0.15	tariff=0.15	tariff=0.05
rc	0.035101	0.033978	0.035101	0.02977
r1	0.035101	0.037998	0.035101	0.02977
r2	0.035101	0.029959	0.035101	0.02977
w1	28.038	26.964	28.038	30.408
w2	28.038	26.964	28.038	30.408
p1	3.5882	3.5882	3.5882	3.5882
p2	0.3623	0.32049	0.32049	0.29262
p	1.1402	1.0724	1.0724	1.0247
c	8.041	7.8409	8.2646	8.4103
d	11.573	11.305	11.825	12.78
b	-1.36E-18	1.4823	0	7.3971
k	161.06	148.57	152.74	178.33
I	4.0266	3.7141	3.8184	4.4583
k1	80.532	74.283	82.761	110.37
k2	80.532	74.283	69.976	67.959
l1	0.20469	0.21253	0.21036	0.21939
l2	0.043208	0.035371	0.037544	0.028514
x1	2.3873	2.3837	2.4533	2.7749
x2	11.146	9.9196	10.948	9.8768
d1	1.8386	1.6893	1.7671	1.8249
d2	18.21	18.914	19.784	22.377
nx1	1.9686	2.4916	2.4624	3.4089
nx2	-2.5592	-2.8825	-2.8317	-3.6578
ca	0	0	0	0
sx	0.15618	0.21237	0.2	0.26534
sm	-0.20304	-0.24569	-0.23	-0.28472
debt/gdp ratio	0.0%	12.6%	0.0%	57.6%
trade volume/GDP	35.9%	45.8%	43.0%	55.0%
GDP	11.05446909	10.94025079	11.48046958	12.5373723
consumption	8.0410	7.8409	8.2646	8.4103
c/y	72.7%	71.7%	72.0%	67.1%
i/py	31.9%	31.7%	31.0%	34.7%

Table A1. Tariff, Trade, and Current account balance in China, 1995~2010

year	Simple-average Tariff (%)	Weighted-average tariff (%)	(Export+import)/GDP (%)	Trade balance/GDP (%)	Current account/GDP (%)
1995	38.79	27.92	38.81	1.64	0.22
1996	26.12	19.77	38.06	2.05	0.85
1997	18.85	15.53	39.01	4.50	3.88
1998	18.73	15.41	36.39	4.30	3.09
1999	18.52	14.29	37.69	2.65	1.95
2000	18.68	14.17	44.24	2.41	1.71
2001	17.41	13.78	43.08	2.12	1.31
2002	14.84	10.13	47.70	2.57	2.44
2003	12.27	6.49	56.91	2.20	2.80
2004	11.11	6.01	65.35	2.55	3.55
2005	10.15	4.83	68.63	5.53	5.94
2006	9.76	4.29	70.57	7.70	8.58
2007	9.91	5.11	68.03	8.80	10.13
2008	9.60	4.69	62.24	7.72	9.12
2009	9.05	4.20	49.02	4.41	5.23
2010	8.81	4.31	54.24	4.66	5.19

Note: Weighted tariff is calculated based on 4 digit ISIC rev2.
Source: World bank database and WITS database