Are Trade Liberalizations a Source of Global Imbalances?

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Abstract

A wave of trade liberalizations have taken place in both developing and developed countries in the last two decades. Global capital flows and the so-called global imbalances have also risen to an unprecedented level. Are the two developments related? We study how trade reforms affect capital flows by introducing a modified Heckscher-Ohlin framework into an intertemporal model of current account. We show that trade liberalizations in a developing country always lead to capital outflow. By contrast, trade liberalizations in a developed country would result in capital inflow. Thus, trade reforms could contribute to global imbalances. The magnitude of capital outflow due to trade liberalizations in a country without financial frictions is significantly larger than that in a country with credit constraints.

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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. Figure 1 (from Caballero, Farhi, and Gourinchas (2008)) displays the main patterns of global imbalances since 1990. 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 and were bolstered by surpluses in emerging Asia and the commodity-producing countries after 1997. Jaumotte, Lall, and Papageorgiou (2008) illustrate the wave of trade liberalizations. 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%.

Figure 2 shows balances of current account in China from 1982 to 2007, which is particularly interesting to us. China joined the WTO in 2001; the average current account balance was 7.6 billion dollars before 2001, but jumped 20 times to 156 billion dollars after 2001. Does China's WTO entrance trigger such a 20 times jump in current account surplus?

While the integration of goods and financial markets deeply intertwined in the real world, as Antras and Caballero (2009) noticed however, the international trade literature which studies the former and the open macroeconomics literature which studies the later are kept largely separate. This paper aims to develop a theoretical model to fill this gap and explain the data patterns indicated above. In particular, we introduce a modified Heckscher-Ohlin (HO) framework into the intertemporal model of current account. We show in a benchmark model that if a developing (labor abundant) country reduces the tariff in the capital intensive sector, the domestic interest rate declines. As a result, capital flows out so that trade liberalizations in a labor abundant country lead to a current account surplus. The intuition is straightforward: trade liberalizations in a developing country change the production composition. The country produces more labor intensive goods but less capital intensive goods. As a result, the investment demand in a country declines, which leads to a capital outflow. By contrast, trade liberalizations in a developed country (capital abundant) lead to a capital inflow.

Financial frictions are viewed as one of major reasons to explain global imbalances in current literature. Caballero, Farhi, and Gourinchas (2008), Mendoza, Quadrini, and Rios-Rull (2009), and Ju and Wei (2010) show that the lower level of financial development induces financial capital flows from developing countries to developed countries. Song, Storesletten, and Zilibotti (2011) contributes China's giant foreign reserves to the incapability of private firms to access credit markets. We argue in this paper, however, the above view should be examined with caution. Especially when credit constraints are asymmetric across sectors, in an extreme case assumed in this paper that there is a credit constraint in one sector but not in another sector, similar to Antras and Caballero (2009), we show that tighter credit constraint induces capital inflow rather than capital outflow. The intuition is: the credit constraint in a sector reduces the capital usage and therefore decreases the marginal product of labor in the sector, which results in a lower wage rate in the economy. Note that the lower wage rate raises the return to capital in the sector without credit constraint, which induces capital inflow. In other words, the credit constraint reduces firms' capital usages and therefore increases the marginal return to capital, which drives capital inflow. The papers by Caballero, Farhi, and Gourinchas (2008), Mendoza, Quadrini, and Rios-Rull (2009), Ju and Wei (2010), and Song, Storesletten, and Zilibotti (2011) emphasize the effect of financial frictions on the supply side of capital: financial frictions reduce investors incentive in investing domestic projects. Similar to Antras and Caballero (2009), this paper focuses on the demand side effect: credit constraints could increase firms' demand to capital. In contrast to Antras and Cabballero (2009), however, we show that trade liberalizations always lead to capital outflow (current account surplus) under credit constraints, although tighter credit constraints reduce the amount of capital outflow resulted from trade liberalizations.

Merging the HO model and the intertemporal model of current account into a unified framework is technically challenging and requires innovations to both models. In HO model, two main problems exist when both goods trade and capital flows are considered. First, As Mundell (1957) argues, goods trade and capital flow are perfect substitutes in the HO model. Without costs of trade in goods or capital, there are infinite combinations of goods trade and capital flow that constitute equilibria. So the exact amount of capital flows is indeterminate. With linear costs of trade in goods and/or capital, the corner solutions occur: either goods trade or capital flow takes place, but goods trade and capital flow do not coexist.[1] Second, if factors are freely mobile across sectors, goods trade and capital flow are substitutes. If factors are sector-specific, however, as Markusen (1983) and Antras and Caballero (2009) point out, goods trade and capital flow could be complement. By introducing convex adjustment costs of foreign bonds in this paper, there is a unique equilibrium in which goods trade and capital flows coexist in transition dynamics and the steady state after trade liberalization. In the initial steady state, we select the equilibrium by an exogenous export to GDP ratio. With labor adjustment costs across sectors, the HO model and the factor-specific model become two polar cases. Thus, the issue of substitutability or complementarity between goods trade and capital flows are examined comprehensively. In all model settings, the results that trade liberalizations in a labor abundant country lead to capital outflow is robust.

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. When there are permanent shocks like trade liberalizations, the steady states before and after shocks differ. The interest rate determined by the discount factor and the one determined by the zero profit conditions may not be equal. This problem is first raised by Stiglitz (1970)

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

where he shows that unless two countries have identical discount factors one country must specialize in a setup of dynamic HO model. We introduce a modified endogenous discount factor into our model to solve this problem: the interest rate is determined by zero profit conditions in the HO model; given the interest rate, through endogenous discount factor, the total consumption in the steady state is then determined.

Our paper is related to a small but growing literature by Cunat and Maffezzoli (2004), Ju and Wei (2007), Jin (2009, 2010), and Ju, Shi and Wei (2011) that introduces HO model into a DSGE framework. None of these papers studies the effect of trade liberalizations. There is also a small literature on the effect of trade policy reforms on current account. Ostra and Rose (1992), and Ju, Wu, and Zeng (2010) show that the effect of tariff reductions on trade balances is ambiguous. Our model provides a natural explanation: trade policy reforms often take the form of reducing trade barriers in capital intensive sectors in a developing country (but of reducing trade barriers in labor-intensive sectors in a developed country). When mixing both types of countries in a sample, it is not surprising to find an ambiguous effect of trade reforms on current account.

2 The Basic model

Our model embeds a Heckscher-Ohlin model inside a standard small open economy dynamic general equilibrium framework. It has two additional features. First, there are adjustment costs for both reallocation of factors between sectors and for cross-border capital flows. Second, an endogenous time discount factor, following Uzawa (1968) and Mendoza (1991), is used.

2.1 Household

The economy is inhibited by a continuum of identical and infinitely lived households that can be aggregated into a representative household. The representative household's preference over consumption and leisure flows is summarized by the following 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 given by

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

where $\theta_0 = 1$ and $\frac{\partial \beta(\tilde{C}_s)}{\partial \tilde{C}_s} < 0$. We assume that the endogenous discount factor does not depend on the household's own consumption, but rather on the economy-wide average per capita consumption $\tilde{C}_s$, which the representative household takes as given.[2] The exact function form of $\beta(\tilde{C}_s)$ will be discussed later. The household owns factors of production, capital K and a fixed labor supply L, and sell its services in competitive spot market. For simplicity, we assume a fixed labor supply.

The final good is produced by two intermediate goods. The household supplies labor to both intermediate good sectors. However, labor can not be costlessly and instantaneously reallocated between two sectors. To model the labor market friction, we assume that the households are subject to quadratic adjustment costs for working in each sector. That is, if the households supply L_{it} to sector i in period t, they will bear the adjustment cost $\frac{\lambda}{2}(L_{it} - L_{i,t-1})^2$, where λ is a parameter that measures the labor market friction in sector i. As a result, the wages can be different in two sectors in the transitional dynamics. In addition, the household can hold foreign asset B_t to smooth consumption. We also assume that trade in foreign bonds is subject to small portfolio adjustment costs. If the household holds an amount B_t, then these portfolio adjustment costs are $\frac{\psi}{2}(B_t - \bar{B})^2$ (denominated in the composite final good),[3] where $\bar{B}$ is an exogenous capacity level of foreign asset management. For simplicity, we assume $\bar{B} = 0$.

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

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

Therefore, the budget constraint and the capital accumulation equation faced by the households are give by

$$
\begin{aligned}
& P_t[C_t + \sum_{i=1}^{2} \frac{\lambda}{2}(L_{it} - L_{i,t-1})^2 + \frac{\psi}{2}(B_{t+1} - \bar{B})^2] + B_{t+1} + I_t \\
= & \sum_{i=1}^{2} w_{it} L_{it} + r_t K_t + (1 + r^*) B_t \qquad (2.2)
\end{aligned}
$$

$$K_{t+1} = (1 - \delta) K_t + I_t \qquad (2.3)$$

$$L_{1t} + L_{2t} = L \qquad (2.4)$$

where I_t is investment in period t, and w_{it} and r_t are the wage rate in sector i and the domestic return to capital, while r^* being the world interest rate. δ is the capital appreciation rate. The tariff revenue, $\tau(D_2 - X_2)$, is redistributed in lump-sum to the final good producer and will be discussed later. That is equivalent to an assumption typical in open macroeconomics literature[4] that the tariff revenue is rebated in lump-sum to the representative consumer and is taken as exogenous by the consumer.

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

$$\frac{U_c'(C_t)}{P_t} = \Omega_t \qquad (2.5)$$

$$\Lambda_t = \beta(\tilde{C}_t)[\Lambda_{t+1}(1 - \delta) + \Omega_{t+1} r_{t+1})] \qquad (2.6)$$

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

$$\Omega_t \left[w_{it} - P_t \lambda (L_{it} - L_{i,t-1})\right] + \Omega_{t+1} \beta(\tilde{C}_t) \lambda (L_{i,t+1} - L_{it}) = \eta_t, \ i = 1, 2 \qquad (2.8)$$

[4] For example, see Devereux and Lee (1999) for a similar assumption.

where Ω_t, Λ_t and η_t are Lagrange multipliers for the budget constraint, the law of capital motion, and labor supply constraint, respectively. Using the first order condition for I_t, we have $\Lambda_t = \Omega_t$.

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 *effective labor.* All production functions are assumed to be homogeneous of degree one.

The unit cost function for X_{it} is $\phi_i(\frac{w_{it}}{A_t}, r_t)$. Let P_i be the 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 intermediate good markets imply that

$$P_{1t} = \phi_1(\frac{w_{1t}}{A_{1t}}, r_t), P_{2t} = \phi_2(\frac{w_{2t}}{A_{2t}}, r_t) \tag{2.9}$$

As tariff revenue is redistributed to the final good producer, the zero profit condition in the final good market is

$$P_t D_t + \tau(D_2 - X_2) = P_t G(D_{1t}, D_{2t}) = P_{1t}D_{1t} + P_{2t}D_{2t} \tag{2.10}$$

2.3 Equilibrium

In equilibrium, trade in intermediate goods equalizes good prices across all countries in every period. That is,

$$P_{1t} = (1+\tau_1)\,P_1^*,\ P_{2t} = (1+\tau_2)P_2^*, \tag{2.11}$$

where P_i^* denotes the world price and is exogenously given, and τ_i is the import tariff. Without loss of generality, we assume that sector 1 is labor intensive while sector 2 is capital intensive. If the economy is labor abundant, it will export good 1 and import good

2, so that $\tau_1 = 0$ and $\tau_2 > 0$. On the other hand, if the economy is capital abundant, we would have the opposite pattern. Following the assumptions in the standard Hecksher-Ohlin model, we assume that production functions (unit cost functions) in all countries are the same. Therefore, in the foreign country we also have:

$$P_1^* = \phi_1(\frac{w^*}{A_1^*}, r^*), P_2^* = \phi_2(\frac{w^*}{A_2^*}, r^*) \tag{2.12}$$

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

$$K_t = K_{1t} + K_{2t} \tag{2.13}$$

$$L_t = L_{1t} + L_{2t} \tag{2.14}$$

$$D = C_t + \frac{I_t}{P_t} + \sum_{i=1}^{i=2} \frac{\lambda}{2}(L_{it} - \bar{L}_{i,t-1})^2 + \frac{\psi}{2}(B_{t+1} - \bar{B})^2 \tag{2.15}$$

Equation (2.15) implies that the domestic usage of final good covers not only consumption and investment, but also the labor adjustment costs and bond adjustment costs. The current account balance over period t is defined as $CA_t = B_{t+1} - B_t$; thus, noting that $P_{it} = w_{it}L_{it} + r_tK_{it}$ and using equations (2.10) and (2.15)), we can rewrite the budget constraint as

$$CA_t = P_1^*(X_{1t} - D_{1t}) + P_2^*(X_{2t} - D_{2t}) + r^*B_t \tag{2.16}$$

That is, the balance of current account is equal to the trade surplus plus the interest income on the net foreign asset position.

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 goods 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 time discount factor takes the following function form:

$$\beta(\tilde{C}_t) = \beta(\frac{\tilde{C}_t}{\bar{C}})^{-\psi} \tag{3.17}$$

where $\psi > 0$ and $\bar{C}$ is the consumption in the initial steady state with tariff τ_0. This form is a variant of Choi, Mark and Sul (2008). The equation (3.17) implies that in the steady state after tariff reforms, the endogenous discounted factor would deviate from the constant β.

3.1 The Effect of Trade Liberalizations in the Steady State

For simplicity, we assume that $A_1^* = A_2^* = 1$. In any steady state, $w_1 = w_2$ even if labor is not perfectly mobile.[5] As a result, labor market frictions do not affect the steady state. Given the production functions, from Equation (2.9), we can have

$$(\frac{w}{A_1})^{1-\alpha_1} r^{\alpha_1} = (1+\tau_1)P_1^* \tag{3.18}$$

$$(\frac{w}{A_2})^{1-\alpha_2} r^{\alpha_2} = (1+\tau_2)P_2^* \tag{3.19}$$

which give

$$w = w^*(1+\tau_1)^{\frac{\alpha_2}{\alpha_2-\alpha_1}}(1+\tau_2)^{-\frac{\alpha_1}{\alpha_2-\alpha_1}} A_1^{\frac{(1-\alpha_1)\alpha_2}{\alpha_2-\alpha_1}} A_2^{-\frac{(1-\alpha_2)\alpha_1}{\alpha_2-\alpha_1}} \tag{3.20}$$

$$r = r^*(1+\tau_1)^{-\frac{1-\alpha_2}{\alpha_2-\alpha_1}}(1+\tau_2)^{\frac{1-\alpha_1}{\alpha_2-\alpha_1}} A_1^{-\frac{(1-\alpha_1)(1-\alpha_2)}{\alpha_2-\alpha_1}} A_2^{\frac{(1-\alpha_1)(1-\alpha_2)}{\alpha_2-\alpha_1}} \tag{3.21}$$

[5] We drop subscript t in this subsection.

It can be immediately seen that $\frac{\partial r}{\partial \tau_1} < 0$, $\frac{\partial r}{\partial \tau_2} > 0$, $\frac{\partial r}{\partial A_1} < 0$, and $\frac{\partial r}{\partial A_2} > 0$. Thus, trade liberalization in a labor abundant country implies a reduction in τ_2, which reduces the return to capital. By contrast, trade liberalizations in a capital abundant country reduces τ_1, which raises the return to capital. Effects of sector-specific TFP increases are similar; while technological progress in the labor intensive sector reduces the return to capital, technological progress in the capital intensive sector does the opposite.

These results are consistent with the Stolper-Samuelson theorem in the HO model. That is, an increase in the price of a good will increase the return to the factor used intensively in that good, and reduce the return to the other factor. A tariff reduction in sector 2 implies a decrease in the price of capital intensive goods, therefore, r decreases but w increases.

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

$$B = \frac{1}{\psi P} \frac{r^* - r + \delta}{1 + r - \delta} \tag{3.22}$$

The bond holding 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 will flow out in the steady state. Summarizing we have:

Proposition 1 *Trade liberalizations in a labor abundant country lead 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. The opposite results hold when trade liberalizations take place in a capital abundant country.*

Using the Euler equation in the steady state (2.6) and the function of endogenous discount factor (3.17), we solve for the level of consumption

$$\tilde{C} = \bar{C}[\beta(1 + r - \delta)]^{\frac{1}{\psi}} \tag{3.23}$$

where $\bar{C}$ is the consumption level in initial steady state, which will be discussed later. Clearly, $\frac{\partial \tilde{C}}{\partial r} > 0$. When the return to capital (bond) declines in a new steady state, the household becomes more patient and consumes less.

The demand for the final good, D, is determined by equation (2.15). We solve it in the Appendix and state here:

$$D = \frac{\tilde{C} - \frac{\delta}{rP}(r^*B + wL) + \frac{1}{2}\psi B^2}{1 - \frac{\delta}{r}} \tag{3.24}$$

In the steady state, $CA = 0$, so equation (2.16) becomes:

$$P_1(X_1 - D_1) + P_2(X_2 - D_2) + r^*B = 0 \tag{3.25}$$

Note that the labor market clear condition also gives us

$$(1 - \alpha_1)\, P_1X_1 + (1 - \alpha_2)\, P_2X_2 = wL \tag{3.26}$$

Equations (3.25) and (3.26) together solve for X_1 and X_2, which are:

$$P_1X_1 = \frac{wL - (1 - \alpha_2)(PD - r^*B)}{(\alpha_2 - \alpha_1)} \tag{3.27}$$

$$P_2X_2 = \frac{(1 - \alpha_1)(PD - r^*B) - wL}{(\alpha_2 - \alpha_1)} \tag{3.28}$$

The optimization conditions for the final good producer give $P_1D_1 = \omega PD$. Thus the exports in intermediate goods are given by

$$NX_1 = P_1(X_1 - D_1) = P_1X_1 - \omega PD \tag{3.29}$$

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

$$K_i = \alpha_i \frac{P_iX_i}{r},\ L_i = (1 - \alpha_i)\frac{P_iX_i}{w},\ \text{and} \tag{3.30}$$

$$\frac{K_i}{L_i} = \frac{\alpha_i}{1 - \alpha_i}\frac{w}{r} \tag{3.31}$$

Consider trade liberalization in a labor abundant country. r decreases but w increases, while B increases. If the demand for the final good D declines, equations (3.27) and (3.28) indicate that P_1X_1 increases but P_2X_2 decreases. That is, the labor intensive sector expands but the capital intensive sector shrinks. As a result, capital and labor usages increase in sector 1 but decrease in sector 2, while capital intensities in both sectors increase since $\frac{w}{r}$ becomes larger. Equation (3.27) indicates that the exports, NX_1, must increase. Using equation (3.25), the imports $P_2(D_2 - X_2)$, which equals the exports NX_1 minus the trade deficit $-r^*B$ in the steady state, must increase as well, since both the exports and trade deficit become larger. Summarizing we have

Proposition 2 *If trade liberalization in a labor abundant country reduces the demand for the final good, in a steady state after the trade liberalizations the country observes an expansion in the labor intensive sector, but a shrink in the capital intensive sector, which results in factors flowing from sector 2 to sector 1, and increases in both exports and imports.*

3.2 Equilibrium Selection in the Initial Steady State

Parameters are assumed in the initial steady state to make $r = r^*$ so that $B = 0$. We cannot use the Euler equation to determine the level of aggregate consumption $\bar{C}$. 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 implies that the country will 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. That is, we define an exogenous export share sx, and correspondingly an import share sm

$$sx = \frac{NX_1}{P_1X_1 + P_2X_2} > 0$$

$$sm = \frac{NX_2}{P_1X_1 + P_2X_2} < 0$$

Since the bond holding is zero in the initial steady state, we have $P_1X_{1+}P_2X_2 = PD$. That is, $sx = -sm$. Using the expressions of X_1 and D_1, we have

$$sx = \left[\frac{wL - (1-\alpha_2)PD}{(\alpha_2 - \alpha_1)} - \omega PD\right] / PD$$

This yields

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

Using the equations $I = \frac{\delta}{r}(PD - wL)$ and $\bar{C} = D - \frac{I}{P}$, we then obtain the level of initial consumption:

$$\bar{C} = \frac{wL}{P}\left[\frac{1-\frac{\delta}{R}}{\omega(1-\alpha_1) + (1-\omega)(1-\alpha_2) + sx(\alpha_2 - \alpha_1)} + \frac{\delta}{R}\right] \tag{3.32}$$

3.3 Calibration and Dynamic Path

The model is calibrated in a standard way (see Backus, Kehoe, and Kydland (1992, 1994, 1995), and Kehoe and Peri (2002)). The parameter values are reported 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 that the annual world interest rate will be 4 percent. We assume an equal share of the intermediate good in the final good production, so $\omega = 0.5$. We choose $\alpha_1 = 0.32$ and $\alpha_2 = 0.68$ so that the average capital share of income is about 50 percent, which is close to the estimate for China in 2001, the year of its WTO accession, by Bai, Hsieh and Qian (2006). Given α_1 and α_2, the capital labor ratio in the import sector is about four times than that in the export sector; this is slightly higher than our estimate for China. Following Schmitt-Grohe and Uribe (2003), the coefficient for bond adjustment costs is set to be 0.0007. The value of the parameter that measures the labor marker friction, λ will be chosen to match the elasticity of relative labor supply at the sectoral level. For experiment, we will set $\lambda = 0$ and 4, which represent two different degrees of labor market rigidities. In our model, we set $\psi = 0.1$, which is close to the value chosen by Choi, Mark and Sul (2008). For the initial productivity, we set $A_1 = 1$ and $A_2 = 0.56566$ so that in the initial steady state, 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.

Table 1: Calibration

β	discount factor in steady state	2
α_1	capital share in sector 1	0.32
α_2	capital share in sector 2	0.68
ω	the share of goods 1 in final good	0.5
λ	the parameter of labor market friction	0/4/20
ψ_b	coefficient of bond adjustment cost	0.0007
ψ	the parameter of endogenous discount factor	0.1
ψ_k	the coefficient of capital adjustment cost	4
A_1	productivity in sector 1	1
A_2	productivity in sector 2	0.56566

We assume that in the initial steady state, the economy imposes a 20% of tariff on imports of the capital intensive good while the rest of the world has zero tariff. After the trade liberalization, the import tariff is reduced to 15%. In columns 2 and 3 of Table 2, we report the values for both the initial and the new steady states. The numerical results confirm Propositions 1 and 2: 1) the return to capital declines while the wage arises; 2) capital flows out, and both consumption and investment fall; 3) the labor intensive sector expands while the capital intensive sector shrinks, and the aggregate capital usage declines; 4) the labor intensive sector exports more while the capital intensive sector imports more. In summary, a moderate tariff reduction (5%) results in a significant capital flow, on the order of about 30 percent of the domestic GDP. The ratio of trade balance to GDP increases from 20% to 64.7%.

In Figure 3, we depict the dynamic path of the economy from the initial to the new steady state after a trade liberalization. Our discussions focus on the dynamics of current account, foreign asset position and the level of international trade in each intermediate good. As intermediary variables, we also report the response of aggregate consumption, capital and labor (both aggregate and sectoral level). We assume that the trade liberalization starts to hit the economy in period 1.

We find that industrial changes take place immediately when the tariff is reduced in the first period. However, consumption responds to the trade liberalization in a different way. There is a consumption boom in the first period, after that, consumption declines gradually to a low steady state level. This is because that the return to domestic capital declines, which reduces the incentive to save and encourages more consumption. The current account has similar pattern, but it is purely due to the capital outflow. This also implies that there should be trade surplus after the trade liberation. We depict the dynamics of trade surplus in Figure 4. In the short run, in response to the trade liberalization, the economy runs a trade surplus, which could be 2 percent of GDP. In the long run, however, the economy will run a trade deficit, which is supported by the interest payment of the foreign asset.

4 Financial Frictions

In this section, we study the effect of financial frictions on current account. Following Antras and Caballero (2009), we assume that financial frictions are asymmetric in two sectors. To simplify the analysis, we assume that firms in the importing sector can employ any desired amount of capital at the equilibrium interest rate, but firms in exporting sector face credit constraints. In particular, the financial friction is represented in the following assumptions: (i) each capitalist owns one unit of capital so there are total K of capitalists. Proportion ξ of K are endowed with "human capital" and are labelled as "entrepreneurs". Only "entrepreneurs" know how to operate in the exporting sector. (ii) due to informational frictions, each entrepreneur can only borrow θ amount of capital. Thus the total amount of capital employed in the exporting sector 1,

$$K_{1t} \leqslant (1+\theta)\xi K_t = \mu K_t \tag{4.33}$$

where $\mu = (1+\theta)\xi$. We assume μ is sufficiently small so that μK is less than the amount of capital firms would like to employ in sector 1 if financial market were frictionless.

Due to the presence of credit constraint, there is a wedge between the returns to capitals across sectors. Let r_i be the return to capital in sector i. The budget constraint (2.2) now is changed to

$$\begin{aligned} & P_t[C_t + \sum_{i=1}^{2} \frac{\lambda}{2}(L_{it} - L_{i,t-1})^2 + \frac{\psi}{2}(B_{t+1} - \bar{B})^2] + B_{t+1} + I_t \\ = & \sum_{i=1}^{2}(w_{it}L_{it} + r_{it}K_{it}) + (1+r^*)B_t \end{aligned} \tag{4.34}$$

In addition to capital accumulation equation (**??**) and labor market clearing condition (2.4), the representative consumer also faces credit constraint (4.33) and capital market clearing condition, $K_{1t} + K_{2t} = K_t$, in solving the optimization problem. When credit constraint (4.33) is binding, we have $K_{1t} = \mu K_t$ and $K_{2t} = (1-\mu)\,K_t$. Using these results, the budget constraint (2.2) now becomes:

$$\begin{aligned} & P_t[C_t + \sum_{i=1}^{2} \frac{\lambda}{2}(L_{it} - L_{i,t-1})^2 + \frac{\psi}{2}(B_{t+1} - \bar{B})^2] + B_{t+1} + I_t \\ = & \sum_{i=1}^{2} w_{it}L_{it} + [\mu r_{1t} + (1-\mu)\,r_{2t}]\,K_t + (1+r^*)B_t \end{aligned} \tag{4.35}$$

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 (2.5), (2.6), (2.7), and (2.8) except that we now replace r_{t+1} by

$$r_{t+1}^C = \mu r_{1,t+1} + (1-\mu)\,r_{2,t+1} \tag{4.36}$$

4.1 Steady State Equilibrium

The steady sate equilibrium in the case of credit constraint is summarized by 15 equations in solving 15 variables in the Appendix. Similar to equation (3.22), in a steady state we have

$$B = \frac{1}{\psi P}\frac{r^* - r^C + \delta}{1 + r^C - \delta} \tag{4.37}$$

Thus, $r^C = \mu r_1 + (1-\mu) r_2$, is a key variable to determine the position of the net foreign asset holding B.

We are not able to obtain an analytic solution in analysis, and therefore resort to numerical results. Here we offer some intuition to the effect of a tighter credit constraint. When credit constraint becomes tighter, the capital usage in sector 1 declines. As a result, the marginal product of capital, r_1, increases, but the marginal product of labor, w_1, declines. Since $w_1 = w_2 = w$ in the steady state, using zero profit condition in sector 2, $P_2 = \phi_2(\frac{w_2}{A_2}, r_2)$, r_2 must increase. Therefore, r^C increases as μ becomes smaller, which results in a decrease in B. That is, a lower level of financial development (tighter credit constraint) results in capital inflow.

Credit constraints impede the expansion of the exporting sector. Under credit constraint the effects of trade liberalization in structural adjustment will be smaller than the case without credit constraints. We expect, therefore, the magnitude of capital outflow due to trade liberalizations will be smaller as well.

4.2 Numerical Results

The calibration of the structural parameters are the same as those in the benchmark case. In the benchmark case without credit constraint, $K_1/K = 72.073/174.18 = 0.41$ in the initial steady state. Thus, we set the credit constraint in the initial steady state as $\mu = 0.35$. We consider two exercises. The first is a tariff reduction from $\tau = 20\%$ to 15%, but under the credit constraints $\mu = 0.35$ and 0.40, respectively. The second is a permanent shock that μ increases from 0.35 to 0.40.

Columns 4 and 5 in Table 2 report the results of the tariff reduction in the case of $\mu = 0.35$. The return to capital in the importing sector, r_2, decreases, but r_1 in exporting sector increases after tariff reduction in sector 2. In contrast to the case without credit constraint, the wage rate now declines. The labor intensive sector expands while the capital intensive sector shrinks, and both export and imports increase. However, the magnitude of structural adjustment is small. In particular, the ratio of trade volume to GDP increases only from 6.7% to 10.5%, a 3.8% increase, comparing to a 44.7% increase in the case without credit constraint. The tariff reduction drives capital outflow; B/GDP increases from 0 to 9.57%, comparing to a 30.14% increase in the case without credit constraint. Results are similar in the case of $\mu = 0.40$. Two important conclusions we draw from the exercises: i) trade liberalizations always lead to capital outflow, and ii) the magnitude of capital outflow in the case with credit constraint is significantly smaller than that in the case without credit constraint.

5 Conclusion

This paper develops a small open economy model with multiple tradable sectors to show that trade liberalizations can help to explain the change in current account imbalances in a labor abundant country, like China. Quantitatively, a moderate tariff reduction (5% tariff reduction) in import sector (capital intensive sector) can lead to a capital outflow more than 30 percent of GDP. So we argue that trade liberalizations might be a source of global current account imbalances. However, the effects of trade liberalization on capital flow depend critically on the financial development. Credit constraints impede the structural adjustments caused by the trade liberalizations, which significant reduce the magnitude of capital flow but do not change the direction of capital flow.

References

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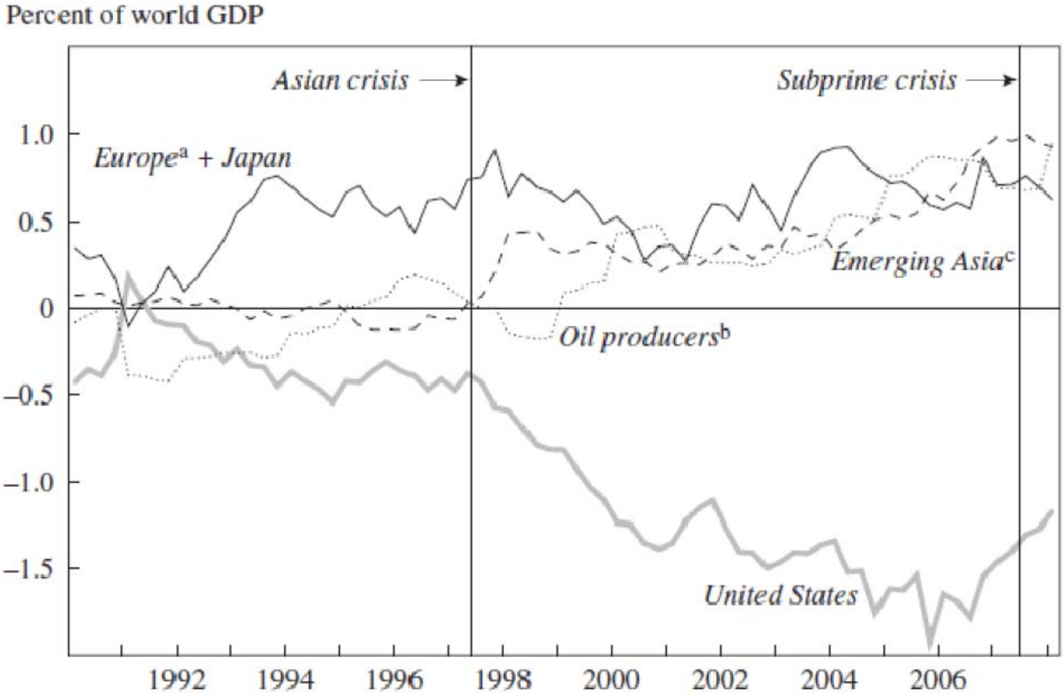
[6] more to be added.

6 Appendix:

to be added

Figure 1 (Figure 1 in Caballero, Farhi, and Gourinchas, 2008)

Figure 1. Current Account Balances, 1990–2008



Sources: World Bank, *World Development Indicators*; International Monetary Fund, *World Economic Outlook* and *International Financial Statistics*; Organization for Economic Cooperation and Development; authors' calculations.

a. Austria, Belgium, Denmark, France, Germany, Iceland, Ireland, Italy, Netherlands, Spain, Sweden, and Switzerland.

b. Bahrain, Canada, Iran, Kuwait, Libya, Mexico, Norway, Oman, Russia, Saudi Arabia, and Venezuela.

c. China, Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Taiwan, and Thailand.

Figure 2: Trade Balances in China

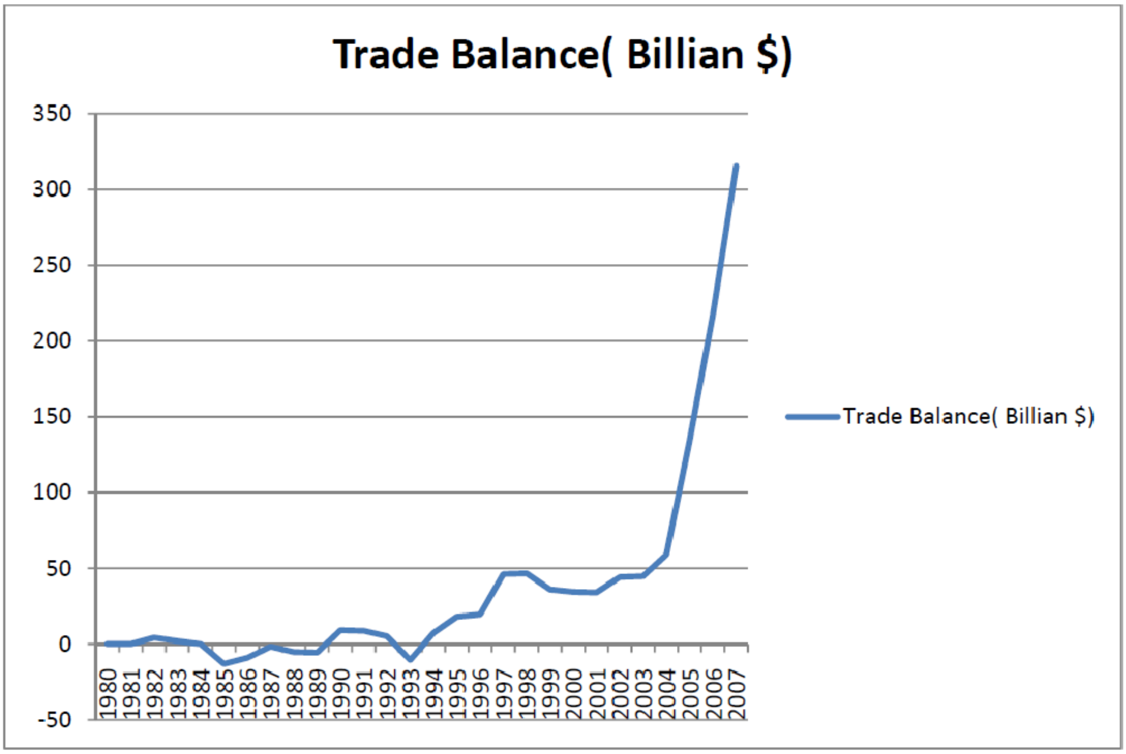


Figure 3: Dynamic Path of Tariff Cut

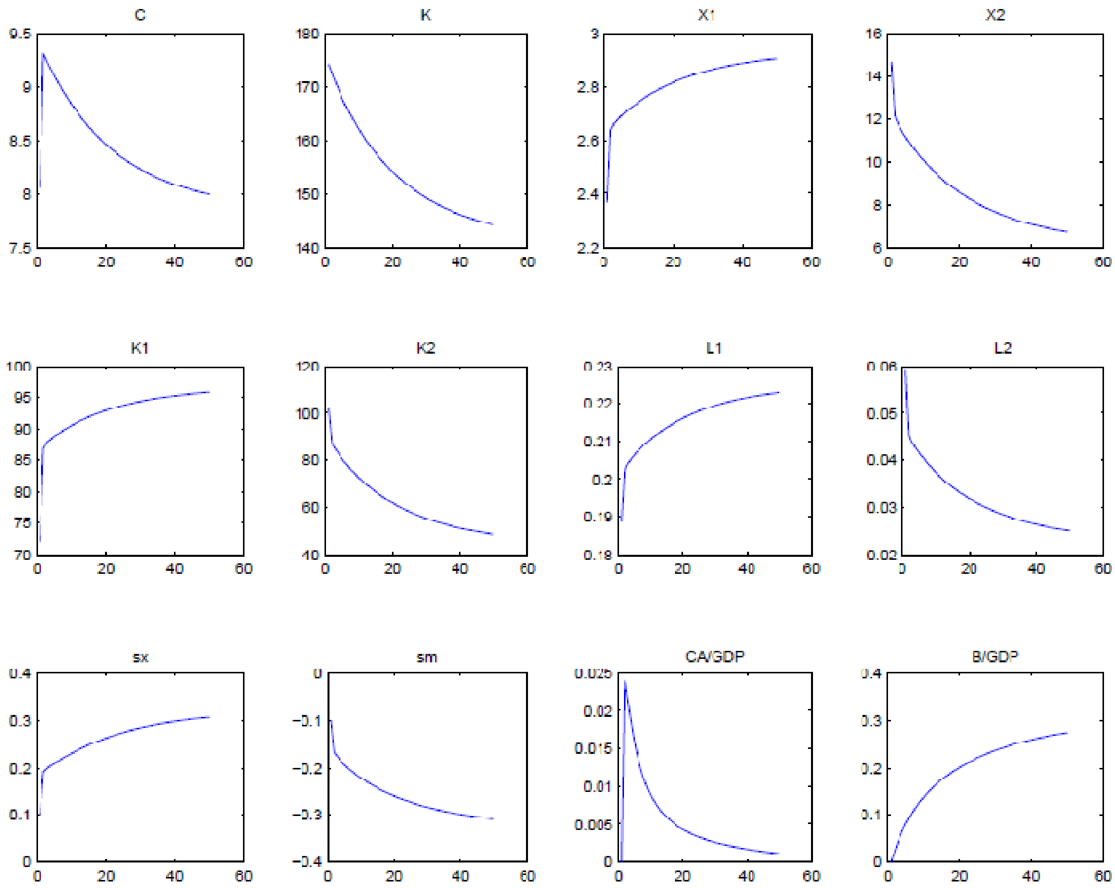


Figure 4: Dynamics of Trade Surplus

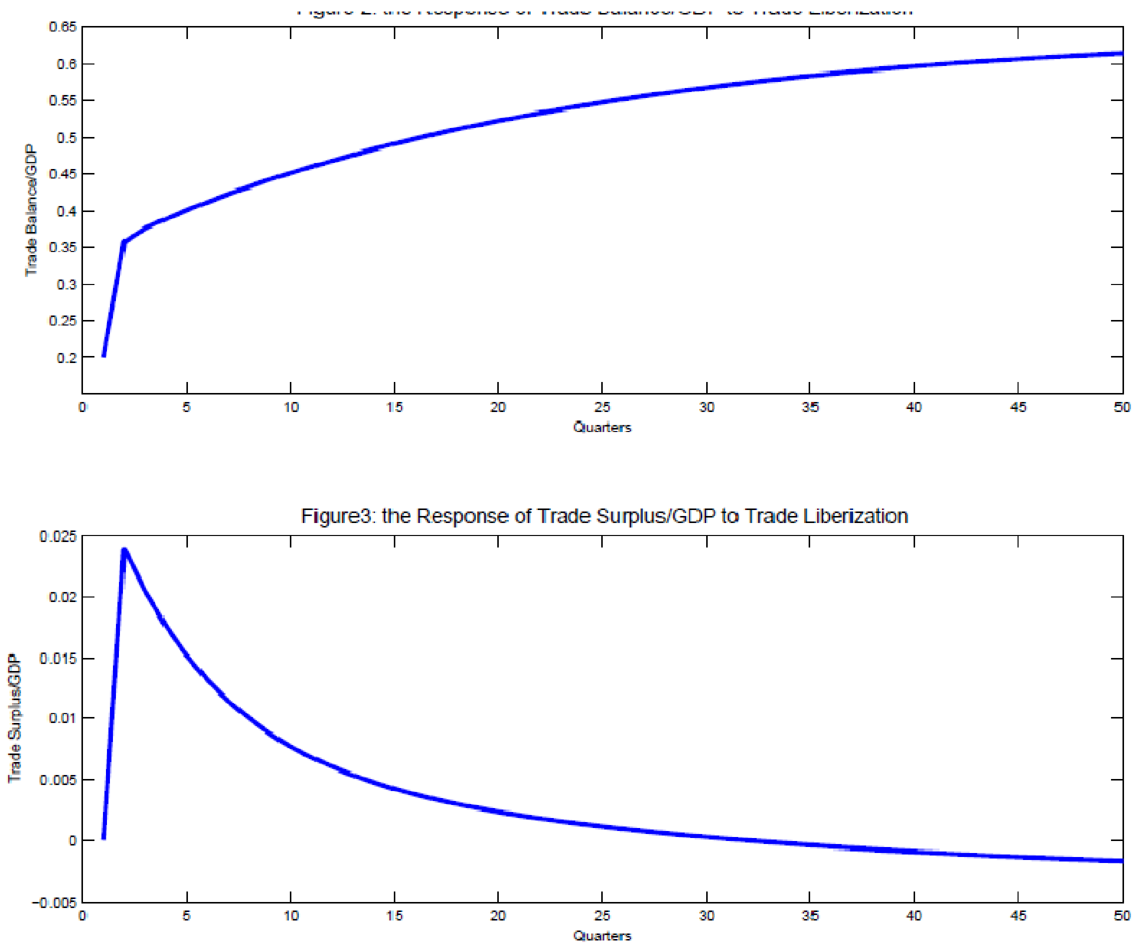


Table 2: Effects of Trade Liberalizations

	no constraint		constrained μ=0.35		constrained μ=0.4	
variable	τ=0.2	τ=0.15	τ=0.2	τ=0.15	τ=0.2	τ=0.15
rc	0.0351	0.03239	0.035101	0.034126	0.035101	0.034345
r1	0.0351	0.03239	0.035101	0.035947	0.035101	0.036097
r2	0.0351	0.03239	0.035101	0.033146	0.035101	0.033176
w1	28.4890	29.588	28.489	28.172	28.489	28.117
w2	28.4890	29.588	28.489	28.172	28.489	28.117
p1	3.3395	3.3395	3.3395	3.3395	3.3395	3.3395
p2	0.3593	0.34436	0.35933	0.34436	0.35933	0.34436
p	1.0954	1.0724	1.0954	1.0724	1.0954	1.0724
c	8.0532	7.8396	8.2147	8.1357	8.0856	8.0252
d	12.0280	11.128	12.589	12.552	12.141	12.083
b	0.0000	3.5854	0.0000	1.287	0.0000	0.99824
k	174.1800	140.86	191.69	189.4	177.69	174.03
l	4.3544	3.5215	4.7923	4.7349	4.4422	4.3509
k1	72.0730	96.812	67.092	66.289	71.075	69.614
k2	102.1000	44.046	124.6	123.11	106.61	104.42
l1	0.1887	0.22521	0.17566	0.17974	0.18609	0.18992
l2	0.0592	0.022691	0.072243	0.068161	0.061814	0.057982
x1	2.3673	2.9343	2.2037	2.2298	2.3345	2.3514
x2	14.6670	6.0925	17.899	17.426	15.315	14.794
d1	1.9728	1.7867	2.0648	2.0153	1.9912	1.94
d2	18.3340	17.327	19.19	19.544	18.506	18.814
nx1	1.3176	3.8325	0.46382	0.71635	1.1465	1.374
nx2	-1.3176	-3.8687	-0.46382	-0.72935	-1.1465	-1.3841
ca	0.0000	0	0	0	0	0
sx	0.1000	0.32213	0.033632	0.053272	0.086207	0.10612
sm	(0.1000)	-0.32518	-0.033632	-0.054239	-0.086207	-0.1069
debt/gdp ratio	0.00%	30.14%	0.00%	9.57%	0.00%	7.71%
trade volume	20.0%	64.7%	6.7%	10.5%	17.2%	21.0%

Table 3: Effects of Financial Development

variable	τ =0.2, constrained μ from 0.4 (initial) to 0.35		τ =0.2, constrained μ from 0.35 (initial) to 0.4	
rc	0.035101	0.0357	0.035101	0.03447
r1	0.035101	0.0363	0.035101	0.033921
r2	0.035101	0.0354	0.035101	0.034836
w1	28.489	28.0420	28.489	28.951
w2	28.489	28.0420	28.489	28.951
p1	3.3395	3.3395	3.3395	3.3395
p2	0.35933	0.3593	0.35933	0.35933
p	1.0954	1.0954	1.0954	1.0954
c	8.0856	8.1329	8.2147	8.1635
d	12.141	12.3290	12.589	12.4
b	0.0000	-0.7614	4.34E-19	0.815
k	177.69	183.8300	191.69	185.6
l	4.4422	4.5958	4.7923	4.6401
k1	71.075	64.3420	67.092	74.241
k2	106.61	119.4900	124.6	111.36
l1	0.18609	0.1770	0.17566	0.18484
l2	0.061814	0.0709	0.072243	0.063058
x1	2.3345	2.1856	2.2037	2.3566
x2	15.315	17.2940	17.899	15.877
d1	1.9912	2.0220	2.0648	2.0337
d2	18.506	18.7920	19.19	18.9
nx1	1.1465	0.5462	0.46382	1.0783
nx2	-1.1465	-0.5385	-0.46382	-1.0865
ca	0	0.0000	0	0
sx	0.086207	0.0404	0.033632	0.079432
sm	-0.086207	-0.0399	-0.033632	-0.080038