

## Chapter 11

# A Modified Harris-Todaro Model of Rural-Urban Migration For China

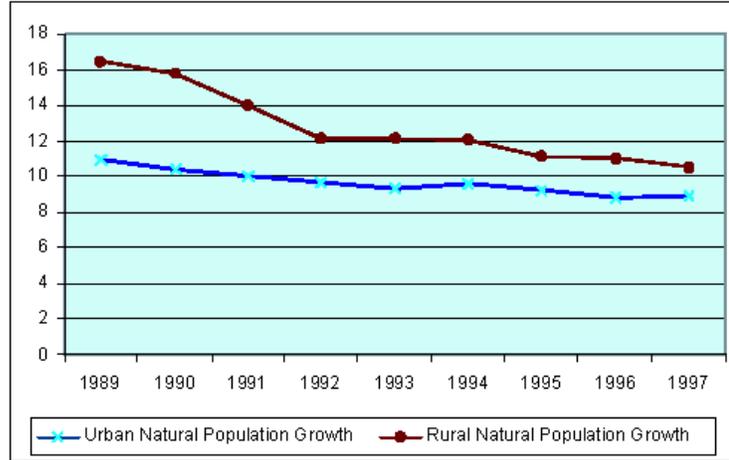
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This paper develops a search equilibrium model of rural-urban migration to study the economic consequence of regionally unbalanced development in China. Due to the enforcement of household registration (*hokou*), illegal migrants from the rural area may search for and take a job in the city, though they suffer a wage mark-down as well as a faster break-up. We characterize the equilibrium wage discount, the job finding rate, and the unemployment rate in the urban labor market. We find that the enforcement of the household registration rule can discourage illegal migration, leading to a higher job finding rate and a lower urban unemployment rate.

### Introduction

With the advent of the *open-door* economic reforms two decades ago, China has experienced a prolonged period of rapid growth. While this has resulted in its per capita income increasing by more than 12 times, an unpleasant by-product is the socioeconomic consequences of *mangliu* (“peasant flood”), or illegal internal migration, which has arisen from regionally unbalanced development and the shift in the surplus of labor from agricultural to industrial sectors.<sup>1</sup> In attempt to stem this tide the Chinese government has adopted a *hokou* system (i.e., a household registration system), which limits legal migration by *legislating* an individual’s locational choice.<sup>2</sup> Despite this, the presence of significant economic incentives for locating urban employment, has led to a flood of illegal migrants who have moved into major industrial cities, such as Shanghai and Shenzhen. For instance, based on the retrospective questions in China’s 1990 census (conducted by the State Statistical Bureau) it has been estimated that over 20 million legal migrants, during the 5-year period from 1985 to 1990, located themselves in Guangdong, Beijing and Shanghai.<sup>3</sup> Among all non-*hokou* migrants over this period, more than 75 percent have been from rural areas, almost two-thirds between age 20 and 39, almost 60 percent relocating for job-related reasons, only less than 12 percent with senior high school education, and approximately two-thirds working in retail, hotel/restaurant service, and manufacturing industries.

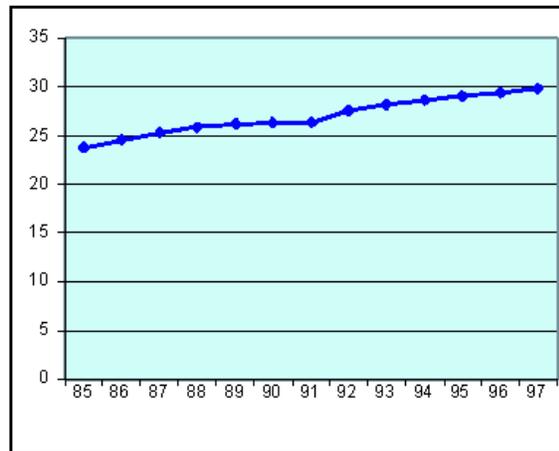
Figure 11.1 below presents the natural population growth rates in Chinese rural and urban areas.<sup>4</sup> While both series exhibited a downward trend (from about 1.65 and 1.1 percent down to 10.5 and 9 percent, respectively, for rural and urban (areas), it is clearly seen that the gap between the two was narrowed over the past decade.



**Figure 11.1: Natural Population Growth Rates in China: Rural vs. Urban (per 1000)**

Notes: Data prior to 1990 are based on interpolation of China's 1982 and 1990 national population censuses; afterwards, data are estimated based on the annual National Sample Survey on Population Change (NSSPC). All data exclude the population of Hong Kong and Macao, but include military personnel.

At the same time, the urbanization ratio continued to rise, from approximately 24 to 30 percent, as suggested by Figure 11.2.



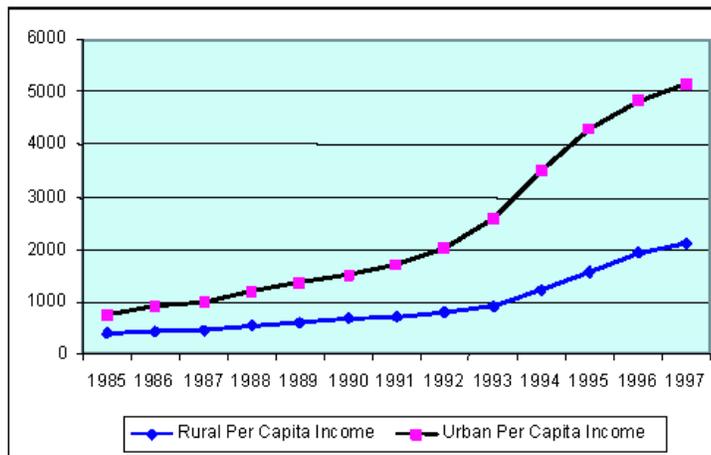
**Figure 11.2: Urbanization Ratio (%)**

Note: See Figure 11.1.

It is expected that the urbanization ratio will reach 70 percent by 2050 as a result of an estimated net migration from rural to urban area of 50 million

persons. Currently, China has about 660 cities and 19,000 towns. By 2050, 80 percent of towns will grow into small or medium-sized cities and by then, China will have 50 large metropolis, each with more than 2 million, 150 big cities, 500 medium-sized cities and 1,500 small cities.

A key factor of such rural-urban migration is the on-going increase in the per capita income differential between the two areas. From Figure 11.3, we can see that the urban-rural per capital annual disposable income differential was only about 341 yuan in 1980, but rose sharply to 3,060 yuan in 1997.



**Figure 11.3: Per Capita Income in China: Rural vs. Urban (in yuan)**

Note: See Figure .11.1.

Todaro (1969) and Harris and Todaro (1970) set up a seminal framework of migration between rural and urban areas. They hypothesize that individuals migrate to urban sectors with the aim of obtaining employment in the formal sector and that informal sector employment is a transitional phase during which migrants are searching for formal sector job. In their decision to migrate, potential migrants balance the probability of unemployment against the real income differentials between the urban formal sector and the rural area. That is, there may exist a higher unemployment in the urban sector due to the existing uncertainty of finding work in the formal sector even though the expected income in the urban sector is higher than that of rural sector. Recently, Bencivenga and Smith (1997) analyzed the interaction between migration and unemployment, in which economic development is accompanied by migration from rural to urban employment and is associated with significant urban unemployment. According to their results, adverse selection in the urban sector keeps the unemployment pools away from the formal urban market so that employers hire only a very small proportion of unemployed workers from the unemployment pools. This adverse selection becomes particularly acute when the economic profits decline in the urban labor markets. In Brueckner and Zenou (1999), the urban land market is explicitly incorporated into the Harris-Todaro framework. As a result, the interactions between rural-urban migration and urban land rent are examined. They find that the increased urban land rent reduces the incentive

for a rural resident to migrate to the city, which provides a partial explanation of the reversed pattern of rural-urban migration (suburbanization) in the U.S. since 1960.

In the present paper, we construct a model particularly suitable for the study of rural-urban migration in China. Following Coulson, Laing and Wang (2001) and Park (1999), we adopt a search theoretic approach where both the migration flows and migration probabilities are endogenously determined.<sup>5</sup> Due to the household registration policy, illegal immigrants may be penalized in two forms: (i) if they fail to submit a legal document to their employers, they receive lower *equilibrium* wages than those enjoyed by legal residents and (ii) as a result of government auditing, they are more likely to lose their jobs than are legal residents. Both legal and illegal workers in the urban labor market conduct job search, that is mediated via a random matching technology. The technology is such that each vacancy can be filled by at most one worker and each worker can hold at most one job at any given point in time. By endogenizing individuals' migration and job-search decision, we determine endogenously the wage schedules for both legal and illegal workers, under a symmetric Nash bargain where workers and firms equally divide the joint surplus accrued from their successful matching.

In a steady-state equilibrium, (i) rural legal residence must have no incentive to migrate to the urban area (or what we call a “no-arbitrage” migration relationship), (ii) population net flows from and to each employed and unemployed pool must be zero and the number of filled jobs must equal to the number of employed workers (or what we call a “steady-state matching” relationship), and (iii) firms continue to enter until their expected market value equals to the fixed entry cost (or what we call an “equilibrium entry” relationship). We show that under a rather weak condition, the steady-state equilibrium exists and is unique. By performing comparative-static analysis, we find that the enforcement of the household registration rule can discourage illegal migration, which in turn leads to a higher job finding rate and reduces the urban unemployment rate.

The remainder of this paper is organized as follows. In Section 2, we present the basic structure of the model. While Section 3 determines the wage schedules for legal and illegal workers by a symmetric Nash bargain, Section 4 proves the existence and uniqueness of the steady-state equilibrium in which there is no net migration flow. We then characterize the steady-state equilibrium in Section 5 and provide some concluding remarks, including possible avenues for future research, in Section 6.

## The Basic Environment

We consider a continuous time closed economy that consists of two sectors corresponding to the rural and city sectors. The total population is normalized to one. The household registration system is such that, the mass of residents who are *legally* obliged to live in the *rural* sector is  $N$ . The mass  $1 - N$  of workers are permitted to move to the city.<sup>6</sup> All agents discount the future at the rate,  $r > 0$ . All workers are identical except for their legal residency status. Each worker is endowed with a unit of labor which can be supplied to firms inelastically.

The one-time interregional migration cost of moving from the rural sector to the city (or *vice versa*) is captured by  $Z > 0$ . We assume that legally registered rural residents can search for jobs in the city without incurring any explicit search costs (although search is time consuming). All agents must present their household registration must be presented when they apply for a job. However, even unregistered households can search for work. If they successfully match with an employer, they become illegal (working) migrants. We assume that they suffer faster job break ups than formal workers and, later prove, that they will earn lower wages as well. The decision regarding whether a rural resident will choose to move to the city depends upon the expected discounted value of income in each of the two regions. We label those who decide to remain in the rural sector by a superscript “ $R$ ” and those who *illegally* move to the city by “ $M$ .” Legal residents in the city are, indexed by “ $C$ .” These individuals always search for jobs in the city (under a condition that ensures the payoff of a city job is sufficiently high).

There is free entry of firms into the urban labor market, in the sense that any firms can enter the market upon incurring a fixed cost  $K > 0$ , which captures both firms’ start-up and capital costs. Firms can exit the labor market without cost.

The rural labor market is assumed to be perfectly competitive. However, in the urban labor market the interactions between workers and firms are governed by random matching processes. This reflects the specialization of labor that occurs in urban labor, and captures the time consuming and difficult task of matching the “right worker” with the “right task.” Each firm consists of a single vacancy that can be filled by a single worker. The mass of unfilled vacancies in the economy is denoted  $V$ . All vacancies are completely durable and identical in every respect.

Upon a successful match, the worker-firm pair negotiates a wage and production takes place immediately. In steady-state equilibrium, there is no migration flow between two regions, as all of those who wish to move to the city do so at the beginning of the period. It follows that our analysis is one that applies to the distribution of a given group of workers between the urban and rural labor markets.<sup>7</sup> One of the key economic relationships in our model is a *no arbitrage* condition. This conditions basically ensures that in steady state equilibrium there are no incentives to move from one location to another. (If this condition were to be violated, then a *mass* of workers would “jump” from one sector to another, which would discretely reduce the value of searching in that sector).

Given the matching process, urban workers are either currently employed ( $E$ ) or else unemployed ( $U$ ) and searching for work. Likewise, employers are in one of two states. They either have a filled vacancy and are producing output,

or alternatively they have an open vacancy and are searching for labor. These two states are denoted by ( $F$ ) and ( $V$ ) respectively. Thus, the total workforce in each region is described by:

$$N = R + \Lambda = R + E^M + U^M; \quad 1 - N = E^C + U^C \quad (1)$$

In view of the fact that each vacancy is filled by at most one worker, the total number of city jobs equals the total number of city employees  $E^M + E^C$ . In view of this, the fraction of workers who illegally migrate to the city is:  $\lambda \equiv \Lambda/N = (E^M + U^M)/N$ .

The flow output per worker in the rural sector is given by:

$$y^R = A \quad (2)$$

where  $A > 0$ . To capture the observed phenomenon, output per worker in the city is specified as:

$$y = A + \Delta \quad (3)$$

where  $\Delta > 0$  denotes the rural-urban productivity differentials, which is the primary economic incentive that induces rural-urban migration.

Let  $\alpha \equiv U^M/(U^M + U^C)$  denote the fraction of searching workers with legal residence in the rural region. (It follows that  $\alpha$  is the fraction of searching workers who are legally allowed to reside in the city). Denote the flow probability that a worker locates a vacancy as  $\mu$  and that a vacancy locates a worker as  $\eta$ . It follows that searching vacancies meet illegal immigrants into the city and legal residents at different rates according to the fraction  $\alpha$ . More specifically, the effective flow probability with which a vacancy locates an illegal migrant is  $\eta\alpha$ , while it meets a legal resident is  $\eta(1 - \alpha)$ .

We assume that worker-firm matches break up for exogenous reasons. Accordingly let  $\delta$  denote the flow break-up probability between jobs and legal workers. Jobs and illegal migrants into the city break up at the rate,  $(\delta + \beta)$ . Here  $\beta > 0$  is an additional job break up component, reflecting the city's enforcement of the residency laws. For simplicity, the government's enforcement behavior and financing are not explicitly modeled in the present paper.

Denote the (endogenous) market wage rate of legal workers by  $w$ . The wage of illegal immigrants is defined as:  $v \equiv (1 - \theta)w$ , where  $\theta \in (0, 1)$  captures the (endogenous) wage reduction of illegal workers. Further, let  $J_E^M$  and  $J_U^M$  denote the respective present-discounted value of a employed and unemployed illegal migrants (more specifically, workers who are officially domiciled in the rural sector, but work or search for work in the urban labor market). The corresponding asset values for legal residents are  $J_E^C$  and  $J_U^C$ . Finally,  $\Pi_F^i$  and  $\Pi_V$ , respectively, denote the present-discounted value of a filled vacancy with a worker of type- $i$  ( $i = M, C$ ) and the expected present-discounted value of an unfilled vacancy (which obviously, is independent of the worker's type).

The associated Bellman equations determining agents' steady state asset values equal:

$$rJ^R = A \quad (4)$$

$$rJ_E^M = v + (\delta + \beta)(J_U^M - J_E^M) \quad (5)$$

$$rJ_U^M = \mu(J_E^M - J_U^M) \quad (6)$$

$$rJ_E^C = w + \delta(J_U^C - J_E^C) \quad (7)$$

$$rJ_U^C = \mu (J_E^C - J_U^C) \quad (8)$$

$$r\Pi_F^M = y - v + (\delta + \beta) (\Pi_V - \Pi_F^M) \quad (9)$$

$$r\Pi_F^C = y - w + \delta (\Pi_V - \Pi_F^C) \quad (10)$$

$$r\Pi_V = \eta [\alpha\Pi_F^M + (1 - \alpha)\Pi_F^C - \Pi_V] \quad (11)$$

These asset value equations have intuitive interpretations. To begin with, the competitive labor market assumption implies that workers' flow incomes in this sector are trivially equal to  $A$ . As indicated by (4)  $J^R$  is equal to the lifetime wealth of a rural worker ( $A/r$ ) given the discount rate  $r$ . Equation (5) says that the flow value of an illegal — but employed — worker equals the net flow value of wage income,  $v$ , plus the expected value of the change in state that arises because of job break-ups (i.e., becoming an unemployed and searching for another job in the urban labor market - which occurs with flow probability  $\delta + \beta$ ). Equation (6) indicates that, because of the absence of either flow income while unemployed, or flow costs while searching, the flow value of an unemployed illegal migrant is simply the flow value of the expected capital gain of finding urban employment. Precisely analogous interpretations hold for the asset values (7) and (8).

Finally, (9) and (10) describe the asset values of employers. Equation (9) equals the flow value of a filled vacancy with a worker of type- $i$ . It equals the sum of its flow profits (flow output net of wages) in conjunction with the the expected flow value of suffering a capital loss due to a job break-up. In equation, (11) the expected flow value of holding open an unfilled vacancy is simply the expected flow capital gain from successfully hiring either a legal resident or illegal migrant.

The aggregate mass of unemployed workers in the economy is:  $U \equiv U^M + U^C$ . Since a vacancy can be filled by exactly one worker and each worker work in at most one job, it is clear that steady-state matching in the urban labor market must satisfy:

$$\mu U = \eta V = \Gamma(U, V) \quad (12)$$

where the first equality says that the instantaneous flow of successful matches of searching workers must equal the flow rate at which unfilled vacancies find workers, The second equality states that these flow matching rates are governed by a random-matching technology  $\Gamma$  a la Diamond (1982). We make standard assumptions about  $\Gamma$ . More specifically,  $\Gamma(\cdot)$  is strictly increasing and strictly concave in the masses of the two searching parties,  $U$  and  $V$ . It exhibits constant returns to scale in  $U$  and  $V$ . Finally, it satisfies the Inada conditions ( $\lim_{j \rightarrow 0} \Gamma_j = \infty$  and  $\lim_{j \rightarrow \infty} \Gamma_j = 0$ , for  $j \in \{U, V\}$ ) and the boundary conditions ( $\Gamma(0, V) = \Gamma(U, 0) = 0$ ). A Cobb-Douglas function, for example, satisfies all of these conditions. These ensure a well-behaved, Beveridge curve in which the absence of either side of the matching parties would result in no matches. By utilizing the constant-returns property, straightforward manipulation of (12) yields  $\eta = \Gamma(U/V, 1) = \Gamma(\eta/\mu, 1)$ , or,

$$\eta = \eta(\mu) \quad (13)$$

where  $\eta_\mu = -(\eta/\mu^2)/(1 - U\Gamma_U/\Gamma) < 0$ . This will be referred to as the *steady-state matching* (SS) locus, which gives a negative relationship between the two

flow probabilities in the steady state. It is immediate from ( ) and ( ) that the mass of vacancy is given by,

$$V = \frac{\mu}{\eta(\mu)}U \quad (14)$$

which is increasing in worker's flow matching probability  $\mu$ .

## Wage Bargaining in the Urban Labor Market

We now turn to the determination of the wage in the urban labor market. Although the flow probabilities  $\eta$  and  $\mu$  are endogenously determined in equilibrium, workers and firms treat them as parametrically given in making their decisions. Furthermore, as vacancies are atomistic, the expected value of an unfilled vacancy is also taken as parametric throughout the analysis (see Pissarides 1987 and Laing, Palivos and Wang 1995 for detailed discussions).

For simplicity, we further assume that the two parties bargain cooperatively to maximize their equally weighted joint surplus:  $(J_E^i - J_U^i)^{1/2} (\Pi_F^i - \Pi_V)^{1/2}$ , for  $i = M, C$ . This optimization problem is characterized by a symmetric Nash bargaining solution. Thus, the wage offers made to illegal migrants,  $v$ , and legal residents,  $w$ , must satisfy:

$$J_E^i - J_U^i = \Pi_F^i - \Pi_V > 0 \quad (15)$$

First, manipulating (5) and (6) implies:

$$J_E^M - J_U^M = \frac{r}{r + \mu} J_E^M = \frac{v}{r + \delta + \beta + \mu} \quad (16)$$

Similarly, (7) and (8) together give,

$$J_E^C - J_U^C = \frac{r}{r + \mu} J_E^C = \frac{w}{r + \delta + \mu} \quad (17)$$

whereas (9) and (10) can be rewritten as:

$$\Pi_F^M - \Pi_V = \frac{1}{r + \delta + \beta} [y - v - r\Pi_V] \quad (18)$$

$$\Pi_F^C - \Pi_V = \frac{1}{r + \delta} [y - w - r\Pi_V] \quad (19)$$

Next, substituting (16)-(19) into (15), we can obtain the wage offer functions and characterize their properties as follows:

**Proposition 1 (Wage Offers):** *The unique wage offer functions determined by the symmetric Nash bargain between a vacancy and a type  $i \in \{M, C\}$  are given by,*

$$v = \frac{r + \delta + \beta + \mu}{2(r + \delta + \beta) + \mu} (y - r\Pi_V) \quad (20)$$

$$w = \frac{r + \delta + \mu}{2(r + \delta) + \mu} (y - r\Pi_V) \quad (21)$$

*They possess the following properties:*

$$\frac{\partial v}{\partial \mu} > 0; \quad \frac{\partial v}{\partial \Pi_V} < 0; \quad \frac{\partial v}{\partial \beta} < 0; \quad \frac{\partial w}{\partial \mu} > 0; \quad \frac{\partial w}{\partial \Pi_V} < 0; \quad \frac{\partial w}{\partial \beta} = 0$$

Intuitively, an increase in the flow probability with which a worker locates a job ( $\mu$ ) enhances his bargaining power, and leads to a higher wage offer. In contrast an increase in the value of an unfilled vacancy,  $\Pi_V$ , reduces the wage offer since it increases the option value to the firm of keeping the vacancy open. An increase in the government's enforcement efforts to capture illegal migrants in captured by an increase in  $\beta$ . The effect of this is to lower the present discounted value of the surplus that accrues to an illegal worker-firm pair, which — in turn — reduces the *relative* wage offer made to illegal migrants.

Recall that  $\theta$  is defined by the condition  $v \equiv (1 - \theta)w$ , where  $\theta \in (0, 1)$ . Using (20) and (21), we can compute the wage “mark-down,”  $\theta \equiv (w - v)/w$ , facing illegal workers. It is given by:

**Proposition 2 (The Wage Discount Factor  $\theta$ ):** *The wage discount rate facing an illegal worker in the urban labor market is given by,*

$$\theta(\mu; \beta) = \frac{\beta\mu}{(r + \delta + \mu)[2(r + \delta + \beta) + \mu]} \quad (22)$$

*It possess the following properties:*

$$\frac{\partial\theta}{\partial\mu} > 0 \text{ if } \beta < \beta_0 \text{ and } \frac{\partial\theta}{\partial\mu} < 0 \text{ if } \beta > \beta_0; \quad \frac{\partial\theta}{\partial\beta} > 0$$

The second result is straightforward: an increase in the city government's attempts to detecting illegal migration (higher  $\beta$ ) enlarges the wage gap between legal and illegal workers, thus raising the wage mark-down (higher  $\theta$ ). The first result says that *provided* the city government's attempts to detecting illegal migration are sufficiently weak (low  $\beta$ ) an increase in market thickness that makes it easier for workers to locate jobs (high  $\mu$ ) increases the gap between the wage offers made to legal and illegal migrants. Alternatively, if detection efforts are vigorous, then an increase in the matching rate  $\mu$  lowers the wage mark-down. This effect can be explained as follows. As  $\mu$  rises it is easier for all workers to find jobs. However, as  $\beta$  rises as well, the value of matches between firms and illegals declines, but at slower rate at the margin. As a result, there exists a critical enforcement rate  $\beta$  after which further increases in the matching rate,  $\mu$ , start to reduce the wage mark-down.

## Steady-State Equilibrium

In steady-state equilibrium, the free entry of vacancies implies the market value of an unfilled vacancy must be equal its fixed entry cost:

$$\Pi_V = K \quad (23)$$

By substituting (3) and (23) into (20) and (21), the equilibrium wage schedules can be written:

$$v(\mu; \beta, K) = \frac{r + \delta + \beta + \mu}{2(r + \delta + \beta) + \mu} (A + \Delta - rK) \quad (24)$$

$$w(\mu; \beta, K) = \frac{r + \delta + \mu}{2(r + \delta) + \mu} (A + \Delta - rK) \quad (25)$$

where,  $\Delta = y - y^R$ . Manipulating (9)-(11) and (13) to express  $\Pi_V$  as a function of  $(\mu, v, w)$ , we can rewrite (23) as:

$$\frac{\eta(\mu)}{r + \eta(\mu)} \left[ \alpha \frac{y - v(\mu) + (\delta + \beta)K}{r + \delta + \beta} + (1 - \alpha) \frac{y - w(\mu) + \delta K}{r + \delta} \right] = K \quad (26)$$

Substituting (3), (24) and (25) into (26) and manipulating, we obtain:

$$\Psi(\mu, \alpha; \beta, K, \Delta) \equiv \frac{\eta(\mu) (A + \Delta - rK)}{2(r + \delta + \beta) + \mu} \left[ 1 + \frac{2\beta(1 - \alpha)}{2(r + \delta) + \mu} \right] - rK = 0 \quad (27)$$

Straightforward differentiation of this expression yields:

$$\frac{\partial \Psi}{\partial \mu} < 0, \frac{\partial \Psi}{\partial \alpha} < 0, \frac{\partial \Psi}{\partial \beta} < 0, \frac{\partial \Psi}{\partial K} < 0, \text{ and } \frac{\partial \Psi}{\partial \Delta} < 0. \quad (28)$$

This condition can be used to derive an *equilibrium entry* (EE) relationship:

**Lemma 1** (*Equilibrium Entry*): *The equilibrium entry condition is given by,*

$$\alpha = \alpha(\mu; \beta, K, \Delta) \equiv 1 - \frac{2(r + \delta) + \mu}{2\beta} \left\{ \frac{rK [2(r + \delta + \beta) + \mu]}{\eta(\mu) (A + \Delta - rK)} - 1 \right\} \quad (29)$$

*satisfying the following properties:*

- (i)  $\frac{\partial \alpha}{\partial \mu} < 0$ ,  $\frac{\partial \alpha}{\partial \beta} < 0$ ,  $\frac{\partial \alpha}{\partial K} < 0$ , and  $\frac{\partial \alpha}{\partial \Delta} < 0$ ;
- (ii)  $\alpha \rightarrow \infty$  as  $\mu \rightarrow 0$  and  $\alpha \rightarrow \alpha_{\min} > 0$  as  $\mu \rightarrow \infty$ .

The *EE* locus gives the set of matching rates  $\mu$  and  $\eta$  such that the net *ex ante* value to a firm from creating a new vacancy is precisely zero. Crucially, the *EE* locus takes into account the fact that firms recognize that their subsequent wage agreements are determined according to the Nash bargaining solution described in Propositions and ).

The EE locus establishes a *negative* relationship between the flow probability with which workers locate jobs,  $\mu$ , and the fraction of illegal migrants,  $\alpha$ , in the population of urban job seekers.

In steady-state equilibrium, there are no net migration flows. This means that at  $t = 0$  rural residents make a decision regarding whether they will remain where they are or, alternatively, search for work in the urban labor market. In order to ensure that there is no migration in steady state it is necessary that the present-discounted value of remaining a rural worker must equal the expected present-discounted value of *illegal* job seekers in the urban sector, *net* of the migration cost  $Z$ .<sup>8</sup> This gives rise to a *no-arbitrage* (NA) condition, which takes the form:

$$J_U^M - Z = \frac{A}{r} = J^R > 0 \quad (30)$$

or, using (3), (6),(16) and (20),

$$\frac{A}{r} + Z = J_U^M = \frac{\mu}{2(r + \delta + \beta) + \mu} \left( \frac{A + \Delta}{r} - K \right) \quad (31)$$

Straightforward manipulation and differentiation establish:

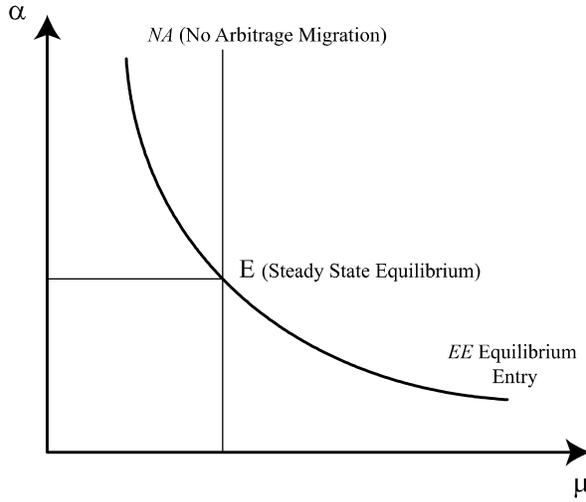
**Lemma 2** (No-Arbitrage): *The no-arbitrage condition is given by,*

$$\mu = \Phi(\beta, K, Z, \Delta) \equiv \frac{2(r + \delta + \beta)(A + rZ)}{\Delta - r(K + Z)} \quad (32)$$

satisfying:

$$\frac{\partial \Phi}{\partial \beta} > 0; \quad \frac{\partial \Phi}{\partial K} > 0; \quad \frac{\partial \Phi}{\partial Z} > 0; \quad \frac{\partial \Phi}{\partial \Delta} < 0$$

One of the appealing features of this condition is that it uniquely determines the flow probability  $\mu$  and does so independently of the fraction of illegals,  $\alpha$  in the population. This means the NA locus is vertical in  $(\mu, \alpha)$  space at a given value of  $\mu$ . Figure 11.4 below depicts the (unique) steady-state equilibrium at point  $E$ . It occurs at the point where the negatively sloped  $EE$  locus intersects the vertical  $NA$  locus.



**Figure 11.4: Steady-State Equilibrium**

Moreover, the urban labor market must exhibit no net flows for either type of workers and hence,

$$(\delta + \beta)E^M = \mu U^M \quad (33)$$

$$\delta E^C = \mu U^C \quad (34)$$

which can be combined with (1) to yield the masses of employed and unemployed workers:

$$E^M = \frac{\mu N \lambda}{\delta + \beta + \mu} \quad (35)$$

$$E^C = \frac{\mu(1 - N)}{\delta + \beta} \quad (36)$$

$$U^M = \frac{(\delta + \beta)N \lambda}{\delta + \beta + \mu} \quad (37)$$

$$U^C = \frac{\delta(1 - N)}{\delta + \beta} \quad (38)$$

A thicker urban labor market — measured by a higher flow probability  $\mu$  — raises employment and reduces unemployment. For a given thickness measure, a greater enforcement on illegal workers by the city government results in a higher unemployment rate for illegal workers, a lower unemployment rate for legal workers, and a reduced mass of employment for either type of workers.

The definition of  $\alpha$  and equations (38) together give:

**Lemma 3** (Aggregate Unemployment): *The aggregate unemployment rate in the society is given by,*

$$U(\mu, \alpha) \equiv U^M + U^C = \frac{\delta(1-N)}{\delta + \beta} \frac{1}{\alpha} \quad (39)$$

satisfying:

$$\frac{\partial U}{\partial \mu} < 0; \quad \frac{\partial U}{\partial \alpha} > 0$$

That is, a thicker urban labor market decreases aggregate unemployment, whereas more illegal workers tends to increase it. Plugging (39) into (14), we have:

$$V(\mu, \alpha; \beta) = \frac{\delta(1-N)}{\delta + \beta} \frac{\mu}{\alpha \eta(\mu)} \quad (40)$$

which is increasing in  $\mu$  and decreasing in  $\alpha$  and  $\beta$ .

Finally, substitution of (37) and (38) into the definition of  $\alpha$  leads to:

**Lemma 4** (Migration Rate): *The rural migration rate into the city is given by,*

$$\lambda(\mu, \alpha; \beta) = \frac{1-N}{N} \frac{\delta}{\delta + \beta} \frac{\alpha}{1-\alpha} \left( 1 + \frac{\beta}{\delta + \mu} \right) \quad (41)$$

satisfying:

$$\frac{\partial \lambda}{\partial \mu} < 0; \quad \frac{\partial \lambda}{\partial \alpha} > 0; \quad \frac{\partial \lambda}{\partial \beta} < 0$$

Intuitively, a thicker urban labor market increases the disadvantages of illegal migrants relative to legal workers, as it is easier for legal residents to find work. In turn, this discourages rural migration into the city. This property contrasts the partial-equilibrium probabilistic model of migration due to Todaro (1969) and Harris and Todaro (1970). While a higher rural migration rate is consistent with a larger fraction of unemployed illegal workers in the city, a strengthened city government's enforcement on illegal workers reduces the rural migration rate into the city.

Consider,

**Definition** (Steady-State Equilibrium): *A steady-state equilibrium is a pair of wage functions,  $v(\mu; \beta, K)$  and  $w(\mu; \beta, K)$ , together with a tuple of quantities  $(\mu, \eta, \alpha, \lambda, E^M, E^C, U^M, U^C, V)$ , satisfying the following conditions:*

- (i) (Symmetric Nash Wage Bargain): (24) and (25);
- (ii) (Steady-State Matching): the SS locus (13);
- (iii) (Equilibrium Entry): the EE locus (29);
- (iv) (No-Arbitrage): the NA locus (32);
- (v) (Migration Rate): (41);

(v) (Steady-State Population): (35)-(38) and (40).

**Condition E:**  $\Delta > r(K + Z)$ , i.e., the productivity gap is sufficiently high relative to the entry and migration costs.

As it can be seen from (32), Condition E is necessary and sufficient to ensure a positive value of  $\mu$  in steady-state equilibrium. Moreover, it is also sufficient to guarantee positive wages and non-trivial migration from rural to urban.

Utilizing Lemmas 1-4, we can establish:

**Proposition 3** (Existence and Uniqueness of the Steady-State Equilibrium): *Under Condition E, the steady-state equilibrium exists and is unique.*

## Comparative Statics

To characterize the steady-state equilibrium, it is useful to understand the recursive nature of the model. First, the EE locus (29) and the NA locus (32) together determine the steady-state equilibrium values of  $\mu$  and  $\alpha$ . These are then substituted into (i) (24), (25) and (22) to pin down the two wage schedules ( $v$  and  $w$ ) and the wage mark-down  $\theta$  facing illegal migrants. Once the contact rates  $\alpha$  and  $\mu$  are determined, equations (13) and (41) pin down firm's flow matching probability ( $\eta$ ) and the migration rate ( $\lambda$ ). Once all of the Poisson arrival rates have been determined, equations (35)-(38) and (40) can be used to derive the steady-state equilibrium masses of the employed, the unemployed and the vacancies ( $E^M, E^C, U^M, U^C$ , and  $V$ ). Finally, equation (39) can be used to determine the steady-state equilibrium rate of aggregate unemployment ( $U$ ).

Applying Lemmas 1-4 as well as equation (41), yields:

**Proposition 4** (Characterization of the Steady-State Equilibrium). *Under Condition E, the unique steady-state equilibrium possesses the following properties.*

- (i) (thickness of the urban labor market):  
 $\frac{\partial \mu}{\partial \beta} > 0$ ;  $\frac{\partial \mu}{\partial K} > 0$ ;  $\frac{\partial \mu}{\partial Z} > 0$ ;  $\frac{\partial \mu}{\partial \Delta} < 0$ ;
- (ii) (fraction of illegal workers in the city):  
 $\frac{\partial \alpha}{\partial \beta} < 0$ ;  $\frac{\partial \alpha}{\partial K} < 0$ ;  $\frac{\partial \alpha}{\partial Z} < 0$ ;  $\frac{\partial \alpha}{\partial \Delta} > 0$ ;
- (iii) (wage mark-down facing illegal workers):  
 $\frac{\partial \theta}{\partial \beta} > 0$ ;  $\frac{\partial \theta}{\partial K} > 0$ ;  $\frac{\partial \theta}{\partial Z} > 0$ ;  $\frac{\partial \theta}{\partial \Delta} < 0$  for sufficiently small  $\beta$ ;
- (iv) (migrate rate from rural to urban):  
 $\frac{\partial \lambda}{\partial \beta} < 0$ ;  $\frac{\partial \lambda}{\partial K} < 0$ ;  $\frac{\partial \lambda}{\partial Z} < 0$ ;  $\frac{\partial \lambda}{\partial \Delta} > 0$ ;
- (v) (aggregate unemployment rate):  
 $\frac{\partial U}{\partial \beta} < 0$ ;  $\frac{\partial U}{\partial K} < 0$ ;  $\frac{\partial U}{\partial Z} < 0$ ;  $\frac{\partial U}{\partial \Delta} > 0$ ;

Many of these results carry over the intuition embodied in the partial-equilibrium relationships described in the earlier Lemmas and Propositions to a general-equilibrium environment in which all of the matching rates, populations, and wage offers are endogenously determined. Accordingly we discuss only the most noteworthy findings.

Key among them is that an increase in the enforcement rate  $\beta$  increases the rate at which *all* workers (both legal and illegal migrants) locate jobs:  $\frac{\partial \mu}{\partial \beta} > 0$ . The intuition is that an increase in  $\beta$  increases the job break up rate which

means that in steady state, there are a greater number of unfilled vacancies searching for a given number of unemployed job seekers.

An increase in the migration cost  $Z$  also raises the rate at which workers find jobs. The explanation is that an increase in  $Z$  reduces illegal migration. As a result, the fraction  $\alpha$  of illegals in the urban population falls ( $\partial\alpha/\partial Z < 0$ ). In turn, this raises the *ex ante* value to firms of entering the city as they are *less likely* to see their matches terminate as a result of government enforcement of residency requirements, since a greater fraction of their employees are legally domiciled. In turn, the greater number of firms makes it easier for workers to find jobs, so that  $\mu$  rises. Evidently, an increase in enforcement efforts (i.e., an increase in  $\beta$ ) also reduces the fraction of illegal migrants in the city,  $\alpha$ , as well as the extent of illegal migration  $\lambda$ . In this regard a notable result is that greater enforcement increases the wage gap:  $\frac{\partial\theta}{\partial\beta} > 0$ . Essentially this is a resurfacing of the partial-equilibrium result reported in Proposition 2 to a general-equilibrium setting.

From a policy perspective, one of the most significant findings is that an increase in the city government's enforcement activities (raising  $\beta$ ) reduces the level of unemployment:  $\frac{\partial U}{\partial\beta} < 0$  - and does so, even though the penalty in the event of detection is the termination of the match. This is a general equilibrium result. It arises because the increase in  $\beta$  deters so many illegal rural migrants from entering the city in the first place.

The results pertaining to the entry cost  $K$  are of some interest, since the government may enjoy some ability in implementing policies that make it more or less costly for firms to enter the market. (For example, the government could devise low tax enterprise zones to encourage entry). As the results make clear this is a double edged sword. While it certainly makes it easier for workers to find jobs ( $\mu$  rises) it also encourages illegal immigration into the city.

## Conclusions

China, it would seem, never does "anything by halves." It's per capital growth rate over the past twenty years or so has been utterly staggering, leading to a twelve fold increase in per capita incomes over the period. However, growth has been uneven. The resultant differences in per capita incomes enjoyed by urban and rural dwellers is now precipitous. This has generated enormous amounts of internal migration, as workers abandon the land in search of urban employment. The labor flows are staggering. Over the five year period 1985-1990, the migration to *three* of China's major cities equalled about half the population of France.

To deal with the problems generated by the mass exodus from the land and the even greater social and economic problems that arise from their movement to the city, China has attempted to control internal migration through a *Hokou* - household registration - system. The snag, of course, is that the economic incentives to migrate are so great that many individuals simply flout the law and illegally migrate from the rural to the urban sector in search of work. This paper is unique in that it extends the basic Harris Todaro model to a search equilibrium setting that includes both legal and illegal migrants. One of the main findings is that stricter enforcement of registration laws may reduce unemployment levels in the city. However, in its attempt to promote economic growth policies that

reduce the cost of capital, and that encourage the entry of vacancies into the city, may only make internal migration policies even more acute.

We believe that this paper can be extended in a variety of ways. Following Laing, Palivos, and Wang (1995) it would be of interest to admit a non trivial educational decision. In this case, illegal migrants - by making it more difficult and time consuming for legal residents to find work - reduce the value of education. As a result, a vigorously enforced household registration system may be welfare enhancing by fostering investment in human capital. Our paper shares with the canonical Harris (1969) and Harris and Todaro (1970) models of migration the unappealing feature that all migration takes place *ex ante* at the very beginning of the period. An interesting extension would be to admit an endogenous migration flow from the rural to the urban sector that arises because of (initially) increasing returns to urban employment. In this case, it would be of great interest to investigate just how the hokou registration system impacts the *distribution of income* during the process of economic development.

## Notes

<sup>1</sup>For an elaboration on peasant flood in China, the reader is referred to Chan (1988) and Wan (1995). For a discussion of the shift of labor force, see Lewis (1954) and Kuznets (1982). With regard to the socio-economic consequences, the Shengzhen City Police Report suggests that crimes committed by non-hokou migrants accounted for approximately 90 percent of the total.

<sup>2</sup>See Yang (1993) for a detailed description of the hokou system.

<sup>3</sup>Based on transportation flows prior to the new year holiday, the total non-hukou migration is estimated at least 35 million. Based on the 1990 Census questionnaire, non-hukou migration is believed almost as large as hukou migration (cf. Chan, Liu and Yang 1999).

<sup>4</sup>Though China's population control policy has brought the total fertility rate down from 5 to 1.8 percent over the period of 1970-95, China did not achieve its goal of stabilizing population at 1.2 billion in 2000. Instead, the total population grew over 1.3 billion and its projectory is towards 1.5 billion by 2025. For issues concerning China's population policy, the reader is referred to Scotese and Wang (1995).

<sup>5</sup>Conventional urban matching models do not consider the stochastic nature of the search process. For example, see Helsley and Strange (1990) and Abdel-Rahman and Wang (1995).

<sup>6</sup>For simplicity, we (harmlessly) ignore those who currently reside in the city, since our focus is on the process of rural to urban migration.

<sup>7</sup>Laing, Park, and Wang (2002) consider the *dynamics* of migration between the city and rural areas.

<sup>8</sup>Recall that all,  $1 - N$ , legally registered workers move to the city. This means that at the margin, it is the decisions of the  $N$  non registered migrants that is crucial.

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