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On the Interaction Between Migration, Capital Formation, and the Price for Housing Services*

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Abstract

We theoretically investigate the effects of interregional labor market integration on the dynamic interaction between migration flows, capital formation, and the price for housing services. The nature of this interaction depends on initial conditions at the time of labor market integration. In an initially capital-poor economy, there may be a reversal of migration flows during the transition to the steady state, like observed in Eastern Europe after 1990. In a high-productivity country which attracts immigrants, the price for housing services and the rental rate of land increase along with (residential) capital investments. Welfare effects are heterogeneous: whereas landless individuals lose from immigration because of increases in the price for housing services, landowners may win because of an increasing rental rate of land.

Key words: Capital formation; Price for housing services; Land distribution; Migration; Welfare.

JEL classification: D90, F20, O10

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1 Introduction

Immigration leads to higher rental rates of both land and housing services. Increased housing costs trigger supply responses like residential investment. Thus, there is a potentially important interaction between migration and capital formation through changes in the price for housing services. The goal and novel contribution of this paper is to theoretically analyze this dynamic interaction and its welfare consequences.

We particularly focus on the dynamic effects of interregional labor market integration, which gives rise to free movement of labor across regions, on migration patterns, capital investment, the rental rate of land, and the price for housing services. We develop a neoclassical, overlapping-generations model with a tradable and a non-tradable goods sector. Production in the non-tradable goods sector is land-intensive and therefore interpreted as residential construction. Firms face capital stock adjustment costs in responding to migration by raising housing supply.

Our analysis predicts a causally positive effect of immigration (emigration), as triggered by labor market integration, on capital accumulation (decumulation). Which exact pattern emerges depends on differences in productivity and the initial population density across regions, which both affect the price for housing services. Productivity differences also determine wage differences. Differences in both wages and the price for housing services critically affect migration decisions.

Despite a *causally* positive effect of migration inflows on capital formation, we find that interregional flows of migration and regional changes in the stock of physical capital may go in either direction. Historically, there are examples for both possibilities. For instance, the first era of globalization in the 19th century was characterized by simultaneous capital and labor flows from Europe to the US (e.g. O'Rourke and Williamson, 1999; Solimano and Watts, 2005). Moreover, at least in an early phase of the enlargement process of the European Union (EU), labor was migrating from Southern and Eastern EU members to countries like Germany and the UK. However, temporarily, capital was flowing in the other direction or was accumulated faster in some emigration countries. Our analysis shows how initial conditions and the time

passed after labor markets integrate determine how migration flows are related to the capital accumulation process. If the initial capital stock is close to the pre-integration steady state level, the capital stock and the population density change in the same direction. However, if the capital stock is initially low, an emigration outflow may occur at the same time as the capital stock accumulates. The price for housing services falls shortly after labor market integration, associated with declining population density. Consequently, the migration pattern is reversed in later phases because of still positive (albeit reduced) net investments.

Thus, our model also provides a candidate explanation for the phenomenon of "reverse migration", i.e. aggregate (net) outward migration followed by aggregate (net) inward migration later on. For instance, Burda (2006) documents labor migration at a large scale from East to West shortly after the German reunification in 1990. More recently, the migration trend has been reversed in some regions in East Germany after 1990 along with an investment boom (e.g. Schäfer and Steger, 2014). Similarly, Poland experienced significant migration outflows most of the time in the post-WWII period which continued in the process of the EU enlargement. However, recently, the trend has been reversed. According to United Nations (2010), in the aftermath of becoming an EU member in 2004, there has been a positive net migration inflow of about 56,000 between 2007 and 2011.¹

We also investigate welfare effects of changes in the population density through changes in the price of housing and the rental rate of land. Welfare effects of interregional labor market integration are heterogeneous and depend on the ownership distribution of land. Whereas landless individuals lose from immigration because of increases in housing costs, landowners may win because of an increasing rental rate of land. In other words, the effects of an unequal distribution of land property are aggravated by immigration. Such distributional concerns have typically been neglected in the previous literature on labor market integration. They potentially help to under-

¹Another example of reverse migration is Ireland. According to United Nations (2010), Ireland experienced a net migration outflow of about 177,000 between 1980 and 1995, with a subsequent net migration inflow until 2010 of 383,000. However, labor market integration appears of minor importance for more recent migration patterns in Ireland.

stand and address reservations to immigration of certain groups in the host economy's population.

The key novelty of the paper is to examine the simultaneous interaction between migration, capital investment and the dynamics of housing costs and the rental rate of land. In addition to explaining stylized facts and analyzing welfare effects, this enables us to guide structural estimations of the determinants and effects of migration. Whereas a large literature on the dynamic effects of migration has emphasized the impact on the level and distribution of wages, we deliberately abstain from modeling productivity or wage effects of migration in most parts of our analysis.² Rather, we shift the focus to the (relative) price for land-intensive, non-tradable goods and the rental rate of land. For instance, Saiz (2003, 2007) and Nygaard (2011) find substantial effects of immigration on rental rates and sales prices for housing in the US and UK, respectively. Jeanty, Partridge and Irwin (2010) estimate a two-equation spatial econometric model which captures the two-way interaction between net migration and the price for housing services. Employing data from the metropolitan area of Michigan, they find that a one percentage point increase in population growth leads to a 0.24 percent increase in housing costs. Similarly, Gonzalez and Ortega (2013) present instrumental-variable estimates for Spain, suggesting that the annual increase in population size of 1.5 percent in the time period 2001-2010 has led to both substantially higher prices for housing services and a boom in residential construction. Our theory is consistent with the evidence on *causally* positive effects of immigration on the price for housing services and residential construction, while at the same time being able to explain that capital and labor may flow in opposite directions. It suggests that the surge in the price for housing services taking place in regions experiencing long run increases in population density are permanent despite long run adjustments in the supply of housing services.

²This is motivated by the rather small labor market effects suggested by empirical evidence. For instance, Friedberg (2001) and Dustmann, Fabbri, and Preston (2005) show that immigration to Israel and the UK, respectively, only slightly reduces wages of low-skilled workers. It may even moderately raise wages of high-skilled workers. For the US, Borjas (2003) reports significant negative wage effects of immigration for low-skilled workers. By contrast, Ottaviano and Peri (2012), by taking into account the substitutability between migrants and natives of similar education and experience levels, do not find any negative effect.

There is a sizable literature on the relationship between capital formation and interregional labor mobility.³ Typically, scholars employ models with increasing returns to scale to explain non-monotonic time paths of a region's population size,⁴ whereas standard neoclassical models do not explain reversed migration flows. For instance, Rappaport (2005) and Burda (2006) study one-sector models with capital adjustment costs, exogenous interest rates and interregional labor mobility. However, their focus is on wage convergence rather than on the effects of migration on the price for housing and land rental as in our two-sector model. Rappaport (2005) argues that higher labor mobility, which triggers increased outflows of workers, does not necessarily increase the speed of income convergence. For a given capital stock, emigration leads to increased wages in the source country. However, emigration also drives down the shadow value of capital and therefore slows down capital investment. The latter effect results in delayed income convergence. Burda (2006) studies the dynamics of labor migration and capital accumulation under factor adjustment costs. In his model, per capita income of the East German economy converges to the West German level as labor moves towards West Germany and capital accumulates in the East. Our model is capable to generate non-monotonic transitions despite resting on constant returns to scale.

The paper is organized as follows. Section 2 presents the basic model in which individuals earn labor income only. Section 3 derives the dynamic system for the basic model, solves for the steady state and provides analytical results. In section 4, we numerically solve for the transition path to the steady state in response to labor market integration under different scenarios. Section 5 first discusses the implications

³For an extensive literature survey, see Felbermayr, Grossmann and Kohler (2014). There is also a large literature on the dynamics of regional development which emphasize agglomeration effects, as surveyed in Breinlich, Ottaviano and Temple (2013). We do not discuss this literature here as it typically abstracts from capital accumulation whereas we emphasize the interaction between migration and capital formation, particularly in the housing services sector.

⁴Faini (1996) contrasts models of exogenous and endogenous growth, arguing that income convergence is not necessarily less likely in the case of learning-by-doing effects. Reichlin and Rustichini (1998) employ an endogenous growth model with learning-by-doing effects to show that immigration enhances interregional wage differences due to a scale effect, benefitting the receiving destination. On the other hand, migration may change the skill composition of the workforce in a way which may also benefit the source economy. Schäfer and Steger (2014) emphasize how equilibrium selection and dynamics depend on both expectations and initial conditions in a multi-region model where increasing returns give rise to multiple equilibria.

of our analysis for empirical estimations of the determinants and effects of migration, also briefly alluding to empirical evidence. Moreover, we extend the basic model to examine distributional effects of labor market integration when individuals differ in their ownership of land. Finally, we introduce capital accumulation in the tradable goods sector, allowing for wage effects of migration. The last section concludes.

2 The Basic Model

Consider a simple overlapping generations model of two perfectly competitive economies ("domestic" and "foreign"). Labor market integration allows individuals to move between the two regions. There are two sectors, a tradeable goods sector and a non-tradable goods sector. Labor can be employed in both sectors and reallocated without any frictions. There is international capital mobility at an (exogenous) interest rate $r > 0$. We distinguish the cases of interregionally immobile and mobile labor, investigating the effects of labor market integration. Time is discrete and indexed by $t = 0, 1, 2, \dots$

2.1 Domestic Economy

We first characterize the domestic economy.

2.1.1 Firms

The non-tradable goods sector, denoted by superscript N , produces with labor, physical capital and a fixed factor which we refer to as land. We interpret the sector as housing services sector. Output Y^N in period t is given by

$$Y_t^N = b (L_t^N)^\alpha (K_t)^\beta Z^{1-\alpha-\beta}, \quad (1)$$

$b > 0$, $\alpha, \beta \in (0, 1)$, $\alpha + \beta < 1$, where K is the amount of physical (residential) capital, L^N the amount of labor employed in the non-tradable goods sector, and Z is the time-

invariant land input (which equals land supply).⁵ The capital stock evolves according to⁶

$$K_{t+1} = I_t + (1 - \delta)K_t, \quad (2)$$

where I is gross investment in the housing services sector in terms of the tradable good, $\delta > 0$ is the depreciation rate and $K_0 > 0$ is given. There are (convex) capital-adjustment costs in the non-tradable goods sector (see Abel, 1982; Hayashi, 1982). The typical firm, taking goods and factor prices as given, solves the following dynamic problem:

$$\max_{\{L_t^N, I_t, Z\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \frac{p_t^N Y_t^N - w_t L_t^N - p_t^Z Z - I_t \left[1 + \theta \left(\frac{I_t}{K_t} \right)^\eta \right]}{(1+r)^t} \quad \text{s.t. (1), (2),} \quad (3)$$

$\theta, \eta > 0$, where p^N denotes the price of the non-tradable good, w is the wage rate, and p^Z is the rental rate of land.

The tradable goods sector, denoted by superscript T , is chosen as numeraire (i.e. output price $p^T \equiv 1$). For simplicity, its firms produce with labor as the only input.⁷ Output Y^T is given by

$$Y_t^T = aL_t^T, \quad (4)$$

$a > 0$, where L^T denotes the amount of labor employed in the tradable goods sector. Since the labor market is perfect, the wage rate equals the (constant) labor productivity in the tradable goods sector, $w = a$. Thus, w is unaffected by migration.

For simplicity, we assume that firms in the non-tradable goods sector are owned by foreigners. In the basic model, the same applies to the fixed factor, land. In an extension of the model in section 5, we examine the welfare consequences of migration when land is owned by natives and unequally distributed.

⁵The time index t is sometimes omitted, provided that this may not lead to confusion.

⁶For simplicity, we assume that the non-tradable good fully depreciates. The important feature is that the (residential) capital stock in this sector may accumulate over time.

⁷At the end of section 5, we modify the production technology such that output of the tradable good is produced with both labor and capital under constant returns. By analyzing first the basic model, we shut down the (empirically weak) link between migration and wages, in order to focus on the effects of migration which interact with the market for housing services.

2.1.2 Households

Each individual lives for two periods ("working-age" and "retirement") and has one child when old, i.e. the size of the native population remains constant over time. In the first period, each individual supplies one unit of labor when young to the sector with the highest wage and chooses how much to save (or borrow). Moreover, individuals decide at the beginning of the first period whether to stay or to migrate to the large economy, seeking to maximize utility. Our simple overlapping-generations structure allows us to focus on a one-shot migration decision of workers.

Also for simplicity, in the case of integrated labor markets, we abstain from imposing limits to labor flows exogenously via assuming psychological migration costs, institutional migration barriers, monetary moving costs or labor adjustment costs of firms. We rather focus on endogenous changes in the prices for housing services in response to migration to limit migration flows despite persistent wage differentials. Thereby, migration flows are endogenously smoothed along with adjustments in the capital stock. In any period, equilibrium utility of (similarly endowed) individuals is equalized across regions.

Let $c_{1,t}^T$ and $c_{1,t}^N$ denote the amount of tradable and non-tradeable goods consumed by a working-age individual born in t , respectively. Analogously, $c_{2,t+1}^T$ and $c_{2,t+1}^N$ are consumption levels during retirement. Life-time utility of an individual born in period t is given by

$$U_t = u(c_{1,t}^T, c_{1,t}^N) + \rho \cdot u(c_{2,t+1}^T, c_{2,t+1}^N), \quad (5)$$

where $\rho \in (0, 1)$. The instantaneous utility function reads $u(c^T, c^N) = \gamma \log(c^T) + (1 - \gamma) \log(c^N)$ with $\gamma \in (0, 1)$.

Recalling that $p^T = 1$, each individual solves

$$\max_{c_{1,t}^T, c_{1,t}^N, c_{2,t+1}^T, c_{2,t+1}^N} U_t \quad \text{s.t.} \quad c_{1,t}^T + p_t^N c_{1,t}^N + \frac{c_{2,t+1}^T + p_{t+1}^N c_{2,t+1}^N}{1 + r} \leq W_t, \quad (6)$$

where W is the present discounted value of income from the perspective of a young individual. Since in the basic model individuals receive labor income only, we have

$W = w = a$.

The number of workers (i.e. the number of young individuals) in period t is denoted by L_t . Thus, total population size in period t is given by $S_t := L_t + L_{t-1}$. The number of initially old natives, $L_{-1} > 0$, is given. In the case where labor is not interregionally mobile, $L_t = L_{-1}$ and $S_t = 2L_{-1}$ for all $t \geq 0$, since each period the same number of individuals is born. Denote the population density by $D^S := \frac{S}{Z}$, where $D_{-1}^S > 0$ is given.

2.2 Foreign Economy

The foreign economy is assumed to be in a steady state and is large in the sense that migration from or towards the domestic economy has no effect on its population density, denoted by D^{S*} . It is therefore time-invariant. Productivity levels in the tradable and non-tradable goods sector of the foreign economy, a^* and b^* , may differ from the domestic levels, a and b . In all other respects than productivity levels and the population density, the domestic and the foreign economy are initially identical such that the steady state before labor market integration is analogous.

3 Equilibrium Analysis

We analyze the equilibrium from the point of view of the domestic economy if not explicitly stated otherwise.

For simplicity, we assume that the following standard relationship between the interest rate and the discount rate holds:

$$\rho(1 + r) = 1. \tag{7}$$

Lemma 1. *The goods demand structure of an individual born in t (solution of optimization problem (6)) is given by*

$$c_{1,t}^T = c_{2,t+1}^T = \frac{\gamma}{1+\rho} W_t, \quad (8)$$

$$c_{1,t}^N = \frac{1-\gamma}{1+\rho} \frac{W_t}{p_t^N}, \quad c_{2,t+1}^N = \frac{1-\gamma}{1+\rho} \frac{W_t}{p_{t+1}^N}. \quad (9)$$

Consequently, individual welfare reads as

$$U_t = (1+\rho) \log \left(\frac{\gamma^\gamma (1-\gamma)^{1-\gamma}}{1+\rho} W_t \right) - (1-\gamma) [\log p_t^N + \rho \log p_{t+1}^N] \equiv V(W_t, p_t^N, p_{t+1}^N). \quad (10)$$

All proofs are relegated to the appendix. Lemma 1 shows that life-time utility V is decreasing in the price of the non-tradable good, p^N , in both periods of life. Thus, if wages are the only source of income (not being affected by immigration) and if immigration raises the price for housing services, then immigration has an unambiguously negative effect on welfare. Obviously, this could change if immigration had positive wage effects, a channel from which we deliberately abstract in the basic model (see, however, section 5).

Denote by V^* the (steady state) life-time utility of an individual who lives in the foreign economy. Moreover, denote by q the shadow price of capital, i.e. the multiplier to capital accumulation constraint (2) in the profit maximization problem (3) of the non-tradable goods sector.

An equilibrium is defined as follows.

Definition 1. *An equilibrium consists of time paths for quantities $\{L_t, L_t^T, L_t^N, K_{t+1}, I_t, Y_t^N, Y_t^T, c_t^N, c_t^T\}_{t=0}^\infty$ and prices $\{p_t^N, q_t, w_t, p_t^Z\}_{t=0}^\infty$ such that the capital stock evolves according to (2) and it holds in any period that*

1. *firms maximize the present discounted value of their cash flow;*
2. *households maximize life-time utility;*
3. *if and only if labor is interregionally mobile, life-time utility of domestic residents equals life-time utility in the foreign economy, $V(w_t, p_t^N, p_{t+1}^N) = V^*$;*

4. *the wage rate is equal across sectors;*
5. *the labor market clears, $L_t^N + L_t^T = L_t$;*
6. *the market for non-tradables clears, $Y_t^N = c_{1,t}^N L_t + c_{2,t}^N L_{t-1}$.*

Conditions 1, 2 and 5 are straightforward. Equilibrium condition 3 holds since individuals can costlessly migrate if labor is interregionally mobile.⁸ Condition 4 holds since individuals are perfectly mobile across sectors and seek the sector with the highest wage. To understand condition 6, recall that the non-tradable good cannot be used for investment purposes. Also note that, in period t , $c_{1,t}^N L_t$ is the total goods demand for non-tradables of young agents and $c_{2,t}^N L_{t-1}$ is the total goods demand for non-tradables of old agents. We next solve for the equilibrium.

3.1 Exogenous Increase in Population Density

We start with the simple case where the population density, $D^S := \frac{S}{Z}$, is exogenous before we turn to endogenous migration. Define $D^K := \frac{K}{Z}$ and $D^I := \frac{I}{Z}$, as the (residential) capital stock per unit of land ("capital density") and gross investment per unit of land ("investment density"), respectively. Note that $D_0^K = \frac{K_0}{Z} > 0$.

Proposition 1. *Suppose that the sequence of population density $\{D_t^S\}_{t=0}^\infty$ is given.*

(i) *The capital density (D_t^K), the investment density (D_t^I), the shadow value of capital (q_t), the price of the non-tradable good (p_t^N) and the rental rate of land (p_t^Z) jointly evolve over time according to a saddle-point stable system which is given by*

$$D_{t+1}^K = D_t^I + (1 - \delta) D_t^K, \quad (11)$$

$$\frac{D_t^I}{D_t^K} = \left(\frac{q_t - 1}{(\eta + 1)\theta} \right)^{\frac{1}{\eta}}, \quad (12)$$

⁸Also recall that life-time income equals the wage rate in the basic model, $W = w$. Taking into account fixed migration costs in terms of utility loss, ζ , would not change the conclusions of our paper. In this case, the no-arbitrage condition would simply modify to $V(w_t, p_t^N, p_{t+1}^N) - V^* = \zeta$.

$$0 = (1 - \delta)q_{t+1} + p_{t+1}^N \beta b \left(\frac{\alpha(1 - \gamma)}{1 + \rho} \right)^\alpha (D_{t+1}^S)^\alpha (D_{t+1}^K)^{\beta-1} + \theta \eta \left(\frac{D_{t+1}^I}{D_{t+1}^K} \right)^{\eta+1} - (1 + r)q_t, \quad (13)$$

$$p_t^N = \frac{a}{b} \alpha^{-\alpha} \left(\frac{1 - \gamma}{1 + \rho} \right)^{1-\alpha} (D_t^K)^{-\beta} (D_t^S)^{1-\alpha}, \quad (14)$$

$$p_t^Z = \phi a D_t^S \equiv \tilde{p}^Z(D_t^S, a), \quad (15)$$

where $\phi \equiv \frac{(1-\alpha-\beta)(1-\gamma)}{1+\rho}$.

(ii) If D^S is time-invariant, then, in the long run, the capital density and the price of the non-tradable good are given by

$$D^K = \chi a D^S \equiv \tilde{D}^K(D^S, a), \quad (16)$$

$$p^N = \nu \frac{a^{1-\beta}}{b} (D^S)^{1-\alpha-\beta} \equiv \tilde{p}^N(D^S, a, b), \quad (17)$$

respectively, where $\chi \equiv \frac{\beta(1-\gamma)}{(1+\rho)[r(1+(1+\eta)\theta\delta^\eta)+\delta+\theta\delta^{\eta+1}]}$ and $\nu \equiv \left(\frac{1-\gamma}{1+\rho} \right)^{1-\alpha} \alpha^{-\alpha} \chi^{-\beta}$.

Corollary 1. Suppose that the population density, D^S , is exogenous.

(i) An increase in D^S , and/or an increase in total factor productivity (TFP) in the tradable goods sector, a , leads to a gradual increase in the capital density, D^K . The rental rate of land, p^Z , jumps upward and is constant thereafter. The price of non-tradables, p^N , also jumps upwards and then gradually declines to a level which exceeds the pre-shock level.

(ii) An increase in the TFP-level of the non-tradable goods sector, b , has neither an impact on capital formation nor on the rental rate of land, but leads to a downward jump of p^N .

For a given capital stock and in the long run, the price of the non-tradable good, p^N , rises with D^S , according to (14) and (17), respectively. This is because immigration leads to a dilution effect with respect to the fixed factor (land) when producing non-tradable goods. The effect of an exogenous increase in population density on p^N is mitigated if there is a supply response in the form of capital formation (increase in D^K), according to (14). For a given population density, D^S , adjustment of the capital

density, D^K , to the steady state is gradual. The capital density (including its long run level, \tilde{D}^K) is increasing in D^S for two reasons. First, an increase in D^S triggers higher employment in both sectors, stimulating capital investments due to the complementarity between capital and labor. Second, the immediate increase in p^N , due to an increase in D^S , raises the shadow value of capital, q , too.

According to (15), in any period, the rental rate of land, p^Z , is independent of the capital density, D^K , and proportional to the population density, D^S . An increase in D^K has two counteracting effects on p^Z , which cancel out. First, an increase in D^K raises the value of the marginal product of land for a given price of non-tradables, p^N . Secondly, however, the decrease in p^N which is associated with an increase in D^K lowers the value of the marginal product of land. By contrast, an increase in D^S raises the value of the marginal product of land for a given price of non-tradables, p^N , and through an increase in p^N (as argued above), thereby raising the rental rate of land.

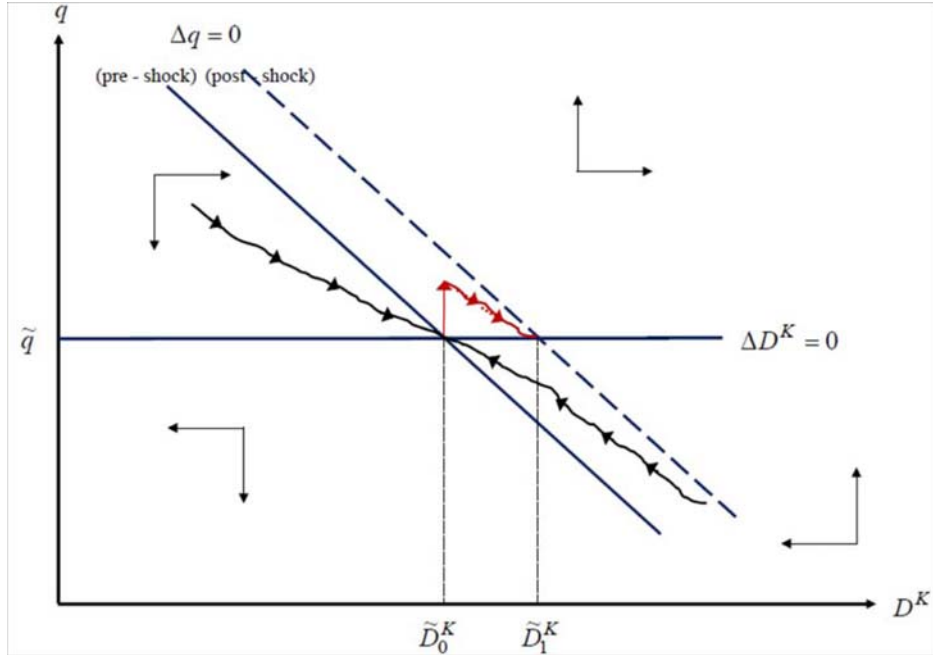


Figure 1: Phase diagram in D^K-q -space and the impact of an increase in population density, D^S .

Fig. 1 illustrates the impact of an increase in population density D^S (exogenous

immigration) on the difference-equation system which governs the dynamics of the capital density, D^K , and the shadow value of capital, q , starting from an initial steady state.⁹ As is easy to see, the locus implied by (11) in $D^K - q$ -space which refers to a time-invariant capital density ($\Delta D^K = 0$) is unaffected. By contrast, the locus implied by (13), which refers to a time-invariant shadow price of capital ($\Delta q = 0$), shifts up. Consequently, for a given initial steady state capital density (\tilde{D}_0^K), the shadow price of capital jumps upwards, triggering gradual adjustment on the saddle path to the new steady state (with capital density $\tilde{D}_1^K > \tilde{D}_0^K$). The implied capital formation mitigates the initial jump in p^N in the further transition.

Qualitatively, the impact of an increase in productivity of the tradable goods sector a is similar to the impact of an exogenous increase in the population density. Since an increase in a raises output of the tradable good for given inputs, it raises the relative price of non-tradables, p^N . Consequently, it spurs capital accumulation in the non-tradable goods sector. By contrast, an increase in the TFP-level of the non-tradable goods sector, b , by raising supply of non-tradable goods for given inputs, has a negative effect on p^N . However, for given p^N , it also raises the marginal productivity of inputs. With respect to capital formation and the rental rate of land, both effects cancel out.

3.2 The Effects of Labor Market Integration

We now turn to the case where labor is interregionally mobile (endogenous migration).

Proposition 2. *Suppose that labor is interregionally mobile.*

(i) *The sequence $\{q_t, D_t^K, D_t^I, D_t^S, p_t^N, p_t^Z\}_{t=0}^\infty$ is jointly determined by (11)-(15) and*

$$(1 + \rho) \log \left(\frac{a}{a^*} \right) = (1 - \gamma) \left[\log \left(\frac{p_t^N}{p^{N*}} \right) + \rho \log \left(\frac{p_{t+1}^N}{p^{N*}} \right) \right], \quad (18)$$

where $p^{N*} = \tilde{p}^N(D^{S*}, a^*, b^*)$.

⁹Locus $\Delta D^K = 0$ follows from using (12) in (11), whereas locus $\Delta q = 0$ can be derived by using (11), (12) and (14) in (13).

(ii) In steady state, the population density \tilde{D}^S is given by

$$\tilde{D}^S = \left[\left(\frac{a}{a^*} \right)^{\frac{1-(1-\beta)(1-\gamma)}{1-\gamma}} \left(\frac{b}{b^*} \right) \right]^{\frac{1}{1-\alpha-\beta}} D^{S*}. \quad (19)$$

With respect to the steady state, the following comparative-static results hold.

Corollary 2. *Suppose that labor is interregionally mobile.*

(i) \tilde{D}^S is increasing in the relative productivity level across regions of both sectors, $\frac{a}{a^*}$ and $\frac{b}{b^*}$.

(ii) \tilde{D}^S is proportional to the foreign population density, D^{S*} .

An increase in relative productivity across regions of the tradable goods sector, $\frac{a}{a^*}$, has two counteracting effects on the steady state labor force of the domestic economy when labor is interregionally mobile. First, since $\frac{a}{a^*}$ is the relative wage rate (and thus relative income) of individuals across regions, the domestic economy becomes more attractive for workers. Second, as implied by part (i) of Corollary 1, for a given population density, it also raises the price of non-tradables in the domestic region relative to the one in the foreign region, $\frac{p^N}{p^{N*}}$; in turn, this lowers the attractiveness of the domestic economy for workers. The first effect dominates the second one. By contrast, an increase in the relative productivity of the non-tradable goods sector, $\frac{b}{b^*}$, has no income effect. However, for given labor inputs, it lowers $\frac{p^N}{p^{N*}}$, making the domestic economy more attractive. Finally, an increase in the foreign population density, D^{S*} , raises the price of non-tradables in the foreign economy, p^{N*} , and therefore enhances attractiveness of the domestic economy.

We next examine the dynamic effects of labor market integration on the key variables. We emphasize the role of initial conditions for factor flows, the price of non-tradables, and the rental rate of land.

Proposition 3. *Suppose that, initially, the labor market is closed interregionally. Opening up the labor market leads to the following effects:*

(i) If the economy is initially in steady state and $D_{-1}^S < (>) \tilde{D}^S$, the long run levels of the capital density (D^K), the price for non-tradables (p^N) and the rental rate of land (p^Z) are higher (lower) than their initial levels.

(ii) If the initial capital density is below its post-integration steady state value (i.e. $D_0^K < \tilde{D}^K(\tilde{D}^S, a)$), then emigration may go along with capital formation during the transition to the steady state equilibrium.

(iii) The price of non-tradables (p^N) instantaneously jumps to its new steady state level.

Suppose first that the population density under a closed labor market is initially lower than its steady state value after labor market integration ($D_{-1}^S < \tilde{D}^S$). Under the presumption in part (i) of Proposition 3, this means that $D_0^K = \tilde{D}^K(D_{-1}^S, a) < \tilde{D}^K(\tilde{D}^S, a)$, $p_0^N = \tilde{p}^N(D_{-1}^S, a, b) < \tilde{p}^N(\tilde{D}^S, a, b)$, $p_0^Z = \tilde{p}^Z(D_{-1}^S, a) < \tilde{p}^Z(\tilde{D}^S, a)$; that is, when starting in steady state, the capital density and the prices of both non-tradables and land will be higher in the long run than initially in response to labor market integration. The opposite holds if $D_{-1}^S > \tilde{D}^S$. Next, suppose $D_0^K < \tilde{D}^K(\tilde{D}^S, a)$, as presumed in part (ii) of Proposition 3. Thus, in the long run, the economy ends up with an increased capital density. A low initial capital density also means that the initial price of non-tradables may be relatively high, according to (14), making the domestic economy rather unattractive. Thus, as illustrated in section 4, emigration and capital formation may occur as an immediate response to labor market integration. In the aftermath, as capital still accumulates (reflecting the standard neoclassical convergence mechanism), the migration flow will be reversed. Finally, as regards part (iii) of Proposition 3, an integration shock leads to an instantaneous jump in the price of non-tradables, p^N , following the jump in the population density on impact. One period after the integration shock, the labor force and the capital stock evolve in the same direction during the remaining transition. Whereas a rising population density (D^S) raises p^N , an increasing capital density (D^K) lowers p^N . Both effects exactly cancel in the basic model.

Notably, the effect on p^N in the case of endogenous migration is different than in

the case of exogenous migration, where a labor inflow first led to a jump in p^N with gradual decreases in p^N along with capital formation thereafter (part (i) of Corollary 1).

4 Numerical Analysis

We now turn to numerical analysis in order to further investigate the role of initial conditions for the relationship between capital formation and migration in response to labor market integration. Moreover, we examine the evolution of the price for non-tradables, the rental rate of land, the shadow price of capital, and gross investment over time. The numerical analysis serves to illustrate Proposition 3 and provides further insights on transitional dynamics.¹⁰

4.1 Calibration

We employ the following baseline calibration. Assuming an annual real interest rate of 2 percent and a length of a generation of about 35 years suggests that $r = 1$; thus $\rho = 0.5$, according to (7). Empirical evidence points to a budget share on housing of about one third (e.g. Johnson, Rogers and Tan, 2001), which suggests $\gamma = \frac{2}{3}$. Moreover, we set $\delta = 0.5$, which reflects an annual depreciation rate of about 2 percent in a period of 35 years. We also employ the standard quadratic specification of capital stock adjustment costs, which means that we set $\eta = 1$. In addition, we assume $\theta = 0.5$ which implies that, in a steady state with $\frac{I}{K} = \delta = 0.5$, one unit of gross investment requires $1 + \theta \left(\frac{I}{K}\right)^\eta = 1.25$ units of the tradable good. For output elasticities in the non-tradable goods sector, we set $\alpha = 0.5$ and $\beta = 0.3$. Finally, we normalize the foreign (exogenous) population density to $D^{S*} = 1$.¹¹

¹⁰We shall emphasize that, despite attempting a reasonable calibration of parameter values, our goal is to characterize transitional dynamics qualitatively rather than quantitatively. For a quantitative analysis, our two-period overlapping-generations structure with full depreciation of the non-tradable good is too stylized. It is this simplicity though which allows us to gain solid intuitions on the economic mechanisms.

¹¹We do not have to calibrate the land size, Z . All endogenous variables can be expressed relative to Z , as apparent from the dynamic system in Proposition 1 and 2.

4.2 Labor Market Integration

We now visualize the effects of labor market integration on the evolution of the population density, $D^S = \frac{S}{Z}$, the capital density, $D^K = \frac{K}{Z}$, the investment density, $D^I = \frac{I}{Z}$, the shadow price of capital, q , the rental rate of land, p^Z , and the price of non-tradables, p^N .

In Fig. 2 (a), the economy is initially in its pre-labor-market-integration steady state, which corresponds to the case in part (i) of Proposition 3. Moreover, we assume that, initially, the population density coincides with that of the foreign economy, $D_{-1}^S = D^{S*} = 1$. Productivity levels are 10 percent higher compared to the foreign economy, i.e. $\frac{a}{a^*} = \frac{b}{b^*} = 1.1$. That is, the initial population density is below its post-integration long run level, $D_{-1}^S < \tilde{D}^S$ (use (19)), and the initial capital density reads as $D_0^K = \tilde{D}^K(D_{-1}^S, a)$. This constellation may be interpreted as the case of an advanced economy which opens up the labor market to another region or country.

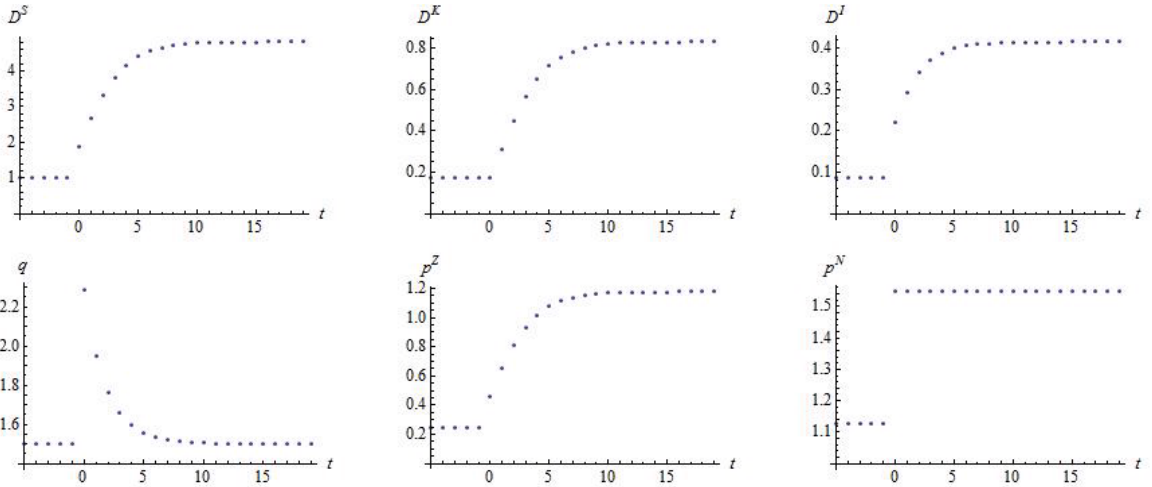


Figure 2 (a): The impact of labor market integration in period $t = 0$ on a high-productivity economy which initially has the same population density as abroad and is in steady state.

Note: $a = b = 5.5$, $a^* = b^* = 5$, $D_0^K = \tilde{D}^K(D_{-1}^S, a)$, and $D_{-1}^S = D^{S*} = 1 < \tilde{D}^S$.

Now, when the labor market is opened up in period $t = 0$, the population density, D^S , jumps upwards and then gradually increases along with an increasing capital

density. The migration inflow, induced by a comparably high domestic wage rate, raises the demand for non-tradables and triggers an increase in the price of non-tradables, p^N , as well as an increase in the rental rate of land, p^Z . The upward jump in p^N represents a drag on further migration inflows. In line with part (iii) of Proposition 3, p^N instantaneously jumps to its new steady state level, as displayed in the last panel of Fig. 2 (a). Also the shadow value of installed capital, q , goes up, fostering higher investment. Consequently, the capital stock rises.

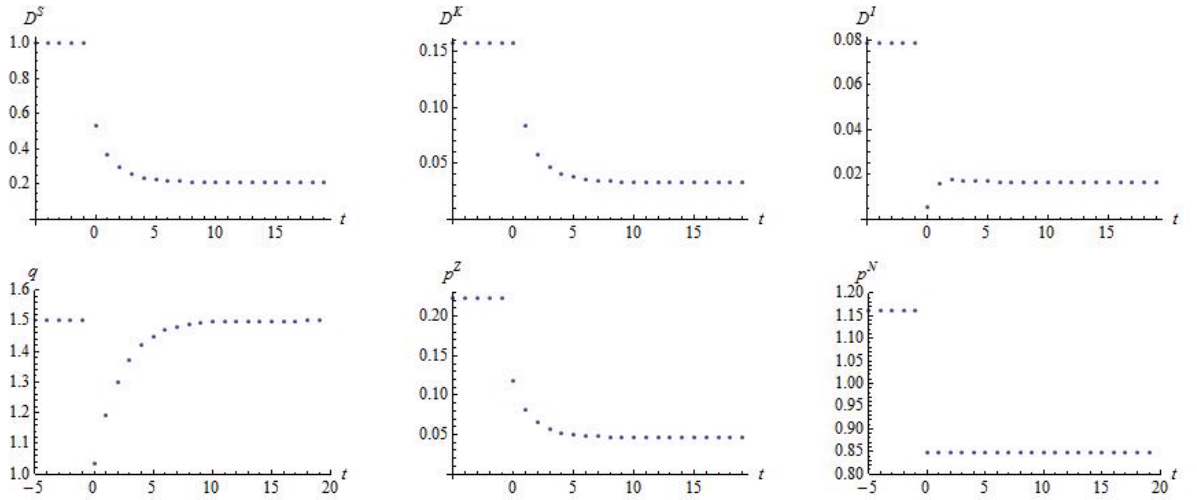


Figure 2 (b): The impact of labor market integration in period $t = 0$ on a low-productivity economy which initially has the same population density as abroad and is in steady state.

Note: $a = b = 5$, $a^* = b^* = 5.5$, $D_0^K = \tilde{D}^K(D_{-1}^S, a)$, and $D_{-1}^S = D^{S*} = 1 > \tilde{D}^S$.

In Fig. 2 (b), as before, the economy is initially in its pre-labor-market-integration steady state and $D_{-1}^S = D^{S*} = 1$. Productivity levels are now about 9 percent lower compared to the foreign economy, i.e. $\frac{a}{a^*} = \frac{b}{b^*} = \frac{10}{11} \cong 0.91$. That is, the initial population density is now above its post-integration long run level, $D_{-1}^S > \tilde{D}^S$. When the labor market is opened up in period $t = 0$, the population density, D^S , jumps downwards and then gradually declines, as does the capital density. Negative net investments are induced by a decline in the shadow value of installed capital, q . The migration outflow also reduces the demand for non-tradables, which is followed by a

decrease in both the price of non-tradables, p^N , and the rental rate of land, p^Z . The downward jump in p^N represents a drag on further migration outflows.

In sum, if the initial capital stock is at the pre-labor-market-integration steady state level, we observe emigration (immigration), lower (higher) housing costs, a lower (higher) rental rate of land, and capital decumulation (accumulation) at the same time.

For Fig. 3 we assume that domestic productivity levels are equal to the foreign economy, i.e. $a = a^*$ and $b = b^*$. Eq. (19) then implies that the post-integration long run population density coincides with that of the foreign economy, $\tilde{D}^S = D^{S*} = 1$. Suppose the initial population density is also equal to this value ($D_{-1}^S = D^{S*}$). However, let the initial capital density be lower than the post-integration value, $D_0^K < \tilde{D}^K(\tilde{D}^S, a)$. The solid time paths of Fig. 3 illustrate transitional dynamics provided that the labor market is opened up at $t = 0$. The dotted lines show, in contrast, economic development under the alternative assumption of closed labor markets.

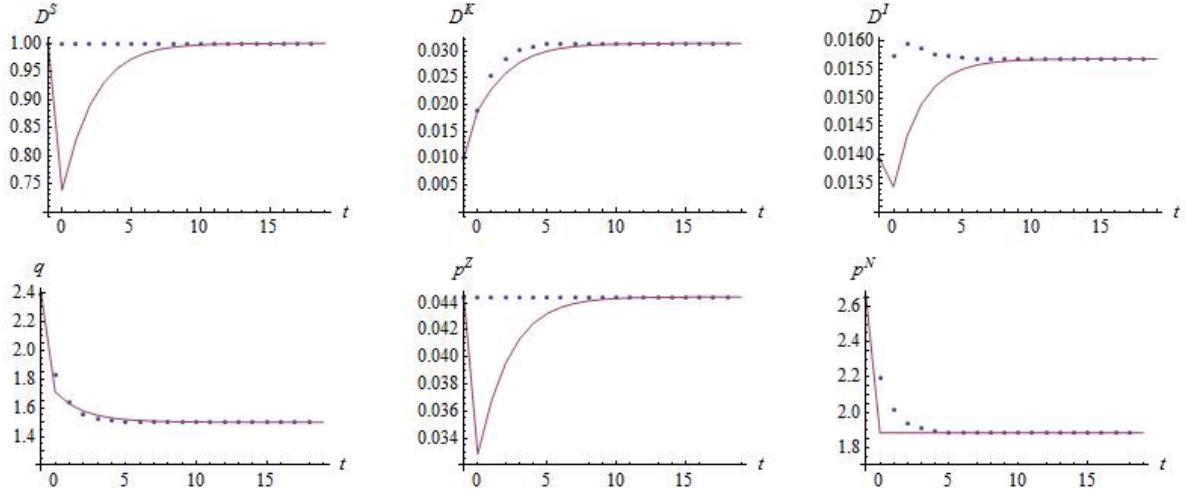


Figure 3: Solid lines show dynamic responses assuming labor market integration at $t = 0$ for an initially capital-poor economy with the same population density as abroad. Dotted lines show dynamic responses assuming that labor markets remain closed. Note:

$$a = a^* = b = b^* = 5, D_0^K < \tilde{D}^K(\tilde{D}^S, a), D_{-1}^S = \tilde{D}^S.$$

The solid lines in Fig. 3 illustrate part (ii) of Proposition 3, i.e. the possibility that

emigration may go along with capital accumulation after labor markets integrate. We see that the population density considerably falls below $D^{S*} = \tilde{D}^S$ immediately after the integration shock. Therefore, also the shadow value of capital drops, leading to a lower investment density, D^I . Nevertheless, as q is still above its steady state level (reflecting the standard neoclassical convergence force), there is still capital accumulation. Over time, and after the immediate response of D^S to integration, population density rises along with capital accumulation. This explains why the rental rate of land, p^Z , rises after its initial drop. The price of the non-tradable good, p^N , again jumps immediately to the new steady state level. As argued in the discussion of part (iii) of Proposition 3, the effect of the gradually increase in both D^S and D^K on p^N cancel out such that p^N remains unchanged below its pre-integration level during the transition. The case in Fig. 3 provides a candidate explanation for a reversal of migration flows, for instance, in line with the recent experience in Poland and East Germany. Turning to the alternative scenario of closed labor markets (dotted lines), where D^S remains constant, D^I is larger than in the case of labor market integration and resulting emigration, such that capital gets accumulated more quickly. The rental rate of land, p^Z , does not drop and the price for non-tradables, p^N , declines gradually, which reflects the absence of emigration.

Reverse migration cannot be explained by standard neoclassical models (Braun, 1993; Rappaport, 2005; Burda, 2006). To understand why, it is worth pointing out a salient difference between our model and standard neoclassical models of migration and capital mobility (based on some form of convex adjustment costs for both capital and labor). In our model, labor is a jump variable, being determined by the no-arbitrage condition $V(w_t, p_t^N, p_{t+1}^N) = V^*$ (see Definition 1), and not a sluggish state variable.

5 Discussion and Extensions

In this section we first discuss the implications of our analysis for structural estimations of the interaction between migration, the price for housing services, and residential capital investment. It thereby helps to avoid misspecifications in empirical analyses.

We also highlight some empirical evidence which is strongly related to our theoretical framework. Second, we extend our framework by allowing for heterogenous landownership in order to examine the effects of labor market integration for the distribution of individual welfare. Finally, we also allow for capital as input into the tradable goods sector, implying wage effects of migration.

5.1 Implications for Empirical Analysis and Evidence

Our analysis has emphasized the interaction between migration flows (determining population density) and the price for housing services, taking into account capital formation in the housing services sector. The two-way interaction suggests that any empirical analysis of the relationship between population density and the price for housing services may run into severe endogeneity problems (also see the discussion in Jeanty et al., 2010, as well as Gonzalez and Ortega, 2013). We now discuss how our theory could help to identify causal effects.

We start with the determinants of migration flows. Empirical studies have emphasized the role of wage differences across regions for migration flows (e.g. Grogger and Hanson, 2011).¹² In our basic model, these are rooted in productivity differences in the tradable goods sector. In addition, our analysis highlights differences in the price for housing services as determinant for migration flows, as reflected in equilibrium condition 3 of Definition 1. However, the causality also runs in the opposite direction: using the expression (17) for the steady state price of non-tradable goods, \tilde{p}^N , differences in sectoral productivity across regions as well as differences in population density affect long-run differences in the price for housing services. Regressing migration flows on interregional differences in the price for housing services via OLS is thus subject to potentially severe omitted variable bias. According to (19) in Proposition 2, the long

¹²Other important determinants of bilateral migration flows are like in gravity-type estimations of trade flows, including distance between countries, whether source and destination share a common language, institutional mobility barriers, among other factors which potentially affect mobility costs. Beine, Docquier and Ozden (2011) also stress migrant networks as an important trigger for further immigration. Felbermayr et al. (2014) provide an overview on the gravity-type framework in the context of international migration.

run difference in the log of population density across regions depends on the differences in the log of sectoral productivity levels:

$$\log \left(\frac{\tilde{D}^S}{D^{S*}} \right) = \lambda_1 \log \left(\frac{a}{a^*} \right) + \lambda_2 \log \left(\frac{b}{b^*} \right), \quad (20)$$

where $\lambda_1 \equiv \frac{1-(1-\beta)(1-\gamma)}{(1-\gamma)(1-\alpha-\beta)}$ and $\lambda_2 \equiv \frac{1}{1-\alpha-\beta}$. Moreover, during the transition, migration patterns which evolve from labor market integration critically depend on the initial capital density as well (Proposition 3). All of these exogenous determinants of migration flows also affect interregional differences in the price for housing services.

We now turn to the effects of migration. Our model implies that the *causal* relationship of immigration (emigration) flows to capital inflows (outflows) is unambiguously positive, although capital formation and emigration could occur at the same time, according to part (ii) of Proposition 3. As illustrated in Fig. 3, emigration slows down capital formation which may take place because of convergence forces when the initial capital density is low (see the time path of D^K). Similarly, the causal effect of immigration (emigration) on the rental rate of land, p^Z , and the price of housing, p^N , is positive (negative). Consistent with our theoretical predictions, Gonzalez and Ortega (2013) provide evidence based on regional data for Spain suggesting that instrumented changes in population density (where the instrument is based on past migration stocks of the foreign-born population in a region) are positively related to changes in the price for housing services and residential capital investments.

5.2 Landownership and Distributional Effects

So far we have assumed that land is not owned by individuals in the domestic economy. As will become apparent, the assumption was made for simplicity, i.e. is not salient for the insights emphasized so far. However, the previous analysis suggests that the price of the non-tradable good is higher than its initial level at all times after a shock which induces labor inflows. Thus, native individuals earning labor income only necessarily lose from immigration, according to (10).

In order to address distributional effects of migration, we now assume that initially land is fully owned by the L_{-1} old natives, where $z(i)$ denotes the landholding of individual i . Landowners bequeath their landholding to their child when leaving the scene, such that the number of landowners and the land distribution among natives is time-invariant. For the sake of realism, suppose that a non-negligible fraction of natives is landless (for a landless individual i , $z(i) = 0$).

In period t , a young individual i who stays in the domestic economy has a present discounted value of life-time income, $W_t(i)$, which is given by

$$W_t(i) = a + \frac{p_{t+1}^Z}{1+r} z(i) \quad (21)$$

(recall that the wage rate is $w_t = a$ and land is owned by old individuals). Life-time utility of individual i born in t is $V(W_t(i), p_t^N, p_{t+1}^N)$, where function V is given by (10).

5.2.1 Equilibrium Analysis

We again start with the case where population density is exogenous. The dynamic system modifies as follows.

Proposition 4. *Suppose that the sequence of population density $\{D_t^S\}_{t=0}^\infty$ is given and land is owned by old natives.*

(i) *The capital density (D_t^K), the investment density (D_t^I), the shadow value of capital (q_t), the price of the non-tradable good (p_t^N), and the rental rate of land (p_t^Z) jointly evolve over time according to (11), (12) and*

$$(1-\delta)q_{t+1} = (1+r)q_t - \theta\eta \left(\frac{D_{t+1}^I}{D_{t+1}^K} \right)^{\eta+1} - p_{t+1}^N \beta b (D_{t+1}^K)^{\beta-1} \left[\frac{\alpha(1-\gamma)}{a(1+\rho)} (aD_{t+1}^S + \rho(p_{t+2}^Z + p_{t+1}^Z)) \right]^\alpha, \quad (22)$$

$$p_t^N = \frac{1}{b} \left(\frac{a}{\alpha} \right)^\alpha \left(\frac{1-\gamma}{1+\rho} \right)^{1-\alpha} [\rho(p_{t+1}^Z + p_t^Z) + aD_t^S]^{1-\alpha} (D_t^K)^{-\beta}, \quad (23)$$

$$p_{t+1}^Z = \frac{1}{\rho} \left(\frac{1 + \rho}{(1 - \alpha - \beta)(1 - \gamma)} - \rho \right) p_t^Z - \frac{a}{\rho} D_t^S. \quad (24)$$

(ii) If D^S is time-invariant, then, in the long run, the rental rate of land, the capital density, and the price of the non-tradable good are respectively given by¹³

$$p^Z = \frac{\tilde{p}^Z(D^S, a)}{1 - 2\rho\phi} \equiv \hat{p}^Z(D^S, a), \quad (25)$$

$$D^K = \frac{\tilde{D}^K(D^S, a)}{1 - 2\rho\phi} \equiv \hat{D}^K(D^S, a), \quad (26)$$

$$p^N = \left(\frac{1}{1 - 2\rho\phi} \right)^{1-\alpha-\beta} \tilde{p}^N(D^S, a, b) \equiv \hat{p}^N(D^S, a, b). \quad (27)$$

It is useful to compare Proposition 4 with Proposition 1. First, the dynamics appear more complicated than in the case where natives do not own land. The reason is that individuals who will inherit land have to anticipate the future rental rate of land. Second, in the long run, the rental rate of land (p^Z), the capital density (D^K) and the price of non-tradables (p^N) exceed the levels of the case where nobody owns land by a constant factor: $\hat{p}^Z > \tilde{p}^Z$, $\hat{D}^K > \tilde{D}^K$, $\hat{p}^N > \tilde{p}^N$. The result reflects the declining marginal productivity of land: if natives receive land rents in addition to wage income, this raises the demand for all goods. However, since land is a fixed factor, it becomes more scarce. This raises the rental rate of land along with the price for housing services. As a consequence of the latter, incentives to accumulate (residential) capital are higher as well. Third, the distribution of land does not affect the dynamic system. The reason lies in the assumption of homothetic preferences, which implies that aggregate goods demand is independent of the income distribution.

We now turn to the equilibrium analysis for the case of interregionally mobile labor.

Lemma 2. *When landless individuals are indifferent whether or not to migrate, no landowner wants to migrate.*

¹³Recall from part (i) of Proposition 1 the parameter definition $\phi = \frac{(1-\alpha-\beta)(1-\gamma)}{1+\rho}$. Note that $\rho, \alpha, \beta, \gamma \in (0, 1)$ and $\alpha + \beta < 1$ imply $1 > 2\rho\phi$.

Lemma 2 suggests that the incentive to migrate is higher for landless individuals. The reason is simple. Land rents are received from the home region irrespective of the location decision, whereas wage income depends on the chosen location. Thus, income-related migration benefits come from wage differentials only. What matters for the migration decision are differences in the log of income across regions, capturing declining marginal utility from consumption. These differences are larger for landless individuals. We focus on an equilibrium where only (some) landless individuals migrate. For such an equilibrium to exist, the share of landless individuals has to be sufficiently large. In this case, the no-arbitrage condition (18) for the migration decision (equilibrium condition 3 of Definition 1) still holds, where now the price of non-tradables abroad is given by $p^{N*} = \hat{p}^N(D^{S*}, a^*, b^*)$. Consequently, the steady state population density is still given by (19) such that Corollary 2 applies.

Moreover, if we conduct the same numerical experiments as in section 4, the dynamics triggered by an integration shock are qualitatively the same as in the case where no individual owns land (available on request). That is, if labor markets are opened when the economy is in steady state initially, population density (D^S), capital density (D^K), and prices for both non-tradables (p^N) and land rental (p^Z) move into the same direction (Fig. 2 (a), (b)). When the economy is not in steady state at the time labor markets integrate, the population density and the capital density may move in different directions on impact and the migration flow may be reversed (Fig. 3).

5.2.2 Welfare

What are the effects of immigration on individual welfare, conditional on individual land endowment? Welfare effects now also run through changes in the rental rate of land (positively related to welfare for landowners by raising their income), in addition to changes in the price for housing (negatively related to welfare).

Long run For the long run, we find the following result.

Proposition 5. *If labor market integration leads, in the long run, to an increase*

population density, then landowners of the steady state generations win if and only if they own a sufficient amount of land; landless individuals lose.

Proposition 5 suggests an important distributional impact of immigration which is different from effects on the distribution of labor income typically discussed in the literature. As housing demand increases in response to immigration, both land rents of landowners and the price of housing increase.¹⁴ If and only if the land estate of an individual is sufficiently high, the positive effect of immigration on land income dominates the negative welfare effect of an increase in housing costs. Thus, there is a threshold amount of landholding, $\bar{z} > 0$, such that all individuals with $z(i) > (<) \bar{z}$ win (lose) from labor market integration.

If there is emigration in response to labor market integration, the result is reversed. Landless individuals who do not migrate win from a reduced price for housing services. (If they migrate, they win because of higher wages.) Welfare of landowners increases if and only if their landholding is sufficiently low because of a decline in the rental rate of land.

Transition What are the welfare effects of integration for non-steady state generations? To answer this question, we need to compare the time paths of the price for housing services as well as the rental rate of land with and without integrated labor markets. We discuss welfare effects during the transition to the steady state for the three scenarios in section 4 (basic model), which are qualitatively similar when natives own land.

In the scenario where the pre-integration capital stock is initially at the steady state level and the domestic economy is initially more attractive, the rental rate of land p^Z gradually rises over time along with immigration and the price for housing services p^N immediately jumps to the new steady state level after integration (Fig. 2 (a)). Thus,

¹⁴As discussed after Proposition 1, there are also two counteracting supply effects of immigration (associated with capital formation) on the rental rate of land, which cancel each other. First, when more houses are built, land becomes scarcer. This raises the rental rate of land, p^Z , for a given price for housing services, p^N . Second, however, the price for housing services declines. This has a depressing effect on the value of the marginal product of land.

the welfare statement in Proposition 5 also holds true for non-steady state generations. As consumers, individuals lose the same way from integration in any period as driven by the upward jump in p^N . But as p^Z rises along with the stock of immigrants, later generations of landowners earn higher income than earlier ones. Thus, the threshold land endowment \bar{z} above which an individual gains from immigration falls over time.¹⁵ In the opposite scenario where initially the capital stock is in steady state and the foreign economy is initially more attractive (Fig. 2 (b)), landowners lose less in an earlier phase of the transition than in later phases because of the gradually declining rental rate of land.

In the scenario of Fig. 3, where the steady state population density with and without migration coincide, steady state generations are equally well off with or without integration. As we have seen, since the economy is initially capital-poor, labor market integration first leads to emigration and retarded capital accumulation. Recall that the price for housing services p^N drops immediately to the steady state level with integration rather than gradually converging to it without integration. Thus, non-steady state generations of landless individuals are better off with integration. For landowners, the welfare effect of integration during the transition is ambiguous, as the rental rate of land drops initially below its steady state level. Non-steady state generations of landowners thus may lose during the transition. They are more likely to do so earlier in the transition, since the rental rate of land gradually rises after the initial drop along with the reversed migration flow. Landowners are also more likely to lose from integration if they own more land.

5.3 Capital in the Tradable Goods Sector

The immediate jump of the price of non-tradables, p^N , to the new steady state after labor market integration (part (iii) of Proposition 3) is not a robust property. The absence of transitional dynamics with respect to p^N rather hinges on the simplifying

¹⁵This particular result is not necessarily robust, however, in the case where capital also enters the production function of tradable goods. In this case, p^N rises gradually to the new steady state; see the next subsection.

assumption that the output level of the tradable good is proportional to the labor input ($Y^T = aL^T$), such that the wage rate is time-invariant ($w = a$). Allowing for capital as a second input in the tradable goods sector modifies the transition path of p^N and implies that w interacts with migration flows. Let K_t^T denote the stock of capital employed in the tradable goods sector and modify the production function to

$$Y_t^T = a (L_t^T)^\kappa (K_t^T)^{1-\kappa}, \quad (28)$$

$\kappa \in (0, 1)$. The tradable goods sector faces similar capital adjustment costs as the non-tradable goods sector. Conducting the same experiment as in Fig. 2 (a), Fig. 4 shows that p^N (left panel) increases smoothly during the transition to the new steady state as driven by gradual immigration. It drops initially because the wage rate, w , falls at $t = 0$ in response to migration inflows, as displayed in the right panel. This reduces the demand for the non-tradeable good. The reduction in the wage rate is, however, not persistent; the wage converges back to its initial steady state value, despite further immigration. This behavior of the wage rate is consistent with empirical evidence on labor market effects of immigration, which suggests a short-run drop in the wage rate (reflecting the decreasing marginal productivity of labor in (28)) and negligible long-run effects (e.g. Friedberg, 2001; Borjas, 2003; Dustmann et al., 2005). The underlying reason for the increase in w along the smooth transition is that, in both sectors, a larger labor force makes installed capital goods more valuable such that firms build up their capital stock. All other properties of the transition paths are qualitatively similar to Fig. 2 (a).

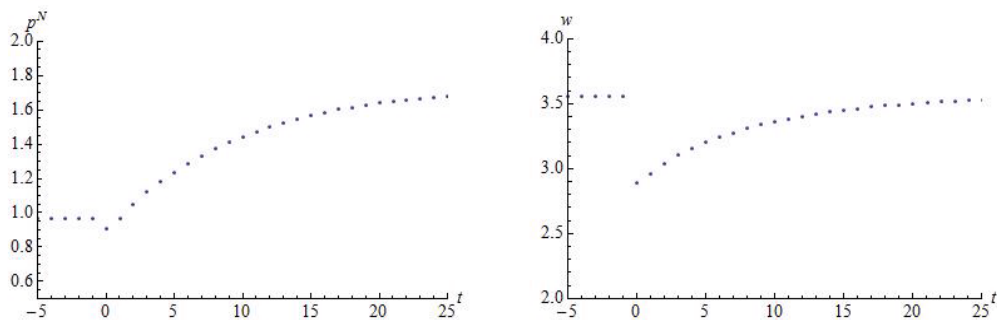


Figure 4: The impact of labor market integration in period $t = 0$ under the same presumptions as in Fig. 2 (a), except that the production technology for the tradable good is modified to (28) with $\kappa = 0.5$.

6 Conclusion

This paper has examined the impact of labor market integration on migration, capital formation, the rental rate of land, and the price for housing services in an intertemporal model in which firms face capital adjustment costs. The mechanism which acts as a drag on migration flows and prevents that everyone moves to high-productivity regions, once this is legally made feasible, works through changes in the price of housing. The predictions of our model are, for instance, in line with migration patterns and implications for the housing market followed by European labor market integration.

We have examined how initial conditions (i.e. initial levels of population density, productivity, and the capital stock) affect the direction and evolution of migration, capital flows, the rental rate of land, and the price for housing services over time. In particular, our theory provides a candidate explanation for reverse migration. According to the best of our knowledge, previous studies based on neoclassical models which rest on constant returns to scale were unable to explain that labor market integration may lead to labor outflows in early phases of the transition to the new long run equilibrium and immigration in later phases. In our model, the number of workers in the domestic economy is determined by the condition that life-time utilities in the

source and the destination are equalized. As a result, technically, population density is a jump variable which allows for non-monotonic transitions. Causally, despite the possibility of emigration while capital accumulates, our theory predicts a positive effect of immigration on capital investment.

Regarding welfare effects, the paper has shown how heterogeneity in the ownership of land determines the distributional consequences in response to labor market integration, caused by changes in the rental rate of land and housing costs. This may help to understand political debates on and resistance to immigration even if migration inflows have negligible effects on the domestic labor market.¹⁶ Our theory in fact suggests that in an advanced immigration country the price for housing services stays permanently high or even further increase over time despite potentially massive residential capital investment triggered by increased housing demand because of immigration.

Future research may exploit our set up to study the political economy side of migration policy more deeply.¹⁷ Moreover, there is still a gap in the literature between (i) models of regional development and interregional migration based on increasing returns and agglomeration effects and (ii) neoclassical models which focus on capital formation. Thus, future research may extend our framework to allow for increasing returns. As a consequence, multiple equilibria may emerge. The modified set up could then be employed to examine how initial conditions and expectations interact for the dynamic evolution of migration, capital formation, and the price for housing services.

¹⁶Switzerland would be a prime example. In a widely discussed referendum on February 9, 2014, Switzerland voted for restricting immigration by opting out of its bilateral agreement with the European Union on the free movement of labor (with a 50.3 percent majority). This was seen as remarkable by commentators, as labor market effects were largely invisible despite massive immigration since the agreement came into full effect in 2007. The main discussion centered about rising prices for housing services.

¹⁷De la Croix and Docquier (2014) propose a very interesting recent political economy perspective of a host country. In their model, higher immigration in a single country does not rise welfare from a nationalist point of view whereas a coordinated increase in immigration quotas of a group of rich countries may lead to a Pareto improvement under an appropriate tax-subsidy scheme. In our set up, the challenge would be to achieve a Pareto improvement within a region when immigration produces winners and losers.

Appendix

Proof of Lemma 1. The household's problem is solved in two steps. In the first step, the intertemporal consumption problem is solved. Omitting subscripts, define a Cobb-Douglas consumption index, $C := (c^T)^\gamma (c^N)^{1-\gamma}$ such that instantaneous utility is given by $\log C$. Consumption expenditure in a given period can be expressed as

$$P \cdot C = c^T + p^N c^N, \quad (29)$$

where P denotes an appropriately defined price index (see below). Life-time utility of an individual born in t reads as $U_t = \log C_{1,t} + \rho \log C_{2,t+1}$.

For later use, we also allow for second-period income. Denote income of an individual born in t in the first and second period of life by $y_{1,t}$ and $y_{2,t+1}$, respectively. First-period income is equal to the wage rate, $y_{1,t} = w_t$. (In the basic model, $w_t = a$ and $y_{2,t+1} = 0$ for all t .) Let Sav_t denote individual savings in working age at time t , i.e. $Sav_t := w_t - P_{1,t}C_{1,t}$. We have

$$C_{1,t} = \frac{w_t - Sav_t}{P_{1,t}}, \quad (30)$$

$$C_{2,t+1} = \frac{(1+r)Sav_t + y_{2,t+1}}{P_{2,t+1}}. \quad (31)$$

The intertemporal problem may be expressed as follows:

$$\max_{Sav_t} \{ \log(w_t - Sav_t) - \log(P_{1,t}) + \rho \log[(1+r)Sav_t + y_{2,t+1}] - \rho \log(P_{2,t+1}) \}. \quad (32)$$

Defining $W_t \equiv w_t + \frac{y_{2,t+1}}{1+r}$, the first-order condition implies

$$P_t C_{1,t} = \frac{1}{1+\rho} W_t, \quad (33)$$

$$\frac{P_{2,t+1} C_{2,t+1}}{1+r} = \frac{\rho}{1+\rho} W_t. \quad (34)$$

In the second step, we analyze the static problems. Given the amount of first-period

consumption expenditure in (33), the household solves

$$\max_{c_{1,t}^T, c_{1,t}^N} \log \left[(c_{1,t}^T)^\gamma (c_{1,t}^N)^{1-\gamma} \right] \quad \text{s.t.} \quad \frac{1}{1+\rho} W_t = c_{1,t}^T + p_t^N c_{1,t}^N. \quad (35)$$

Hence,

$$c_{1,t}^T = \frac{\gamma}{1-\gamma} p_t^N c_{1,t}^N, \quad (36)$$

which combined with the first-period budget constraint in (35) implies

$$c_{1,t}^T = \frac{\gamma}{1+\rho} W_t, \quad c_{1,t}^N = \frac{1-\gamma}{1+\rho} \frac{W_t}{p_t^N}. \quad (37)$$

This confirms the first expressions in (8) and (9). Similarly, given the amount of second-period consumption expenditures in (34), the household solves

$$\max_{c_{2,t+1}^T, c_{2,t+1}^N} \log \left[(c_{2,t+1}^T)^\gamma (c_{2,t+1}^N)^{1-\gamma} \right] \quad \text{s.t.} \quad \frac{\rho(1+r)}{1+\rho} W_t = c_{2,t+1}^T + p_{t+1}^N c_{2,t+1}^N. \quad (38)$$

Hence, we get

$$c_{2,t+1}^T = \frac{\gamma}{1-\gamma} p_{t+1}^N c_{2,t+1}^N \quad (39)$$

which combined with the second-period budget constraint in (38) leads to

$$c_{2,t+1}^T = \frac{\gamma(1+r)\rho}{1+\rho} W_t, \quad c_{2,t+1}^N = \frac{(1-\gamma)(1+r)\rho}{1+\rho} \frac{W_t}{p_{t+1}^N}. \quad (40)$$

Substituting $(1+r)\rho = 1$ into (40) confirms the second expressions in (8) and (9). Inserting (8) and (9) into the intertemporal utility function (5) confirms (10). It remains to be shown that there exists a price index as used above. Using $C = (c^T)^\gamma (c^N)^{1-\gamma}$, the price index P may be expressed as

$$P = \frac{c^T + p^N c^N}{C} = \left(\frac{c^T}{c^N} \right)^{1-\gamma} + p^N \left(\frac{c^N}{c^T} \right)^\gamma. \quad (41)$$

Noting that $\frac{c^T}{c^N} = \frac{\gamma}{1-\gamma} p^N$ one gets

$$P = (p^N)^{1-\gamma} \left[\left(\frac{\gamma}{1-\gamma} \right)^{1-\gamma} + \left(\frac{1-\gamma}{\gamma} \right)^\gamma \right]. \quad (42)$$

This concludes the proof. ■

Proof of Proposition 1. The Lagrangian function to the optimization problem (3) of firms in the non-tradable goods sector, implied by equilibrium condition 1 in Definition 1, is given by

$$\begin{aligned} \mathcal{L} = & \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t \left(p_t^N b (L_t^N)^\alpha (K_t)^\beta Z^{1-\alpha-\beta} - w_t L_t^N - p_t^Z Z - I_t \left[1 + \theta \left(\frac{I_t}{K_t} \right)^\eta \right] + \right. \\ & \left. q_t [I_t + (1-\delta) K_t - K_{t+1}] \right). \end{aligned} \quad (43)$$

Using $w_t = a$, the associated first-order conditions $\frac{\partial \mathcal{L}}{\partial L_t^N} = \frac{\partial \mathcal{L}}{\partial Z} = \frac{\partial \mathcal{L}}{\partial I_t} = \frac{\partial \mathcal{L}}{\partial K_{t+1}} = 0$ imply

$$p_t^N = \frac{a (L_t^N)^{1-\alpha}}{\alpha b (K_t)^\beta Z^{1-\alpha-\beta}}, \quad (44)$$

$$p_t^Z = p_t^N (1-\alpha-\beta) b (L_t^N)^\alpha (K_t)^\beta Z^{-\alpha-\beta}, \quad (45)$$

$$I_t = \left(\frac{q_t - 1}{(\eta + 1) \theta} \right)^{\frac{1}{\eta}} K_t, \quad (46)$$

$$(1-\delta)q_{t+1} + p_{t+1}^N \beta b (L_{t+1}^N)^\alpha (K_{t+1})^{\beta-1} Z^{1-\alpha-\beta} + \theta \eta \left(\frac{I_{t+1}^N}{K_{t+1}^N} \right)^{\eta+1} = (1+r)q_t. \quad (47)$$

Recall $D^K = \frac{K}{Z}$ and $D^I = \frac{I}{Z}$. Then, first, (46) gives us (12). Substituting (46) into (2) confirms (11). Substituting (1) as well as $c_{1,t}^N$ and $c_{2,t}^N$ as given by (9) into equilibrium condition 6 in Definition 1, $Y_t^N = c_{1,t}^N L_t + c_{2,t}^N L_{t-1}$, and using $W_t = a$ implies

$$b (L_t^N)^\alpha (K_t)^\beta Z^{1-\alpha-\beta} = \frac{1-\gamma}{1+\rho} \frac{a}{p_t^N} (L_t + L_{t-1}). \quad (48)$$

Substituting (44) into (48) and solving for L_t^N we obtain

$$L_t^N = \frac{\alpha(1-\gamma)}{1+\rho}(L_t + L_{t-1}). \quad (49)$$

Advancing (49) by one period and using it in (47), as well as recalling $D^K = \frac{K}{Z}$, $D^I = \frac{I}{Z}$, $D^S = \frac{S}{Z}$, and $S_t = L_t + L_{t-1}$ confirms (13). Moreover, substituting (49) into (44) confirms (14). Substituting (44) into (45) and using (49) confirms (15).

We next show that, for a given population density (D^S), the dynamic system is saddle-point stable. To see this, use (12) in (11) to find

$$\Delta D_{t+1}^K := D_{t+1}^K - D_t^K = \left[\left(\frac{q_t - 1}{(\eta + 1)\theta} \right)^{\frac{1}{\eta}} - \delta \right] D_t^K. \quad (50)$$

Thus, ΔD_{t+1}^K is increasing in q_t . Moreover, the locus which is given by $\Delta D_{t+1}^K = 0$ in $D_t^K - q_t$ -space is a horizontal line which is given by

$$q_t = 1 + (1 + \eta)\theta\delta^\eta \equiv \tilde{q}. \quad (51)$$

Next, using (11), (12) and (14) in (13) defines q_{t+1} implicitly as a function of D_t^K and q_t . It is easy to confirm that $\Delta q_{t+1} := q_{t+1} - q_t$ is increasing in D_t^K . However, substituting $q_{t+1} = \Delta q_{t+1} + q_t$ in (13) and setting $\Delta q_{t+1} = 0$ could give us a positive or negative relationship between D_t^K and q_t . Thus, it is possible that the locus which is given by $\Delta q_{t+1} = 0$ in $D_t^K - q_t$ -space is positively sloped or negatively sloped. Fortunately, in either case, the phase diagram based on the derived properties of the dynamic system reveals saddle-point stability. In either case, like in Fig. 1, the saddle-path is negatively sloped. This confirms part (i).

To derive steady state expressions in part (ii), set $q_{t+1} = q_t = \tilde{q}$ as given by (51) in (13) to confirm (16). Substituting $D_t^K = \chi a D^S$ into (14) gives us (17). This concludes the proof. ■

Proof of Corollary 1. First, recall from the proof of Proposition 1 that the saddle-path of the phase diagram in $D^K - q$ -space is downward-sloping. Moreover,

note that an increase in D^S or in a shifts the locus $\Delta q = 0$ to the right and leaves the locus $\Delta D^K = 0$ unaffected. This explains the effects on D^K in part (i). The impact on p^Z follows from (15). The impact on p^N follows from (14) and (17). With respect to part (ii), note by inspection of (11)-(13) that parameter b does not enter the dynamic system. ■

Proof of Proposition 2. Steady state utility of a foreign individual with wage income only is given by $V^* \equiv V(a^*, p^{N*}, p^{N*})$. Using this and (10) in equilibrium condition 3 in Definition 1 then confirms (18). Setting $p_t^N = p_{t+1}^N = \tilde{p}^N(D^S, a, b)$ and, as the foreign economy is in steady state by assumption, $p^{N*} = \tilde{p}^N(D^{S*}, a^*, b^*)$ in (18), using (17) and solving for D^S confirms (19). This concludes the proof. ■

Proof of Corollary 2. Directly follows from (19). ■

Proof of Proposition 3. Part (i) directly follows from (15)-(17), as discussed in the main text. For part (ii), an example suffices. It is given in Fig. 3. To prove part (iii), rewrite (18) as

$$\log p_{t+1}^N + \frac{1}{\rho} \log p_t^N = \frac{1+\rho}{\rho} \left[\frac{\log\left(\frac{a}{a^*}\right)}{1-\gamma} + \log p^{N*} \right] \equiv \Omega. \quad (52)$$

Defining $x_t := \log p_t^N$, we can write (52) as $x_{t+1} = -\frac{1}{\rho}x_t + \Omega$, which represents a linear, non-homogeneous, first-order difference equation. The solution is given by

$$x_t = \left(x_0 - \frac{\Omega}{1+\frac{1}{\rho}} \right) \left(-\frac{1}{\rho} \right)^t + \frac{\Omega}{1+\frac{1}{\rho}}. \quad (53)$$

Difference equation $x_{t+1} = -\frac{1}{\rho}x_t + \Omega$ also implies that, in a steady state where $x_{t+1} = x_t$ as $t \rightarrow \infty$, we must have $\lim_{t \rightarrow \infty} x_t = \frac{\Omega}{1+\frac{1}{\rho}}$. Since $0 < \rho < 1$, this requires $x_0 = \frac{\Omega}{1+\frac{1}{\rho}}$. In this case the solution for p_t^N as given by (52) is constant over time. ■

Proof of Proposition 4. First, note that (44)-(47) still hold. Thus, (11) and (12) still hold.

We now have to reconsider equilibrium condition 6 in Definition 1 (clearing of the non-tradable goods market). According to (9) and (21), demand for the non-tradable good of a young and an old individual i in period t , with landholding $z(i)$ in the second period of life, is

$$c_{1,t}^N(i) = \frac{1 - \gamma}{1 + \rho} \frac{a + \rho p_{t+1}^Z z(i)}{p_t^N}, \quad c_{2,t}^N(i) = \frac{1 - \gamma}{1 + \rho} \frac{a + \rho p_t^Z z(i)}{p_t^N}, \quad (54)$$

respectively, where we used (7). Thus, total demand for the non-tradable good, denoted by C_t^N , reads as

$$C_t^N = \frac{1}{p_t^N} \frac{1 - \gamma}{1 + \rho} [(L_t + L_{t-1})a + \rho(p_{t+1}^Z + p_t^Z)Z]. \quad (55)$$

Substituting (44) into (55) and using (1), goods market clearing condition $Y_t^N = C_t^N$ implies

$$\frac{L_t^N}{Z} = \frac{\alpha}{a} \frac{1 - \gamma}{1 + \rho} [aD_t^S + \rho(p_{t+1}^Z + p_t^Z)], \quad (56)$$

where we used the definition of D^S . Combining (44) and (45) yields

$$p_t^Z = \frac{a}{\alpha} (1 - \alpha - \beta) \frac{L_t^N}{Z}. \quad (57)$$

Combining (56) and (57) confirms (24). Advancing (56) by one period and using it in (47) confirms (22). Inserting (56) into (44) leads to (23). This confirms part (i).

To derive steady state expressions in part (ii), recall the definitions of parameters in part (ii) of Proposition 1. First, set $p_{t+1}^Z = p_t^Z = p^Z$ in (24) to confirm (25). Using $q_{t+1} = q_t = \tilde{q}$ as given by (51) in (22) and substituting the steady state value for the rental rate of land as given in (25) for p_{t+2}^Z confirms (26). Substituting the steady state values for p^Z from (25) and for D^K from (26) into (23) gives us (27). This concludes the proof. ■

Proof of Lemma 2. Individual i born in t does not want to migrate from the domestic to the foreign economy if $V(W_t(i), p_t^N, p_{t+1}^N) > V(W_t(i), \hat{p}^{N*}, \hat{p}^{N*})$. According

to (10) and (21), this is equivalent to

$$(1 + \rho) \log \left(\frac{a + y_{2,t+1}(i)}{a^* + y_{2,t+1}(i)} \right) > (1 - \gamma) \left[\log \left(\frac{p_t^N}{p^{N*}} \right) + \rho \log \left(\frac{p_{t+1}^N}{p^{N*}} \right) \right], \quad (58)$$

where $y_{2,t+1}(i) := \frac{p_{t+1}^Z z(i)}{1+r}$ denotes the present discounted value of land income of an individual i born in t received in the second period of life, $t + 1$. Note that for $y > 0$, we have $\frac{a+y}{a^*+y} > (<) \frac{a}{a^*}$ if $a < (>) a^*$. Thus, if $a < a^*$ and (18) holds, a landowning individual does not want to migrate from the domestic to the foreign economy, as (58) is fulfilled. Similarly, if $a > a^*$ and (18) holds, a landowning individual does not want to migrate from the foreign to the domestic economy. This concludes the proof. ■

Proof of Proposition 5. Recall that $w_t = a$ and that the dynamic system in Proposition 5 is independent of the distribution of land among individuals. The result then follows from using (21), (25) and (27) in (10). ■

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