Urbanization and Economic Development: A Tale of Two Barriers

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Abstract

In this paper we determine the main driving forces underlying the structural transformation and urbanization process in rapidly industrializing countries. We use a dynamic, small open economy model with an abundant supply of surplus labor in rural areas, two types of traded goods manufactured in urban areas, and barriers to both trade and migration. The model is supplemented with quantitative analysis fitting the data from China, to explore the role that reductions in trade and migration barriers played in China's growth and urbanization. We find that the primary drivers for real per capita GDP growth are migration cost reduction and skill accumulation. While trade liberalization is important for urbanization during the transition toward China's admission to the WTO it does not contribute much to real per capita GDP growth. During this transition process, migration cost reduction and TFP changes are also important, accounting for a significant proportion of increased urbanization.

Keywords: Barriers to Migration and Trade, Urbanization, Economic Development, Surplus Labor.

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1 Introduction

In the post-WWII era, we have witnessed a number of rapidly industrializing countries that experienced sustained growth, fast structural transformation accompanied by greater openness and urbanization. What are the main driving forces underlying the rapid structural transformation and urbanization process? In the present paper, we address this question in a general dynamic framework with quantitative analysis targeted at the specific experience of China in the period 1980-2008. We choose China not only because it had spectacular economic growth over the past three decades and also experienced very significant rural-urban migration, but also because it had major trade and migration liberalization during this time period.

More specifically, we explore the roles of reductions in trade and migration barriers played in China's growth and urbanization. To do this, we construct a simple, dynamic framework exhibiting the following specific features:

(i) A small open economy with an abundant supply of surplus labor in rural areas at which a nontraded good is produced using unskilled labor with a Ricardian technology.

(ii) There are two types of traded goods manufactured in urban areas: an exportable and an importable. The production of the import-competing goods is more capital and skill intensive.

(iii) Unskilled labor is paid a market wage rate that makes potential migrants from rural areas indifferent between migrating and not migrating.

(iv) There are barriers to both trade and migration – in the case of China, import tariff had been high before its admission to the WTO, and its strict household registration (hukou) system limited rural-urban migration.

We establish that the migration equilibrium directly pins down the real unskilled wage, which leads to very different comparative-static predictions from the dynamic Hecksher-Ohlin model. Under this essentially fixed real unskilled wage, independent of changes in trade or migration barriers, both trade liberalization and relaxation of migration constraints promote capital accumulation. Moreover, by mitigating trade or migration barriers, such policies encourage the allocation of capital and unskilled labor toward production of the exportables. Furthermore, we establish sufficient conditions under which a reduction in either trade or migration barriers speeds up the urbanization process and promotes economic development.

By calibrating the model to fit observations from China we can conduct counterfactual analysis that determines the quantitative significance of the underlying drivers of the process of urbanization and development. We find that the primary drivers for real per capita GDP growth are migration cost reduction and skill accumulation. While trade liberalization is important for urbanization during the transition toward China's admission to the WTO it does not contribute much to real per capita GDP growth. During this transition process, migration cost reduction and TFP changes are also important, accounting for a significant proportion of increased urbanization.

Related Literature

Our paper is related to three strands of the literature: one on structural transformation, one on surplus labor and the other on migration and growth.

The literature on structural transformation goes back to classic papers by Rostow (1960) and Kuznets (1966). More recently this literature has placed more emphasis on the use of dynamic, general equilibrium models. For example, Laitner (2000) highlights savings as a key driver of modernization, whereas Hansen and Prescott (2001) and Ngai and Pissaridis (2007) emphasize the role that technology growth rates have played on the process of structural change. Gollin, Parente, and Rogerson (2002) focus on the idea that advancement in agricultural productivity is essential for providing the means to allow labor to be reallocated to the modern sector. Using a non-balanced growth model, Kongsamut, Rebelo, and Xie (2003) illustrate that subsistence consumption of agricultural goods can lead to a downward trend in agricultural employment. With agricultural subsistence as an integral part of their model, Casselli and Coleman (2001) study structural transformation and regional convergence in the United States, while Duarte and Restuccia (2010) investigate structural transformation based on cross-country differences in labor productivity. Buera and Koboski (2009) examine whether sector-biased technological progress or non-homothetic preferences as a result of agricultural subsistence fit the data. Buera and Koboski (2012) further elaborate that theme by arguing that scale technologies for mass production are important forces leading to industrialization. For a comprehensive survey, the reader is referred to Herrendorf, Rogerson, Valentinyi (2013).

There is a large literature on surplus labor economies beginning with important work by development economists such as Lewis (1954), Fei and Ranis (1961, 1964) and Sen (1966) (hereinafter referred to as LFRS). They studied its implication for labor-market performance and economic development. We extend this work using a dynamic, open-economy model to examine how the existence of a large supply of rural unskilled labor affects trade, urbanization, capital accumulation, as well as sectoral and aggregate output and social welfare. Our approach stresses the importance of international trade for capital accumulation and economic development in surplus labor economies. Since the seminal work by LFRS, the implications of rural surplus labor in a dual economy have been widely studies by development economists. The papers by Todaro (1969) and Harris and Todaro (1970, (hereinafter referred to as HT) are perhaps most influential applications of LFRS, where urban unemployment and labor policies are examined under an institutionally fixed minimum wage (above its equilibrium level) in the urban areas.

Among the many extensions of HT, we highlight the trade and migration strand which is most relevant to our study. In a seminal paper, Khan (1980) reexamines generalized HT models from the perspective of Heckscher-Ohlin and finds that a uniform subsidy to labor with a differential subsidy to capital is optimal (in the sense of second-best). In Batra and Naqvi (1987), gains from trade are evaluated in the presence of urban unemployment and the optimal policy established is a uniform subsidy to labor together with free trade (no tax levied on goods). In Beladi and Marjit (1996), the rural sector employs labor and an intermediate good, while both the intermediate good and the final good sectors in the urban area employ capital and labor. A reduction in tariffs on the urban final good is shown to lower capital rental and to raise urban employment as long as the urban final good sector is capital intensive. Recently, Chang, Kaltanic and Loayza (2009) argue that a reduction in tariffs improves production efficiency but increases labor market distortions in a simple HT setting.

There is also a closely related literature initiated by Drazen and Eckstein (1988) and Glomm (1992). Drazen and Eckstein (1988) propose a 2-period overlapping generations framework with land as a specific factor in the rural sector and capital as a specific factor in the urban sector, while Glomm (1992) designs an infinite lifetime model allowing for rural-urban migration where higher urban productivity is a result of lower communication costs associated with higher population density. While the decentralized equilibrium in Drazen and Eckstein is suboptimal, that in Glomm is Pareto optimal. Rural-urban migration has also been used to explain equilibrium low-growth traps under informational asymmetries. For example, Bencivenga and Smith (1997) illustrate such a possibility due to the adverse selection of workers into urban areas, while Banerjee and Newman (1998) achieve a similar goal by considering the modern urban sector to have imperfect credit markets and associated higher agency costs.

The most closely related paper to ours is by Lucas (2004), who addresses the issue of rural/urban migration as a transition from a no-growth agricultural sector using traditional technology to an urban sector where there is persistent growth due to human capital accumulation. Workers in the urban sector must choose their time allocation between human capital accumulation and work. His model explains the existence of a persistent wage differential between the urban and rural sectors as reflecting the return to human capital accumulation that workers must engage in when they migrate to the city. This contrasts with the Harris-Todaro model, where the differential reflects the possibility of spending time in unemployment due to a rigid urban wage.

We next turn to developing our dynamic, open economy model.

2 The Model

We examine a model of a small open economy in which there is a rural sector and an urban sector. In the rural sector, unskilled workers are engaged in subsistence agriculture whose output is consumed only in the rural area. In the urban sector, two tradeable goods are produced using unskilled labor, skilled labor, and capital. The exportable good, X, requires inputs of unskilled labor and capital and is not consumed domestically. The importable good, Y, can be either consumed or used for investment purposes, and is produced using inputs of unskilled labor, skilled labor, and capital. The economy's supply of skilled labor and unskilled labor is taken as exogenously given, although the allocation of unskilled labor between the rural and urban sectors is determined by household migration decisions. The supply of capital to the urban sector is assumed to be endogenously determined by the savings decisions of households that own skilled labor. In this section we derive the conditions determining the allocation of unskilled labor between the rural and urban areas, the allocation of income between consumption and investment, and the allocation of capital and unskilled labor between the X and Y sectors in the urban areas.

2.1 The Rural/Urban Migration Decision

The exogenously given stock of unskilled labor, denoted $\overline{N} > 0$, consists of a group of size N residing in the rural area and a group of size L located in the urban area. By staying in the rural area, an unskilled worker receives a subsistence utility of $\overline{U}$ per period, which represents the payoff received from subsistence farming. By migrating to the urban area, an unskilled worker earns the unskilled wage w and consumes the imported good Y. We will choose the world price of good Y as numeraire, so the domestic price of good Y will be $T_Y = (1 + \tau)$, where τ is the ad valorem tariff on imports of Y. The consumption of an unskilled worker located in the urban sector at time t will be

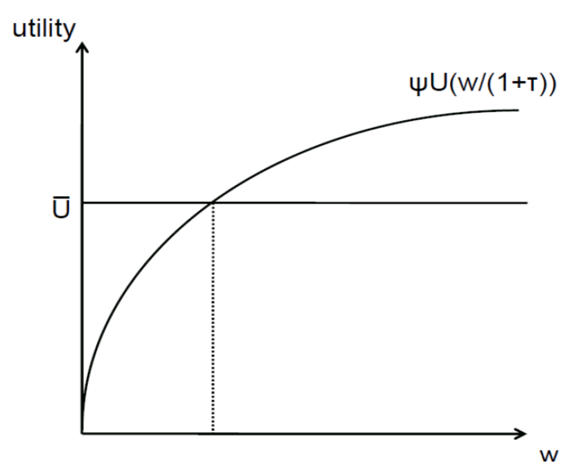
$$c^u_{Y,t} = \frac{w_t}{T_Y} \tag{1}$$

An unskilled worker in the rural area can receive utility of $\psi U(c^u_{Y,t})$ by relocating to the urban sector, where $\psi \in (0, 1]$ and U is strictly increasing and strictly concave, and satisfies the Inada conditions. Think of ψ as a migration discounting factor. For example, rural workers could discount the welfare from earning the urban wage because they are away from home and family. This discount could also reflect training costs or skill accumulation required in order to work in the urban area. In general, this is a wedge that also summarizes the *migration barrier*. In the quantitative analysis of this paper when we calibrate the model to data from China, such barriers include costs associated with the migration restrictions resulting from the household registration (hukou) regulations.

Using (1), the migration equilibrium implies:

$$\psi U(\frac{w_t}{T_Y}) = \overline{U} \tag{2}$$

which pins down the equilibrium real unskilled wage rate, $\frac{w_t}{T_Y}$.[1] This reservation real wage for unskilled labor is driven by ψ which captures crucial institutional factors affecting rural-urban migration. As long as $\psi < 1$, there will be a urban-rural wage gap with the unskilled wage in urban areas exceeding that in rural areas. We will allow for the possibility that ψ can be influenced by government policy, which will directly affect the amount of rural/urban migration. Figure 1 illustrates the determination of the unskilled wage rate in the migration equilibrium.



Later, when we conduct comparative-static exercises, we will take a constant-elasticity-of-intertemporal-substitution utility form $U = \frac{1}{\nu}(c_Y)^{\frac{1}{\nu}}$, with $\nu > 1$ and the elasticity of intertemporal

[1] Since the unskilled wage will turn out to be constant along the path to the steady state in our formulation, this condition is equivalent to what would be obtained if workers compared the discounted future returns in each location.

substitution being measured by $\frac{\nu}{\nu-1}$. Under this specification, the migration condition is given by

$$w = T_Y \left(\frac{\overline{U}}{\psi\nu} \right)^{\nu} \tag{3}$$

2.2 Capital Accumulation

It will be assumed that all capital is owned by households that own skilled labor. The stock of skilled labor is assumed to be exogenously given, which we will normalize to unity for simplicity, $\bar{H} = 1$. The wage rate earned by skilled workers is denoted s_t, so the budget constraint at time t for a household owning a unit of skilled labor can be written as

$$c^s_{Y,t} + I_t = \frac{s_t + r_t K_t}{T_Y} + T_t \tag{4}$$

where K is the stock of capital goods owned by the household, I is investment, r is the return on existing capital, and T is the net transfer from the government in terms of good Y. In addition, we assume that capital investment is subject to barriers. Thus, the (beginning-of-period) household capital stock is accumulated according to:

$$K_{t+1} = (1-\delta)K_t + \frac{I_t}{\mu(I_t)} \tag{5}$$

Here $\mu(I_t) > 1$ captures the severity of capital investment barriers, with $\epsilon = I\mu'(I)/\mu(I) \in (0,1)$ denoting the (constant) elasticity of the capital investment barrier with respect to the level of investment. The marginal cost of investment will be increasing for $\epsilon > 0$, and $\epsilon < 1$ is required for investment to be productive.[2] The capital barrier may be viewed as a variant of the conventional investment adjustment cost or the Parente-Prescott (1994) technology adoption barriers. Note that, while the capital barrier fits the observed high capital rental and high capital-output ratio in China, it is not the focus of the present paper.

The saving decision for a skilled worker household can be derived from the Bellman equation:

$$\begin{aligned} V(K_t) = \quad & \max_{c^s_{Y,t}, I_t} \left[U(c^s_{Y,t}) \right] + \tfrac{1}{1+\rho} V\left(K_{t+1}\right) \\ & \text{s.t.} \quad (4) \quad \text{and} \quad (5) \end{aligned} \tag{6}$$

where ρ is the rate of time preference. The solution to this optimization problem yields the Euler equation governing intertemporal consumption:

$$(1+\rho)\frac{U_{c^s_{Y,t}}}{U_{c^s_{Y,t+1}}} \left(\frac{\mu(I_t)}{\mu(I_{t+1})} \right) = \left[1 - \delta + \frac{r\,(1-\epsilon)}{\mu(I_{t+1})\,(T_Y)} \right] \tag{7}$$

[2] An alternative setup is to assume that capital investment barriers depend on the aggregate level of investment $\bar{I}$ where $\bar{I} = I$ in equilibrium. Mathematically, this is equivalent to setting the elasticity $\epsilon = 0$ in the optimization conditions (MRS) and (MG) below, under which all our main findings remain unchanged.

Equation (7) shows that the marginal rate of intertemporal substitution will be equated to the intertemporal relative price on the optimal path. The intertemporal relative price of future consumption is determined by the rental rate on capital, r, divided by the marginal cost of a unit of the investment good, $\mu(I_{t+1})T_Y/(1-\epsilon)$. Greater investment barriers and larger marginal costs of adjustment will reduce the return to postponing consumption, since they reduce the real return to a unit of capital.

In steady state, (7) yields the modified Golden Rule:

$$r = \frac{(\rho+\delta)\,\mu(I_t)T_Y}{1-\epsilon} \tag{8}$$

Note that the cost of the investment good on the right hand side of (8) is increasing in I, because the investment barriers/adjustment costs are increasing I. This yields a positive relationship between the steady state return on capital and the steady state investment level, with the elasticity of the steady state investment level with respect to the return on capital given by $1/\epsilon$.

2.3 Factor Allocation in the Urban Sector

We now turn to the determination of factor prices and outputs in the urban sector, which will determine the allocation of factors between the X and Y sectors. Production in each sector is assumed to take place under conditions of constant returns to scale in production and perfect competition.

The exportable is produced using capital and unskilled labor with a Cobb-Douglas technology, $X = BK_X^{\theta_{KX}}L_X^{\theta_{LX}}$ where $B > 0$, θ_{jX} is the cost share of factor $j \in \{K, L\}$ in production of good X, and $\theta_{KX} + \theta_{LX} = 1$. This production technology has the associated unit cost function

$$C^X(w, r_X) = \frac{1}{B}\left(\frac{r_X}{\theta_{KX}}\right)^{\theta_{KX}}\left(\frac{w}{\theta_{LX}}\right)^{\theta_{LX}} \tag{9}$$

where $r_X = r$ is the rental on capital paid by firms in the X sector. The producer price of good X is pT_X, where p is the world price of the exportable, $T_X \equiv 1+\eta$, and η is the ad valorem export subsidy rate applied to the world price. Assuming that the world price of the exportable and the government policy wedges are constant over time, the zero profit condition for the Y sector at time t will be

$$C^X(w_t, r_t) = pT_X \tag{10}$$

This condition must hold with equality if good X is produced at time t.

The import-competing good is produced with capital, unskilled labor and skilled labor under the following constant-returns technology: $Y = A\left[F(K_Y, H)\right]^{1-\theta_{LY}} L_Y^{\theta_{LY}}$ where $A > 0$, $\theta_{LY} \in (0, 1)$ is labor's share in unit costs and F is a well-behaved constant-returns-to-scale function satisfying $F_K > 0$, $F_H > 0$, $F_{KK} < 0$, $F_{HH} < 0$ and $F_{KH} > 0$. The last property ensures capital-skill complementarity in the Pareto sense (i.e., more skilled labor raises the marginal product of capital), which has strong empirical support (e.g., see Griliches 1969 and Krusell et al 2000). Thus, skilled labor is used as a specific factor only in the import-competing sector, which we assume for analytical simplicity.[3] The unit cost function for the Y sector is

$$C^Y(w, r_Y, s) = \frac{1}{A}\left(\frac{G(r_Y, s)}{1-\theta_{LY}}\right)^{1-\theta_{LY}}\left(\frac{w}{\theta_{LY}}\right)^{\theta_{LY}} \tag{11}$$

Note that the cost function for the Y sector can be written as $C^Y(w, r_Y, s) = \phi(w, G(r_Y, s))$, where $G(\cdot)$ is the unit cost function corresponding to the "sub-production function" $F(\cdot)$and $\phi(\cdot)$ is the unit cost function for the Cobb Douglas function with inputs of unskilled labor and the composite input F. The functions ϕ and G will be increasing and homogeneous of degree one in their respective input prices, and with negative own and positive cross price effects. We assume capital moves freely in the urban sector so, $r_Y = r$. Assuming Y sector tariff policies are constant over time, the zero profit condition will be

$$C^Y(w_t, r_t, s_t) = T_Y \tag{12}$$

where $T_Y \equiv 1+\tau$, and τ is the import tariff rate. The tariff is the *trade barrier*, which is the second barrier of our primary interest[4].

Equilibrium in the urban factor markets and goods markets will require that firms earn zero profits in each sector, and that the demand for each of the productive factors equal their supply in the urban sector. Using the unit cost functions (9) and (11), the full employment conditions for skilled labor, capital, and unskilled labor can be expressed as:

$$C_s^Y(w_t, r_t, s_t)Y_t = H = 1 \tag{13}$$

$$C_r^X(w_t, r_t)X_t + C_r^Y(w_t, r_t, s_t)Y_t = K_t \tag{14}$$

$$C_w^X(w_t, r_t)X_t + C_w^Y(w_t, r_t, s_t)Y = L = \overline{N} - N_t \tag{15}$$

[3] We could allow skilled labor to be used in the exportable sector as long as it is used less intensively relative to unskilled labor than in the import sector. In this case, the results remain qualitatively unchanged.

[4] Note that the export subsidy is not a policy choice by the government. We assume that it is set to achieve a balanced budget.

For a given level of factor supplies $\{H, K_t, \bar{N}\}$, the competitive profit conditions ((9) and (11)), the migration condition (3), and the full employment conditions ((13)-(15)) will determine the factor prices $\{w_t, r_t, s_t\}$, output levels, $\{X, Y\}$ and the allocation of unskilled workers to the urban sector, L.

We are now able to define real aggregate output, R as

$$R = \frac{pT_X}{T_Y} X + Y \tag{16}$$

2.4 Budget Balance and Goods Market Equilibrium

The demand for Y sector output for domestic consumption will be $c_{Y,t} = L_t c^u_{Y,t} + c^s_{Y,t}$. Using the household budget constraints (1) and (4) and letting M_t denote the level of imports, we can express the goods market equilibrium condition as

$$M_t = \frac{s_t + r_t K_t}{T_Y} + T_t + \frac{w_t L_t}{T_Y} - Y_t \tag{17}$$

Given the pair of import tariff and export subsidy (τ, η) and hence (T_Y, T_X), the passive government in our model economy simply set transfers T_t to balance the budget:

$$T_t = (T_Y - 1)M_t - \frac{p_t(T_X - 1)}{T_Y} X_t \tag{18}$$

These two equations (17) and (18) can be used to solve for imports M_t and government transfers T_t. Because our focus is on tariff based trade liberalization, in the quantitative analysis we will choose the level of export subsidy such that the government transfer in the steady state is zero. This would eliminate the undesirable artificial redistribution between the skilled and the unskilled.

3 Equilibrium Characterization

We now turn to an analysis of the steady state equilibrium for the surplus labor economy. The analysis of the competitive equilibrium is greatly simplified by the fact that the model has a block recursive structure:

(i) the three factor prices can be first solved, independently of the factor supplies or the goods output;

(ii) capital, investment and the outputs of the traded goods are subsequently pinned down;

(iii) the allocation of unskilled labor in the urban sector is then be determined;

(iv) finally, other quantities such as consumption, imports, exports, and government transfers are solved.

More specifically, the competitive profit conditions, (10) and (12), require that price equal unit cost in a sector at each point in time. Combining these equations with the rural/urban migration condition, (3), yields a recursive system of three equations in the three factor prices (w, r, s). That is, the unskilled wage w is pinned down by the world price of importable and the migration-related institutional factors given in (3). Given the equilibrium value of w, (10) determines the rental r and then (12) determines the skilled wage s.

The effect of changes in the two main policy parameters (T_Y, ψ) on factor prices can be determined by total differentiation of the system of equations (10), (12), and (3). It is convenient to express these comparative statics results using the percentage changes, where $\hat{Z} \equiv \frac{\dot{Z}}{Z}$:

$$\hat{w} = \hat{T}_Y - \nu\hat{\psi} \tag{19}$$

$$\hat{r} = -\frac{\theta_{LX}}{\theta_{KX}}\left(\hat{T}_Y - \nu\hat{\psi}\right) \tag{20}$$

$$\hat{s} = \frac{(1\text{-}\theta_{LY})\,\theta_{KX}+\theta_{LX}\theta_{KY}}{\theta_{KX}\theta_{HY}}\hat{T}_Y - \frac{\theta_{LX}\theta_{KY}\text{-}\theta_{LY}\theta_{KX}}{\theta_{KX}\theta_{HY}}\nu\hat{\psi} \tag{21}$$

The existence of surplus labor locks the real wage of unskilled labor into the utility level available in the rural sector, so it will only be affected by policies that affect the cost of migration to the urban areas. With a fixed real wage (in terms of good Y), the return to capital is increasing in policies that favor the exportable sector and the return to skilled labor is decreasing in policies that favor the exportable sector.

When there are changes (either policy driven or exogenous) in favor of rural-urban migration it mitigates the associated barriers and $\hat{\psi} > 0$. It follows then that the unskilled wage is lower and the capital rental higher. Its' effect on the skilled wage is negative if the import-competing sector is more capital intensive in the cost sense relative to the exporting sector (i.e., $\theta_{LX}\theta_{KY} > \theta_{LY}\theta_{KX}$). Combining (19) and (21), we obtain:

$$\hat{s} - \hat{w} = \frac{1}{\theta_{KX}\theta_{HY}}\left[\theta_{KY}\hat{T}_Y - (\theta_{KY} - \theta_{KX})\,\nu\hat{\psi}\right]$$

An increase in the relative protection offered to the Y sector relative to the X sector raises the skill premium. Moreover, if the capital cost share in the Y sector exceeds one in the X sector

($\theta_{KY} > \theta_{KX}$), then a change in the institutional factor in favor of rural-urban migration reduces the skill premium.[5]

The following proposition summarizes these results on factor prices:

Theorem 1 *(Factor Prices) The wage of skilled labor increases proportionately with the import tariff with the real unskilled wage being unaffected, whereas the rental on capital is decreasing in the tariff. While a reduction in migration barriers lowers the unskilled wage and raises the return to capital, it suppresses the skilled wage rate if the importable sector is capital intensive in the cost sense.*

Due to the abundant availability of surplus labor, the migration equilibrium under our model framework leads to insensitivity of the real unskilled wage in urban areas to trade liberalization. This may serve to explain, at least partly, why there is little growth in the real effective wage rate of the unskilled workers in urban areas despite the presence of a persistent and significant urban-rural wage gap.

The steady state investment level is positively related to the return to capital from (8), so we can invert that relationship and use the fact that the steady state capital stock will equal $K = I/(\delta\mu(I))$ from (5) to solve for the steady state capital stock,

$$K = \kappa\left(\frac{r}{T_Y}\right) \tag{22}$$

where κ is an increasing function of the real return on capital. Totally differentiating this condition and substituting from (20):

$$\hat{K} = \gamma\left(-\frac{1}{\theta_{KX}}\hat{T}_Y + \frac{\theta_{LX}}{\theta_{KX}}\nu\hat{\psi}\right) \tag{23}$$

where $\gamma \equiv \frac{1-\epsilon}{\epsilon} > 0$. The steady state supply of capital is more elastic the lower is ϵ, where ϵ is the rate at which the cost of investment increases with the level of investment. From this expression, one can clearly see that the effects of trade-related policies are all magnified when capital supply is more elastic.

Applying the results of Theorem 1 to (23) yields the effects of parameter changes on the steady state capital stock.

[5] Notice that, even when Y is more capital intensive in the cost sense, the captial cost share in the Y sector need not exceed one in the X sector.

Theorem 2 *(Capital Accumulation) A reduction in the import tariff or migration barriers increases the steady state capital stock.*

That is, both trade liberalization in forms of tariff reduction and relaxation of migration constraints promote capital accumulation.

Given the solution for factor prices, the equilibrium levels of $\{X_t, Y_t, L_t\}$ can be solved from the full employment conditions for the three urban sector factor markets, (13)-(15). Since skilled labor is used only in the production of good Y, the factor prices are determined independently of factor supplies, the full employment conditions can be solved recursively for the output levels and the employment of unskilled labor in the urban sector.

With skilled labor being used only in the import-competing sector, the equilibrium output of good Y is determined by (13),

$$Y = \frac{H}{C_s^Y(w, r, s)} \tag{24}$$

With constant factor prices, output of Y will be constant along the path to the steady state. Substituting this solution into (14), we obtain the solution for X as a function of K_t. In the steady state, K_t will be given by (22), so X is given by,

$$X = \kappa\left(\frac{r}{T_Y}\right) - \frac{C_r^Y(w, r, s)H}{C_r^X(w, r)C_s^Y(w, r, s)} \tag{25}$$

In order to derive the effect of policy changes on the steady state output levels, we will find it useful to derive some preliminary results on the effect of policy changes on the unit factor requirement in each of the traded good sectors. Under the assumption of Cobb-Douglas production function for the X sector, the own price elasticities of the factor demands are given by $rC_{rr}^X/C_r^X = -\theta_{LX}$ and $wC_{ww}^X/C_w^X = -\theta_{KX}$. Utilizing (19) and (20), we have:

$$\begin{aligned} \hat{C}_w^X &= -\hat{T}_Y + \nu\hat{\psi} \\ \hat{C}_r^X &= \tfrac{\theta_{LX}}{\theta_{KX}}\left(\hat{T}_Y - \nu\hat{\psi}\right) \end{aligned} \tag{26}$$

A lower relative price of the import-competing good will result in substitution of unskilled labor for capital in the X sector, because the cost of capital is positively related to the relative price of good X. Similarly, a reduction in the migration barrier will reduce w/r, resulting in substitution of unskilled labor for capital.

The unit cost function for the Y sector takes the form $C^Y = \phi(w, G(r, s))$, where ϕ is Cobb-Douglas and G is constant returns to scale. Due to the Cobb Douglas formulation for ϕ, the unit labor requirement will $C_w^Y = \theta_{LY} T_Y / w$. Since the real wage is locked in place by the migration condition, (3), the unit labor requirement in Y will respond only to changes in the migration costs, ψ. For the input requirements of of capital and skilled labor, we can define the elasticity of demand associated with the sub-production function F as $\eta_{sr} \equiv rG_{sr}/G_s > 0$ and $\eta_{rs} \equiv sG_{rs}/G_r > 0$. The constant returns to scale assumption for G then implies $\eta_{ss} = -\eta_{sr}$ and $\eta_{rr} = -\eta_{rs}$.[6] Using these properties, we further obtain the change in unit labor requirements in the Y sector to be:

$$\begin{aligned}
\hat{C}_w^Y &= \nu\hat{\psi} \\
\hat{C}_r^Y &= \eta_{rs}\frac{\theta_{KY}+\theta_{HY}}{\theta_{HY}}\left(\frac{1}{\theta_{KX}}\hat{T}_Y - \frac{1}{\theta_{KX}}\frac{\theta_{LX}-\theta_{LY}}{\theta_{KY}+\theta_{HY}}\nu\hat{\psi}\right) \\
\hat{C}_s^Y &= \eta_{sr}\frac{\theta_{KY}+\theta_{HY}}{\theta_{HY}}\left(-\frac{1}{\theta_{KX}}\hat{T}_Y + \frac{1}{\theta_{KX}}\frac{\theta_{LX}-\theta_{LY}}{\theta_{KY}+\theta_{HY}}\nu\hat{\psi}\right)
\end{aligned} \tag{27}$$

Comparing (26) and 27), it can be seen that an increase in the relative price of X will result in substitution away from capital in both sectors, and substitution toward the use of skilled (unskilled) labor in the Y (X) sector. A reduction in migration costs will reduce the price of unskilled labor, which increases the demand for skilled labor and reduces the demand for capital in the X sector iff X has a larger unskilled labor cost share than does Y.

We are now ready to analyze the effects of the parameters on sectoral outputs and unskilled labor in urban areas. Since $\hat{Y} = \hat{H} - \hat{C}_s^Y$ from (13), we can totally differentiate (24) and substitute from (27) to obtain:

$$\hat{Y} = \hat{H} + \eta_{sr}\left(\frac{\theta_{KY}+\theta_{HY}}{\theta_{HY}}\right)\left(\frac{1}{\theta_{KX}}\hat{T}_Y - \frac{1}{\theta_{KX}}\frac{\theta_{LX}-\theta_{LY}}{\theta_{KY}+\theta_{HY}}\nu\hat{\psi}\right) \tag{28}$$

The output in the Y sector is increasing in the import protection, T_Y. The impact of a reduction in migration costs and capital market subsidies on output of Y reflects the impact of these changes on the demand for skilled labor per unit of output noted above.

Totally differentiating the steady state capital market equilibrium condition (25) and substituting from (26), (27), and (19)-(21) yields,

$$\hat{X} = -\frac{\Delta + \gamma + \lambda_{KX}\theta_{LX}}{\lambda_{KX}\theta_{KX}}\hat{T}_Y + \frac{\left(\frac{\theta_{LX}-\theta_{LY}}{\theta_{KY}+\theta_{HY}}\right)\Delta + (\gamma + \lambda_{KX})\,\theta_{LX}}{\lambda_{KX}\theta_{KX}}\nu\hat{\psi} \tag{29}$$

where where $\lambda_{KX} \equiv XC_r^X/K$ denotes the fraction of all capital employed in the X sector and $\Delta \equiv (1-\lambda_{KX})(\eta_{rs}+\eta_{sr})\left(\frac{\theta_{KY}+\theta_{HY}}{\theta_{HY}}\right) > 0$ captures the degree of substitutability between skilled labor and capital in the Y sector. Thus, the output of good X is decreasing in T_Y. A reduction in

[6] If the function G is Cobb-Douglas, $\eta_{sr} = \theta_{KY}/(\theta_{KY}+\theta_{HY}) = 1 - \eta_{rs}$.

migration barriers will increase the output of exportables because it lowers the real cost of unskilled labor. Note also that the short run effects of policy changes (i.e. with a fixed K_t) can be obtained by setting $\gamma = 0$. A uniform subsidy to capital in both sectors will have no effect on the output of X in the short run, but will raise output in the long run due to its positive effect on the steady state capital stock.

Results on outputs from (28) and (29) can be summarized as:

Theorem 3 *(Sectoral Outputs) A reduction in the import tariff or the migration barrier raises the output of the exportables but lowers the output of the import-competing good.*

The following proposition regarding the effect of the changes in the two barriers on the allocation of factors between sectors follows immediately.

Theorem 4 *(Factor Allocations) A reduction in the tariff encourages the allocation of capital and unskilled labor toward the production of the exportable good and lowers the capital-labor ratio in both sectors. A reduction in migration barriers lowers the exportable sector's capital-labor ratio unambiguously and lowers the importable sector's capital-labor ratio if the importable sector is capital intensive in the cost sense.*

A tariff reduction lowers the return to producing the importable and hence encourages both factors to be reallocated toward the exportable sector. While the real unskilled wage remains unchanged, the real the real rental rate rises, thus leading to lower capital-labor ratios in both sectors. The intuition underlying the migration barrier reduction follows similarly, however, it is a bit more complicated due to capital intensity considerations.

We are now prepared to examine the extent of rural-urban migration governed by the mass of unskilled workers in the urban area L. This can be done by totally differentiating the unskilled labor market clearing condition (15) and applying (26) and (27):

$$
\begin{aligned}
\hat{L} &= \lambda_{LX}\left(\hat{X} + \hat{C}_w^X\right) + (1-\lambda_{LX})\left(\hat{Y} + \hat{C}_w^Y\right) \\
&= -\frac{\Gamma + \lambda_{LX}(\gamma + \lambda_{KX})}{\lambda_{KX}\theta_{KX}}\hat{T}_Y \\
&\quad + \frac{(1-\lambda_{KX})(\theta_{LX} - \theta_{LY})(\frac{\Gamma}{\theta_{KY}+\theta_{HY}} + \frac{\lambda_{LX}\lambda_{KX}\eta_{rs}}{\theta_{HY}}) + \lambda_{LX}(\gamma\theta_{LX} + \lambda_{KX})}{\lambda_{KX}\theta_{KX}}\nu\hat{\psi}
\end{aligned} \tag{30}
$$

where $\lambda_{LX} = XC_w^X/L$ is the share of urban unskilled labor employed in the X sector and $\Gamma \equiv [(\lambda_{LX} - \lambda_{KX})\eta_{sr} + \lambda_{LX}(1 - \lambda_{KX})\eta_{rs}]\left(\frac{\theta_{KY}+\theta_{HY}}{\theta_{HY}}\right)$. To see the effect via Γ, we note that if the X sector is unskilled labor intensive relative to Y in the quantity sense (i.e., $\lambda_{LX} > \lambda_{KX}$), then one obtains $\Gamma > 0$. From (30), this factor intensity condition is also sufficient for a reduction in the tariff to raise urban employment of unskilled workers. However, $\Gamma > 0$ is not necessary for this result because a tariff reduction also has a positive impact on steady state capital (as long as $\gamma > 0$), and a higher steady state capital stock will raise the demand for unskilled labor by increasing its marginal product. Moreover, should the import-competing sector be capital intensive in the quantity sense but sufficiently labor intensive in the cost sense such that $\theta_{LX} < \theta_{LY}$, then the factor intensity condition $\lambda_{LX} > \lambda_{KX}$ is also sufficient for a reduction in rural-urban migration barriers to increase urban employment of unskilled workers. Thus, these conditions on factor intensity rankings ensure "mobility normality" in the sense that a lower barrier encourages migration. Summarizing these results, we have:

Theorem 5 *(Urbanization) When the import-competing sector is more capital intensive in the quantity sense, a reduction in the tariff speeds up the urbanization process. When the import-competing sector is more capital intensive in both quantity and cost sense, a reduction in the migration barrier promotes urbanization.*

We conclude our equilibrium characterization by examining the effect of changes in the two barriers on the steady-state aggregate manufacturing output (in units of the import-competing goods). Defining the output share of the X sector as χ (and hence that of the Y sector as $1 - \chi$), we can totally differentiate (16) to yield,

$$\begin{aligned} \widehat{R} &= \chi\left(\hat{X} - \hat{T}_Y\right) + (1-\chi)\,\hat{Y} \\ &= -\frac{1}{\theta_{KX}}\left[\Upsilon + \chi(1+\frac{\gamma}{\lambda_{KX}})\right]\hat{T}_Y + \left[\frac{(\theta_{LX} - \theta_{LY})\Upsilon}{\theta_{KX}(\theta_{KY} + \theta_{HY})} + \chi(1+\frac{\gamma}{\lambda_{KX}})\frac{\theta_{LX}}{\theta_{KX}}\right]\nu\hat{\psi} \end{aligned} \tag{31}$$

where $\Upsilon \equiv \chi\frac{\Delta}{\lambda_{KX}} + (1-\chi)\,\eta_{sr}\frac{\theta_{KY}+\theta_{HY}}{\theta_{HY}} > 0$ if the import-competing sector is capital intensive in the quantity sense to which we restrict our attention. Then, a lower tariff for Y leads to greater aggregate manufacturing output because the benefit from import reduction outweighs the loss from export expansion. Moreover, the long-run effect of mitigating migration barriers raises aggregate manufacturing output if the import-competing sector is also capital intensive in the cost sense, which together with the intensity assumption in the quantity sense assures mobility normality. Summarizing the above findings yields:

Theorem 6 *(Aggregate Manufacturing Output) When skilled workers receive zero net real transfer from the government, when the import-competing sector is more capital intensive in the quantity sense, a reduction in the import tariff raises aggregate manufacturing output. When the import-competing sector is more capital intensive in both the quantity and cost sense, a reduction in migration barriers also raises aggregate manufacturing output.*

Whether these factor intensity conditions hold true and how large the urbanization and output effects of a reduction in trade and migration barriers are both quantitative issues, to which we now turn.

4 Quantitative Analysis

To investigate how reduction in trade and migration barriers speeds up the urbanization process and promotes economic development quantitatively, we calibrate the model to fit observations from China over the period of 1980 to 2008. China is selected not only because it had large trade and migration barriers, but also because it experienced one of the most prominent reductions in each barrier over the past twenty years. Both economic reforms are related to the Southern Trip of Deng Xiao-Ping in 1992 when he made his market orientation and international openness announcement. Two key policy changes were to allow foreign direct investment and to apply to join the WTO. Related to potential WTO accession, China's average effective import tariff rate went from 33.5% in 1995 to 14.8% by 2001. Tariffs were further reduced to 5.84% following acceptance into the WTO in 2002. Also in conjunction with the market and trade reforms, the hokou system was relaxed in 1995 to enable more rural-urban migration so as to accommodate the expected needs for a much larger labor force in urban areas. Based on survey data from several provinces, Liao, Wang, Wang and Yip (2014) document that relaxation of hokou restriction reduced migration cost by about 15%. These trade and migration reforms will be key elements in the quantitative exercises.

To incorporate the aforementioned reduction in trade and migration barriers, we divide the entire sample period into three regimes:

(i) Regime 1 (1980-1994): this subperiod featured high import tariff and restricted migration regulation by Hokou;

(ii) Regime 2 (1995-2001): this subperiod experienced transitional reduction in tariff and relaxed migration regulations;

(iii) Regime 3 (2002-2008): this subperiod had low import tariffs due to WTO accession and continuation of relaxing migration restrictions.

In each regime, we will also adjust a few major variables to better fit the data. For example, after 1999, there was a major expansion of college admissions with those students joining the labor force in summer 2002. This is translates into an increase in the supply of the skilled labor in our model. In addition, for the sake of simplicity, we have not modeled the urban service sector, but its expansion is even faster than the manufacturing sector during the post-1992 period. In our calibration analysis, we extend the model by allowing for an urban service sector to grow proportionately to the urban manufacturing sector (the aggregate of exportable and import-competing sectors) and to have the same skill proportion as in the manufacturing sector. Both the service employment share and the skill proportion are allowed to vary across the three regimes. Furthermore, the total labor force population is adjusted by the data in each regime and the relative productivity between the two urban manufacturing sectors is calibrated to fit key moments in the calibration. We will summarize all such cross-regime differences at the end of the next subsection.

4.1 Calibration

In the calibration analysis, the utility function is assumed to be log linear, $\ln(c)$, the production function of the importable to be Cobb-Douglas, and the capital barrier function $\mu(I)$ to take an iso-elastic form, $\mu(I) = \mu_0 I^{\epsilon}$.

Following the standard in the dynamic macro and growth theory literature, we choose the subjective time discount rate as $\rho = 0.03$ and the capital depreciation rate as $\delta = 0.05$. We normalize the average skilled labor in the urban manufacturing sector over the entire period to be $H = 1$ and the reservation value to be $\overline{U} = 1$. The urban-rural unskilled wage ratio is set at $\varpi = 2$, as documented in the rural-urban migration literature (see the documentation by Laing, Park and Wang 2005 and the papers cited therein).

We begin by matching the average moments over the entire sample period of 1980-2008. When we are constrained by data availability, the shorter period of 1992-2008 is used. Based on the average effective tariff rate over 1992-2008, we have $\tau = 15.0\%$. A major task of the calibration exercise is to construct an exportable sector and an import-competing sector. Using 2 digit sectoral data covering 29 manufacturing industries over 1992-2008 (a later starting year due to data limitation), we apply each sector's export and import content and output to compute the aggregate outputs of exportables and importables (X and Y, respectively). We then use sectoral employment data, capital data and skilled proportion data to back out sectoral allocation of unskilled labor and capital under the assumption that all skilled workers are in the import-competing sector. Based on sectoral wages and skilled proportions, we can also compute the average skilled and unskilled wage rates. We assume, as in the existing literature on China, the capital rental is 20%. Using the above we compute the following ratios: (i) capital income share in the exporting sector $= \beta = 0.528$; (ii) capital income share in the import-competing sector $= \alpha_K = 0.600$; (iii) skilled wage income share in the import-competing sector $= \alpha_H = 0.072$; (iv) skill premium $= s/w = 1.55$; (v) the unskilled labor share and the capital share in the exporting sector are $\frac{L_X}{L} = 57.8\%$ and $\frac{K_X}{K} = 45.6\%$, respectively; and, (vi) sectoral productivity growth rates measured by the rates of change of Solow residuals rates $g_A = 1.14\%$ and $g_B = 2.56\%$, respectively (indicating, not surprisingly, faster productivity growth of the exportable sector compared to the import-competing sector). Under these technology parameters, it is easily verified that the *import-competing sector is capital intensive in both quantity and cost sense.*

We then calibrate the remaining parameters as well as unobserved variables based on the model. To fit the unskilled labor and capital shares in the exporting sector with a 10% capital barrier, we obtain: $\mu_0 = 0.1761$ and $\epsilon = 0.4940$, which imply $I = 40.809$ and $\mu = 1.1$ (noting that $\mu = 1$ implies no capital barrier). Using $\overline{U} = 1$, the observed skill premium and the migration equilibrium condition, we can solve the unskilled and the skilled wage $w = 6.2520$ and $s = 9.6907$, as well as the migration discounting factor $\psi = 0.5906$. Further applying the two competitive profit conditions and the trade balance condition and setting the net transfer to be zero, we can calibrate $A = 1.6835$, $B = 1.7470$, $p = 0.9866$ and $\eta = 0.1765$, so the sectoral TFP ratio is $A/B = 0.96364$. Finally, under the normalization of $H = 1$ and given the observed service sector employment share in the urban area $\zeta = 22.9\%$, we can compute the employment of the unskilled in urban manufacturing $L = 16.732$ and back out the employment in the urban service sector $N_S = 5.2668$. Thus, the urbanization rate (measured by employment) is given by:

$$\upsilon = \frac{L + H + N_S}{\overline{N} + H + N_S} \tag{32}$$

By matching the average urbanization rate of $\upsilon = 29.4\%$ over the period of 1980-2008, we can then compute the total unskilled population as $\overline{N} = 71.962$ and the total working population as $POP = \overline{N} + H + N_S = 78.229$. With identical skilled proportion in urban manufacturing and service sectors, the skilled proportion is given by, $\sigma = \frac{H}{H+L} = 5.64\%$. We can then compute the population of the unskilled and the skilled in the urban areas, denoted $\overline{L}$ and $\overline{H}$ respectively, as:

$$\begin{aligned}\overline{L} &= \frac{(1-\zeta\sigma)L+\zeta(1-\sigma)H}{1-\zeta}=21.702\\ \overline{H} &= \frac{\zeta\sigma L+[1-\zeta(1-\sigma)]H}{1-\zeta}=1.2970\end{aligned}$$

That is, about 5.6% of urban workers are skilled and about 28.1% of the unskilled (and, by construction, 100% of the skilled) are working in urban areas.

To evaluate our calibration exercise we need to compute real GDP per capita. To do so, we first construct a price index:[7]

$$P=(pT_X)^{\xi}\,(T_Y)^{1-\xi}$$

where ξ is the weight of the exportable sector. In our calibrated steady-state equilibrium, the manufacturing output share of the exportable sector is $\frac{X}{R}=48.3\%$. It is thus reasonable to set $\xi=0.5$ over time (which would be kept constant throughout all counterfactual exercises). Now, real manufacturing output using this price index is given by.

$$\frac{pT_XX+T_YY}{P}=\left(\frac{pT_X}{T_Y}\right)^{1-\xi}X+\left(\frac{pT_X}{T_Y}\right)^{-\xi}Y$$

By including the service sector, real urban output becomes:

$$\frac{1}{1-\zeta}\left[\left(\frac{pT_X}{T_Y}\right)^{1-\xi}X+\left(\frac{pT_X}{T_Y}\right)^{-\xi}Y\right]$$

To calculate real GDP, we need to incorporate rural output,

$$\left(\frac{pT_X}{T_Y}\right)^{1-\xi}\frac{w}{\varpi}N$$

where $\frac{w}{\varpi}$ is the rural wage. This can be added to real urban output to yield real GDP:

$$RGDP=\frac{1}{1-\zeta}\left[\left(\frac{pT_X}{T_Y}\right)^{1-\xi}X+\left(\frac{pT_X}{T_Y}\right)^{-\xi}Y\right]+\left(\frac{pT_X}{T_Y}\right)^{1-\xi}\frac{w}{\varpi}N \tag{33}$$

In the benchmark economy, real GDP per capita (more precisely, per worker) is: $\frac{RGDP}{POP}=5.7065$.[8] We can then compute the urban output share as:

$$\varphi=\frac{\frac{1}{1-\zeta}\left[\left(\frac{pT_X}{T_Y}\right)^{1-\xi}X+\left(\frac{pT_X}{T_Y}\right)^{-\xi}Y\right]}{RGDP}=66.4\% \tag{34}$$

[7] While the steady-state measure of R in units of the importables is valid, prices are changing over time and hence we must construct a price index to recompute real output without using numeraire.

[8] Notice that this real GDP per capita figure is computed with the average skill labor in the urban manufacturing sector normalized to one and the price index of 1980 set to 100.

Finally, it is noted that about 48.8% of import-competing goods are imported and the trade dependence ratio measured by total imports and exports as a ratio of GDP is about 49.9%. These untargeted moments are overall in line with the data – the respective figures are 41.9% and 45.6%.

With the above benchmark economy calibrated, we now turn to the 3 regimes, where, in each regimes, the total working population POP, skill proportions σ, and service employment shares ζ are recalculated based on average data whereas sectoral TFP ratios A/B are recalibrated.

(i) Regime 1 (1980-1994): high tariff $\tau = \tau^H = 0.335$, restricted migration regulation by Hokou with $\psi = \psi^L = 0.546427$, low college admission with $H = H^L = 0.463378$, low working population $POP = POP^L = 71.34489$, low service employment share $\zeta = \zeta^L = 0.178$, and high sectoral TFP ratio $A/B = A^H/B^H = 1.06854$;

(ii) Regime 2 (1995-2001): intermediate tariff $\tau = \tau^M = 0.148$, relaxed migration regulation by Hokou with $\psi = \psi^H = 0.640823$, low college admission with $H = H^L = 0.463378$, intermediate working population $POP = POP^M = 83.705079$, intermediate service employment share $\zeta = \zeta^M = 0.270$, and intermediate sectoral TFP ratio $A/B = A^M/B^M = 0.920668$;

(iii) Regime 3 (2002-2008): low tariff $\tau = \tau^L = 0.0584$, relaxed migration regulation by Hokou with $\psi = \psi^H = 0.640823$, high college admission with $H = H^H = 3.285563$, high working population $POP = POP^H = 89.181112$, high service employment share $\zeta = \zeta^M = 0.310$, and low sectoral TFP ratio $A/B = A^L/B^L = 0.840637$.

The migration wedge ψ is computed based on the consumption-equivalent measure for the Hokou reformed regimes (Regimes 2 and 3) to feature a 15% lower migration cost compared to the much restricted Regime 1. Also, other things being equal, the reduction in the sectoral TFP ratios over time (to match the observed sectoral TFP growth rates) would slow down the urbanization and development process. In reality, this potential detrimental effect is outweighed by reductions in trade and migration barriers as well as increases in the skill and the service proportions.

4.2 Basic Results

The benchmark values of key variables including most importantly the urban output share and the urbanization rate (measured by employment) are reported in first row of the Table below. In rows 2 to 4, we report the comparable figures under the 3 regimes.

	Sectoral Shares			Real GDP	Urban Share	
	labor	capital	output	per capita	output	employment
	$\frac{L_X}{L}$	$\frac{K_X}{K}$	$\frac{X}{R}$	$\frac{RGDP}{POP}$	φ	υ
Benchmark 1980-2008	57.8%	45.6%	48.3%	5.706	66.4%	29.4%
Regime 1: 1980-1994	60.6%	47.9%	44.8%	4.048	60.2%	26.0%
Regime 2: 1995-2001	58.2%	46.0%	55.5%	5.975	68.9%	30.3%
Regime 3: 2002-2008	56.4%	44.2%	54.2%	9.634	75.4%	36.2%

These results have three main implications. First, and most noticeably, both the urban output share and the urbanization rate rose sharply over time. Second, real GDP per capita also increased sharply, particularly in the later period after China joined the WTO. Third, and somewhat unexpectedly, The sectoral shifts are different than a simple Hecksher-Ohlin would have predicted. Trade liberalization should result in reallocation from the import sector to the export sector. Because of surplus labor what we see is a modest allocation of unskilled labor and physical capital toward the import-competing sector. We will explore in the counterfactual analysis below why this occurred.

4.3 Counterfactual Analysis

We begin our counterfactual analysis by individually setting important parameters, one at a time, in Regime 2 (Regime 3) to their values in Regime 1 (Regime 2), to try and isolate the effect of these changes.

If there were no reduction in the tariffs (Case 1a and Case 2a), sectoral reallocation works in the same way as Hecksher-Ohlin theory, namely, protection leads to resources allocated toward the protected sector. Because the import-competing sector uses unskilled labor less intensively, higher migration cost (i.e., a lower migration wedge ψ) leads to resource reallocation in favor of the import-competing sector. Since the import-competing sector uses skilled labor more intensively, less availability of skilled labor leads resource allocation away from the import-competing sector.

	Sectoral Shares (%)			Real GDP	Urban Share (%)	
	labor	capital	output	per capita	output	employment
	$\frac{L_X}{L}$	$\frac{K_X}{K}$	$\frac{X}{R}$	$\frac{RGDP}{POP}$	φ	υ
Regime 1: 1980-1994	60.6	47.9	44.8	4.048	60.2	26.0
Regime 2: 1995-2001	58.2	46.0	55.5	5.975	68.9	30.3
Regime 3: 2002-2008	56.4	44.2	54.2	9.634	75.4	36.2
Case 1: Counterfactual for Regime 2 (changing parameter value as it were in Regime 1)						
a. when τ^M is raised to τ^H	46.4	34.6	42.7	5.820	67.2	28.3
b. when ψ^H is lowered to ψ^L	44.2	32.6	38.0	4.774	63.9	28.7
c. when A^M/B^M becomes A^H/B^H	82.2	73.8	68.9	5.409	65.0	28.9
Case 2: Counterfactual for Regime 3 (changing parameter value as it were in Regime 2)						
a. when τ^L is raised to τ^M	46.6	34.8	43.5	9.406	74.0	34.2
b. when H^H is lowered to H^L	65.3	53.5	71.0	7.155	72.6	34.0
c. when A^L/B^L becomes A^M/B^M	67.7	56.1	59.9	8.790	72.0	33.8

Next, we shift our focus to the indicators concerning urbanization and economic development, measured by urban output/employment shares and real GDP per capita, respectively. It is informative to decompose the changes in urbanization and economic development into the respective factors: (i) tariff and migration cost reduction and TFP changes in Case 1 and (ii) tariff reduction, skill expansion and TFP changes in Case 2. The decomposition results are reported in the table below. The primary drivers to explain real per capita GDP growth are migration cost reduction, skill accumulation, population growth slowdown, and service expansion.

It is striking that tariffs explain less than 10% of real per capita GDP growth in both counterfactuals. This is consistent with a large literature on gains from trade which finds relatively small gains from tariff reduction. For a recent contribution to this literature see Arkolakis, Costinot and Rodriguez-Clare (2012). Tariffs are important for the transition from Regime 1 to 2, especially for employment. In this transition, migration cost reduction and TFP changes are also important, accounting for more than 30% of increased urbanization. It is somewhat surprising that TFP contributes more to urbanization than to real per capita GDP growth.

In the transition from Regime 2 to 3 after China was admitted to the WTO, the main contribution to urbanization is due to population growth slowdown and service expansion.

Decomposition Analysis (all in %)	Real GDP per capita	Urban Share	
		output	employment
	$\frac{RGDP}{POP}$	φ	υ
Case 1: Counterfactual for Regime 2			
a. contribution of tariff reduction	8.0	19.5	46.5
b. contribution of migration cost reduction	62.3	57.5	37.2
c. contribution of TFP ratio change	29.4	44.8	32.6
d. contribution of population change and service expansion	0.3	-21.8	-16.3
Case 2: Counterfactual for Regime 3			
a. contribution of tariff reduction	2.4	1.9	5.5
b. contribution of skill expansion	25.7	3.7	6.1
c. contribution of TFP ratio change	8.8	4.5	6.6
d. contribution of population change and service expansion	63.1	89.9	81.8

Remark: In sensitivity analysis, we have changed the urban-rural unskilled wage ratio to 1.5 or 2.5, the capital rental to 15% or 25%, or the capital barrier to 5% or 20%. Our main findings on the relative contributions to output growth and urbanization and the timing of the role played by trade liberalization remain robust.

5 Concluding Remarks

We have developed a model that we have used to examine the main driving forces for developing countries with surplus labor that have experienced rapid growth and urbanization. We use a dynamic, open economy framework with surplus labor. Given the surplus labor, we find very different comparative-static predictions from the dynamic Hecksher-Ohlin open-economy models. Both trade liberalization and relaxation of migration constraints promote capital accumulation. Moreover, mitigating trade or migration barriers, leads to the allocation of capital and unskilled labor toward the production of exportables. We also establish sufficient conditions under which a reduction in either trade or migration barriers speeds up the urbanization process and promotes economic development.

We have also calibrated the model to fit observations from China over the period of 1980 to 2008. We find that the primary drivers for real per capita GDP growth are migration cost reduction and skill accumulation. While trade liberalization is important for urbanization during the transition toward China's admission to the WTO (particularly for the employment measure), it does not contribute much to real per capita GDP growth. During this transition process, migration cost reduction and TFP changes are also important, accounting for a significant proportion of increased urbanization.

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Appendix

In this appendix, we provide calibration details. As mentioned in the main text, a major task of the calibration exercise is to construct an exportable sector and an import-competing sector. This is done by using 2 digit sectoral data covering 29 manufacturing industries over 1992-2008. Basically, we apply each sector's export and import content and output to compute the aggregate outputs of exportables and importables (X and Y, respectively). We then use sectoral employment data, capital data and skilled proportion data to back out sectoral allocation of unskilled labor and capital under the assumption that all skilled workers are in the import-competing sector. For notation consistency, we shall add "C" to each variable (employment and output) to denote it calibrated value.

More specifically, we compute the averages of employment (LC) and output (YC) shares of sector i by exports (EX) and imports (IM) content in each year t:

$$\begin{aligned}
\widehat{EX}_t^L &= \sum_i (\frac{LC_{it}}{LC_t}) EX_{it} \\
\widehat{EX}_t^Y &= \sum_i (\frac{YC_{it}}{YC_t}) EX_{it} \\
\widehat{IM}_t^L &= \sum_i (\frac{LC_{it}}{LC_t}) IM_{it} \\
\widehat{IM}_t^Y &= \sum_i (\frac{YC_{it}}{YC_t}) IM_{it}
\end{aligned}$$

from which we can obtain their mean values over the sample period: $\mu(\widehat{EX}_t^L)$, $\mu(\widehat{EX}_t^Y)$ $\mu(\widehat{IM}_t^L)$ $\mu(\widehat{IM}_t^Y)$. By definition,

$$\begin{aligned}
EX_t &= \sum_i EX_{it} \\
IM_t &= \sum_i IM_{it}
\end{aligned}$$

Simple aggregation implies:

$$\begin{aligned}
\sum \frac{EX_{it}}{EX_t} N_{it} &= \widehat{N}_t^X \\
\sum \frac{EX_{it}}{EX_t} YC_{it} &= \widehat{Y}_t^X \\
\widehat{N}_t^X + \widehat{N}_t^M &= \widehat{N}_t \\
\widehat{Y}_t^X + \widehat{Y}_t^M &= \widehat{Y}_t
\end{aligned}$$

By population identity, we have urban manufacturing employment (NC) divided into skilled (HC) and unskilled (LC) with each type of employment further classified into the two sectors (X and

Y):

$$N_t \begin{cases} HC_t & \begin{cases} \widehat{HC}_t^X \\ \widehat{HC}_t^M \end{cases} \\ LC_t & \begin{cases} \widehat{LC}_t^X \\ \widehat{LC}_t^M \end{cases} \end{cases}$$

Denoting the (average) share of the skilled labor in sector M as $\bar{\theta}$ (to be computed below), we have:

$$\begin{aligned} \widehat{LC}_t^M &= (1-\bar{\theta})\widehat{N}_t^M \\ \widehat{LC}_t^X &= \widehat{N}_t^X = \widehat{N}_t - \widehat{LC}_t^M - \widehat{HC}_t^M \end{aligned}$$

To compute all components of employment, we assume:

$$\widehat{HC}_t^M = \bar{\theta} N_t^M$$

Using data HC_{it} (available for $t = 1995, 2004, 2008$), we have:

$$\sum_i (\frac{IM_{it}}{IM_t}) HC_{it} = \widehat{HC}_t^M$$

Thus, we can use $\theta_t = \frac{\hat{H}_t^M}{\hat{N}_t^M}$ to obtain $\bar{\theta} = \mu(\theta_t)$, which can be subsequently substituted into the above population identities to compute all components of employment:

$$\begin{aligned} \widehat{LC}_t^X &= \widehat{N}_t^X = \widehat{N}_t - \widehat{N}_t^M \\ \widehat{LC}_t^M &= \left[1 - \mu\left(\frac{\hat{H}_t^M}{\hat{N}_t^M}\right)\right] \widehat{N}_t^M \\ \widehat{HC}_t^X &= 0 \\ \widehat{HC}_t^M &= \mu\left(\frac{\hat{H}_t^M}{\hat{N}_t^M}\right) N_t^M \end{aligned}$$

In the calibration exercises, we also need to compute Solow residuals and use them to back out the TFP ratios. The Solow residuals in the two sectors are computed from the following regressions (unrestricted):

$$\begin{aligned} \ln(\frac{Y_t^X}{L_t^X}) &= b_0^X + b_1^X \cdot \ln(\frac{K_t^X}{L_t^X}) + error_t^X \\ \ln(\frac{Y_t^M}{L_t^M}) &= b_0^M + b_1^M \cdot \ln(\frac{K_t^M}{L_t^M}) + error_t^M \end{aligned}$$

where the estimates of the regression coefficients are: $\hat{b}_0^X = -1.5708$, $b_1^X = 1.1363$, $b_0^M = -1.8402$, and $b_1^M = 2.5594$. The computed TFPs yield an average growth rate of $g_A = 1.14\%$ and $g_B = 2.56\%$, respectively.

Finally, we document that China's urban employment ratio in 1952 was 12.0%; it increased to 15.8% in 1960 (by extrapolation using data from 1957 and 1965), to 18.3% in 1970 and to 24.8% in 1980. The series over our sample period 1980-2008 is ploted below (where the data in 1981-84 are by extrapolation).