Reversal of Migration Flows: A Fresh Look at the German Reunification*

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Abstract

We investigate the dynamic effects of interregional labor market integration on migration flows, capital formation, and the price for housing services. The co-evolution of these variables 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, while housing costs are increasing over time. Although capital may accumulate while labor emigrates early in the transition, the causal effect of immigration on capital investments and housing costs is positive. We present new data on the evolution of net migration flows and rental rates for housing in East Germany after 1990. Our results are consistent with the presented evidence in the reverse migration scenario.

Key words: Capital formation; German reunification; Housing services; Labor market integration; Reverse migration.

JEL classification: D90, F20, O10.

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"Today, the decision was taken that makes it possible for all citizens to leave the country through East German border crossing points. [...] As far as I know - effective immediately, without delay."[1]

1 Introduction

The fall of the Berlin Wall in November of 1989 can be viewed as a quasi-natural experiment of the effects of interregional labor market integration. From one day to the next, literally overnight, East German citizens had the opportunity to move to West Germany (and vice versa), after the sudden removal of all institutional migration barriers. To begin with, there were no language barriers. Moreover, there were plenty of family ties that made migration costs, other than costs associated with finding a new shelter, almost negligible. In other words, we have seen a historically unique case of an exogenous integration shock from fully closed to fully open borders.

This paper examines the dynamic effects of interregional labor market integration on migration patterns, private investment, wages, and the price for housing services. In particular, we take up the challenge to explain the mechanics of the remarkable migration pattern in East Germany for the period 1991-2014. This period is characterized by a "reversal of migration flows", i.e. prolonged net outward migration followed by net inward migration later on. Fig. 1 shows the net migration flows for East Germany ("New Laender"), excluding Berlin. To smooth out business cycle fluctuations, we take five-year annual averages for the periods 1991-1995, 1996-2000, 2001-2005 and 2006-2010 as well as the four-year annual average for the period 2011-14. According to Fig. 1, there was a massive outflow in the 1990s and 2000s for East Germany as a whole.[2] The outflow was larger for the 1990s when leaving out the state of Brandenburg that surrounds the city of Berlin which became not only the political but also an important economic center in reunified Germany. As many workers of Berlin-based employers are

[1] Guenther Schabowski (First Secretary of the East Berlin chapter of the Socialist Unity Party - SED - in the former German Democractic Republic - GDR - and a member of the SED Politbuero), November 9, 1989. Translated from German.

[2] Burda (2006) also documents for the 1990s labor outflows from East Germany that were directed to West Germany.

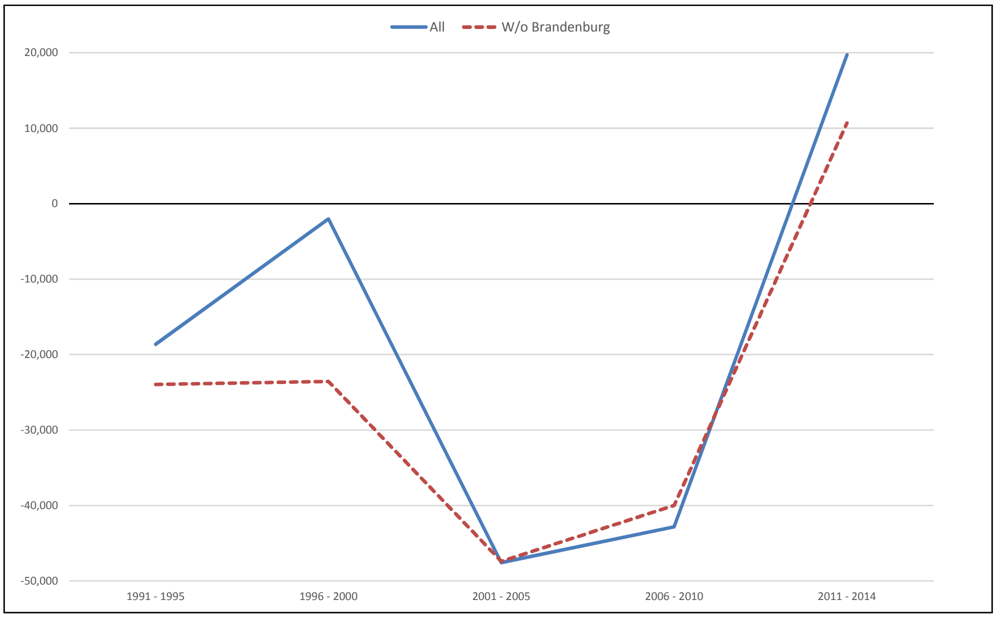

Figure 1: Net migration flows (annual averages) to the New Laender (Brandenburg, Mecklenburg-Western Pomerania, Saxony-Anhalt, Saxony, and Thuringia), 1991-2014. Data: See Online Appendix.

commuting to work from Brandenburg, the state experienced net immigration in the mid 1990s. Strikingly, the migration pattern in the New Laender has reversed to net inflows after 2011. As displayed in Fig. 2, the reversal of migration flows is particularly apparent for cities with more than 100,000 inhabitants. It has started already in the 2000s, with the largest inflows to the two largest cities, Dresden and Leipzig. More recently there have been positive net inflows to all East German cities.

To explain such a migration pattern, we develop a neoclassical, overlapping generations model with a tradable goods sector and a housing sector. The housing sector combines land and residential structures, that is accumulated through construction activities, to produce (non-tradable) housing services.[3] Firms in the tradable goods sector face capital adjustment costs to install new physical capital. We study the effects of implementing free interregional labor movement, conditional on initial differences (across

[3] This borrows from the business-cycle literature on housing and macroeconomics (Davis and Heathcote, 2005; Hornstein, 2008, 2009; and Favilukis et al., 2015). Chambers et al. (2009a, 2009b) employ an OLG model with housing and mortgage markets, excluding the fixed factor land, to explain the evolution in homeownership rates. Grossmann and Steger (2017) develop a long-term macroeconomic model that focusses on the housing sector. Piazzesi and Schneider (2016) provide an excellent survey.

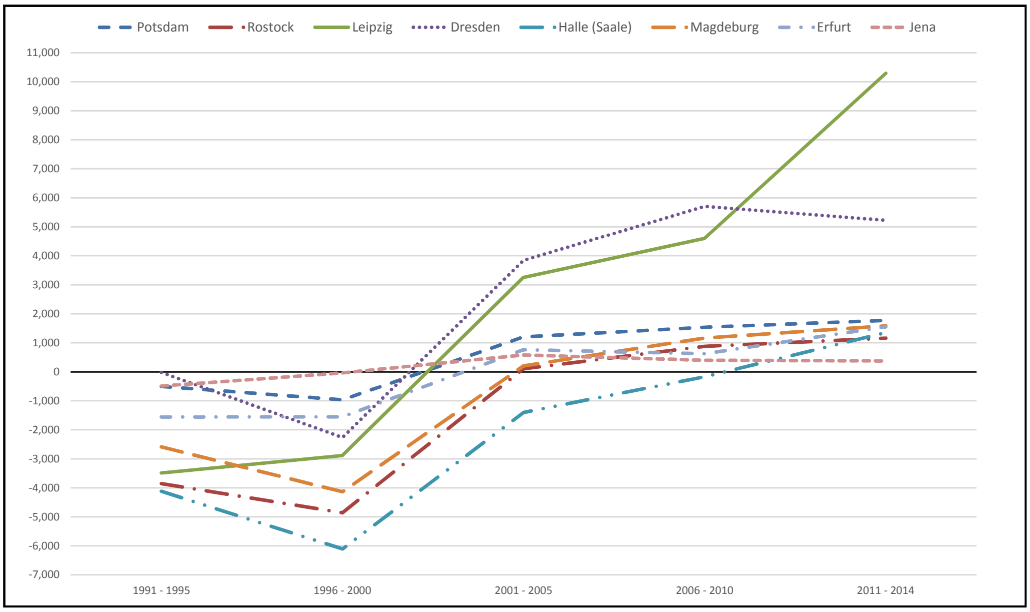

Figure 2: Net migration flows (annual averages) to cities with more than 100,000 inhabitants in the New Laender, 1991-2014. Data: See Online Appendix.

regions) in both the two capital stocks (physical capital and residential structures) and total factor productivity levels. These interregional differences drive migration decisions by determining differences in both wage rates and the price for housing services across regions.

Our analysis suggests a causally positive (negative) effect of immigration (emigration) on capital accumulation although interregional flows of labor and regional changes in capital stocks may transitorily evolve in opposite directions.[4] We demonstrate how initial conditions and the time that has elapsed after labor market integration determine how migration flows are related to the evolutions of capital stocks and housing costs over time. In particular, we consider the case of low initial total productivity levels and/or low initial capital stocks (both implying a low marginal product of labor), such as in East Germany vis-à-vis West Germany at the time of the German reunification.

[4]Historically, there are examples for labor and capital to flow in the same or in opposite directions. For instance, the Atlantic 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, in response to the enlargement of the European Union (EU), labor was migrating from Southern and Eastern EU members to countries like Germany and the UK, while there were net capital inflows in some countries with net emigration.

We show that a net outflow of migrants may occur from the low-wage region during an early transition period, despite lower housing costs. During this early period, there may be accumulation of capital stocks nevertheless. Later in the transition period, the migration pattern may be reversed, while net investments remain positive. Net investments in physical capital and structures are indeed positive during the entire transition period to the long run equilibrium if productivity levels eventually become sufficiently high. The price for housing services is increasing in the aftermath of the integration shock, as the economy develops, reflecting that increasing demand for housing over time (implied by increasing wage income and net immigration) meets the scarcity of land.

Our analysis suggests the following explanation for the reversal of migration flows in East Germany. From an individual point of view, emigration to West Germany (and other developed regions) has promised a wage gain (emigration incentive) but also required to pay a higher price for the non-tradable good "housing services" (immigration incentive). Early during the transition period, the emigration incentive has dominated the immigration incentive. Emigration has, however, come to a halt before wages were equalized across regions because of the housing cost differential. Despite the early and substantial emigration, there were incentives for net investments in physical capital and residential structures in East Germany because TFP levels increased in response to adopting West German institutions and enjoying a technology transfer from the West (Burda and Severgnini, 2015). Capital accumulation and productivity gains have raised wages, thereby reducing the emigration incentive. Rising East German wages, however, have induced an increase in housing costs through an income effect on housing demand, thereby weakening the immigration incentive.[5] Nevertheless, later during the transition the immigration incentive (lower domestic housing costs) has started to dominate the emigration incentive (lower domestic wages). As a result, East Germany (particularly its cities) has experienced net immigration in recent times, along with rising wages (associated with increasing capital stocks) and eventually rising housing costs.

The analysis also suggests that higher population density causally raises housing costs even in the long run, i.e. after housing supply fully adjusted to the increase

[5] Net investments in residential structures, on the other hand, have kept housing costs low.

in housing demand as a response to immigration. This finding is consistent with the evidence on causally positive effects of immigration on both the price for housing services and residential construction (e.g. Gonzalez and Ortega, 2013).[6] The reason is that the production of housing services is land-intensive and land is a fixed factor that becomes increasingly scarce in a growing economy. Thus, the price of housing services is closely related to the rental rate of land and increasing in a growing economy (Grossmann and Steger, 2017; Knoll, Schularick and Steger, 2017).

The main contribution of the paper is twofold. *First*, whereas a large literature on the dynamic effects of migration was confined to either the labor market or the housing market separately, we shift the focus to the interaction between housing costs and wage rates over time in determining migration patterns[7] and show how it can generate a reversal of migration patterns. While our model shares the features of capital adjustment costs, exogenous interest rates and interregional labor mobility with the one-sector frameworks of Rappaport (2005) and Burda (2006), their focus is on wage convergence rather than on the reversal of migration flows.[8] In fact, we argue that a reversal of migration flows could not occur in their models even if productivity increased

[6] Gonzalez and Ortega (2013) employ Spanish regional data for the period 2001-2010 (characterized by an annual population growth rate of 1.5 percent). They instrument changes in population density by past migration stocks of the foreign-born population in a region. About half of the construction boom in the 2000s is attributed to immigration. Saiz (2003, 2007) and Nygaard (2011) find substantial effects of immigration on rental rates and sales prices for housing in the US and UK. Jeanty et al. (2010) estimate a two-equation spatial econometric model which captures the two-way interaction between net migration flows and the price for housing services. Employing data from the metropolitan area of Michigan, they find that a one percentage point increase in the rate of population growth leads to a 0.24 percent increase in housing costs. Similarly, Degen and Fischer (2017) show that immigration flows from 85 regions between 2001-2006 to Switzerland explains two-third of its price increases of single-family homes.

[7] Important studies on wage effects of immigration include Friedberg (2001) for Israel, Dustmann, Fabbri, and Preston (2005) for the UK, and Borjas (2003) as well as Ottaviano and Peri (2012) for the US.

[8] Felbermayr, Grossmann and Kohler (2015) provide an extensive literature survey on the interaction between migration and capital formation. Rappaport (2005) argues that higher labor mobility that leads to an 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. Per capita income of the East German economy fully converges to the West German level as labor moves towards West Germany and capital accumulates in the East Germany economy.

to the level abroad, whereas the existence of a non-tradable goods sector, as in our framework, can generate such a pattern even under constant returns to scale.[9] *Second*, the paper provides a new comprehensive data set for the New Laender in Germany at the regional (county and state) level on net migration flows and on the rental costs of housing services for the period after the German reunification until 2014. It is demonstrated that our results are qualitatively consistent with the presented evidence.

The paper is organized as follows. Section 2 presents the model. Section 3 provides analytical results for the long run equilibrium. In Section 4, we solve the model numerically for the transition path to the steady state in response to labor market integration. We demonstrate the model's potential to explain a reversal of migration flows and discuss the salient role of the housing sector for this outcome. Section 5 demonstrates that the suggested explanation for the reversed migration phenomenon is also consistent with the joint evolution of housing rental rates and wage rates in East Germany after 1990. The last section concludes.

2 The Model

Consider a simple neoclassical model economy with two sectors. The tradeable goods sector produces a final good (the "numeraire"). The non-tradable goods sector produces housing services by combining accumulable "structures" and a fixed amount of land. Labor can be reallocated across sectors without any frictions. There is international mobility of physical capital at an (exogenous) interest rate $r > 0$. Labor market integration allows individuals to move between two regions ("domestic" and "foreign"). We distinguish the cases of interregionally immobile and mobile labor, investigating the

[9] It is well known that non-monotonic time paths of a region's population size may occur in models with increasing returns to scale. Faini (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. Moreover, 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.

effects of labor market integration. Time is discrete and indexed by $t = 0, 1, 2, ...$

2.1 Domestic Economy

2.1.1 Firms

There is a tradable goods sector producing a homogenous good, which is chosen as numeraire (i.e. output price $p^Y \equiv 1$). The production technology of the representative firm is given by

$$Y_t = A_t \cdot \left(L_t^Y\right)^{\alpha} \left(K_t\right)^{1-\alpha}, \tag{1}$$

$\alpha \in (0,1)$, where L^Y denotes the amount of labor, K physical capital, and $A > 0$ total factor productivity (TFP) in the tradable goods sector.[10] Accumulating physical capital is subject to (convex) capital-adjustment costs (Abel, 1982; Hayashi, 1982). Let I^K denote the amount of the tradable good that is devoted to gross investment in the tradable goods sector. Taking the time path of the wage rate, w, as given, the representative firm solves

$$\max_{\{L_t^Y, I_t^K\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \frac{A_t \cdot \left(L_t^Y\right)^{\alpha} \left(K_t\right)^{1-\alpha} - w_t L_t^Y - I_t^K \left[1 + \theta \left(\frac{I_t^K}{K_t}\right)^{\eta}\right]}{(1+r)^t} \tag{2}$$

$$\text{s.t.} \quad K_{t+1} = I_t^K + (1-\delta^K) K_t, \tag{3}$$

where $\delta^K > 0$ is the depreciation rate of physical capital and $\theta, \eta > 0$ are adjustment cost parameters. $K_0 > 0$ is given.

The non-tradable sector produces residential structures (a non-tradable stock) and housing services (a non-tradable flow). The representative construction firm combines labor, L^X, and materials (e.g. cement), M, to manufacture gross investment in structures, I^X, according to

$$I_t^X = B_t \cdot \left(L_t^X\right)^{\beta} \left(M_t\right)^{1-\beta}, \tag{4}$$

$\beta \in (0,1)$, where $B_t > 0$ is TFP in the construction sector. Materials are produced from the tradable good on a one-by-one basis. The stock, X, depreciates at rate $\delta^X > 0$

[10] The time index t is often omitted, provided that this may not lead to confusion.

and accumulates according to

$$X_{t+1} = I_t^X + (1-\delta^X)X_t \tag{5}$$

$$= B_t \cdot \left(L_t^X\right)^{\beta} (M_t)^{1-\beta} + (1-\delta^X)X_t, \tag{6}$$

where $X_0 > 0$ is given. The representative construction firm then solves

$$\max_{\{L_t^X,\, M_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \frac{p_t^X X_t - w_t L_t^X - M_t}{(1+r)^t} \quad \text{s.t. (6)}, \tag{7}$$

taking p^X, w, and r as given. The representative housing services firm produces a non-tradable consumption good by combining structures and a fixed (i.e. time-invariant) amount of land Z (which equals land supply), according to

$$H_t = (X_t)^{\gamma} Z^{1-\gamma}, \tag{8}$$

$\gamma \in (0,1)$.[11] Denote by p^H the price per unit of housing services, by p^X the rental rate per unit of structures, and by p^Z the rental rate of land. Each period t, the representative housing services firm solves

$$\max_{X_t,\, Z} \left(p_t^H (X_t)^{\gamma} Z^{1-\gamma} - p_t^X X_t - p_t^Z Z\right), \tag{9}$$

taking p^H, p^X, and p^Z as given.

2.1.2 Households

Each individual lives for two periods ("working-age" and "retirement") and has one (working-aged) child when old. 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 life-time utility. Our simple

[11] TFP in the housing services sector is set to unity. A higher B captures better technology in the housing sector as a whole.

overlapping-generations structure allows us to focus on one-shot migration decisions of workers. There may be (exogenous) institutional and social migration costs: migration reduces utility by $\Delta \geq 0$ units. We assume that a worker migrates if and only if the utility gain from migrating is equal to or higher than Δ.

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 $L_t + L_{t-1}$. The number of initially old natives, $L_{-1} > 0$, is given. In the case where labor is not interregionally mobile, we assume a constant labor force, $L_t = L_{-1}$ for all $t \geq 0$. The population density is given by $D_t \equiv (L_t + L_{t-1})/Z$. Labor market clearing requires

$$L_t^X + L_t^Y = L_t. \tag{10}$$

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 simplicity, we assume that firms in the non-tradable goods sector are owned by foreigners. In period t, a young individual i who stays in the domestic economy thus has a present discounted value of life-time income, $W_t(i)$, which is given by

$$W_t(i) = w_t + \frac{p_{t+1}^Z}{1+r} z(i). \tag{11}$$

For the sake of realism, suppose that a non-negligible fraction of natives is landless (for a landless individual i, $z(i) = 0$).

Let $c_{1,t}$ and $h_{1,t}$ denote the amount of tradable goods and housing services consumed by a working-age individual born in t, respectively. Analogously, $c_{2,t+1}$ and $h_{2,t+1}$ are consumption levels during retirement. Life-time utility of an individual born in period t is given by[12]

$$U_t(i) = u(c_{1,t}(i), h_{1,t}(i)) + \rho \cdot u(c_{2,t+1}(i), h_{2,t+1}(i)), \tag{12}$$

[12] This preference specification can be viewed as a dynamic extension of the static model of locational choice by Roback (1982), who argues that differences in wage income across regions can be explained by different amenities associated with the chosen location, also endogenizing the rental rate of land.

$\rho \in (0,1)$, with instantaneous utility function

$$u(c,h) = \chi \cdot \log c + (1-\chi) \cdot \log h, \tag{13}$$

$\chi \in (0,1)$. Recalling that $p^Y = 1$, the intertemporal budget constraint of consumer i reads as

$$c_{1,t}(i) + p_t^H h_{1,t}(i) + \frac{c_{2,t+1}(i) + p_{t+1}^H h_{2,t+1}(i)}{1+r} \leq W_t(i). \tag{14}$$

We assume that the time discount rate is given by the standard condition

$$\rho \cdot (1+r) = 1. \tag{15}$$

2.2 Foreign Economy

The foreign economy is in steady state and large in the sense that migration from or towards the domestic economy has no effect on its population density. The population density, denoted by $D^*(= L^*/Z^*)$, is therefore time-invariant. TFP levels in the tradable goods sector of the foreign economy, A^*, and in the housing sector, B^*, may differ from the domestic levels, A and B, respectively. Apart from productivity levels and initial conditions, the domestic and the foreign economy are identical.

3 Equilibrium Analysis

As shown in the appendix, individual i has life-time utility

$$V(W_t(i), p_t^H, p_{t+1}^H) \equiv \max_{c_{1,t}(i), h_{1,t}(i), c_{2,t+1}(i), h_{2,t+1}(i)} U_t(i) \text{ s.t. } (14) \tag{16}$$

$$= \Omega + (1+\rho)\log W_t(i) - (1-\chi)\left[\log p_t^H + \rho \log p_{t+1}^H\right], \tag{17}$$

with $\Omega \equiv (1+\rho)\log\left(\frac{\chi^\chi(1-\chi)^{1-\chi}}{1+\rho}\right)$. Let w^* denote the wage rate and p^{H*} the price for housing services in the foreign economy. Moreover, define by $\mathcal{V}_t \equiv V(w_t, p_t^H, p_{t+1}^H)$ and $\mathcal{V}^* \equiv V(w^*, p^{H*}, p^{H*})$ the life-time utility (in equilibrium) of a landless native in the domestic and foreign economy, respectively. If labor is interregionally mobile, landless domestic residents born in t do not want to migrate to the foreign economy as long as $\mathcal{V}_t \geq \mathcal{V}^* + \Delta$. Similarly, landless foreign residents born in t do not want to migrate to the domestic economy as long as $\mathcal{V}_t + \Delta \leq \mathcal{V}^*$. If $\Delta > 0$, there is the possibility that, for a given set of parameters, a multiplicity of equilibria with $L_t = L_{t-1}$ (no migration) exists whenever $|\mathcal{V}_t - \mathcal{V}^*| \leq \Delta$ (indeterminacy of equilibrium).[13] To avoid such difficulty and to capture the absence of institutional migration costs within Germany after the fall of the Berlin Wall, we follow Roback (1982) and abstract from exogenous migration costs in the remainder of this paper, assuming $\Delta = 0$. We focus on equilibria where landless individuals are indifferent whether or not to migrate under integrated labor markets, such that

$$\mathcal{V}_t = \mathcal{V}^* \text{ for } t \geq 0. \tag{18}$$

If $\Delta = 0$, a domestic native i born in t with land holding $z(i)$ does not want to migrate to the foreign economy if

$$V(w_t + \rho \cdot p^Z_{t+1} z(i), p^H_t, p^H_{t+1}) > V(w^*_t + \rho \cdot p^Z_{t+1} z(i), p^{H*}, p^{H*}). \tag{19}$$

Using (17) in (19), the incentive-compatibility constraint for a domestic native i born in t with land holding $z(i)$ to remain in the domestic region reads as

$$\frac{1+\rho}{1-\chi} \log\left(\frac{w_t + \rho \cdot p^Z_{t+1} \cdot z(i)}{w^*_t + \rho \cdot p^Z_{t+1} \cdot z(i)}\right) > \log\left(\frac{p^H_t}{p^{H*}}\right) + \rho \cdot \log\left(\frac{p^H_{t+1}}{p^{H*}}\right). \tag{20}$$

Notice that for $z > 0$, we have $\frac{w+\rho \cdot p^Z \cdot z}{w^*+\rho \cdot p^Z \cdot z} > (<) \frac{w}{w^*}$ if $w < (>) w^*$. Thus, if in equilibrium $w < w^*$ and $\mathcal{V}_t = \mathcal{V}^*$ (i.e. landless individuals are indifferent whether or not to migrate), incentive-compatibility constraint (20) is satisfied and thus no land-owning domestic native wants to migrate to the foreign economy. Vice versa, if $w > w^*$ and $\mathcal{V}_t = \mathcal{V}^*$ holds in equilibrium, a land-owning foreign native does not want to migrate to the domestic

[13] Armenter and Ortega (2011) employ a static multi-regions model with skilled and unskilled workers under endogenous redistribution and mobility costs. In their setup, redistribution and mobility costs affect the incentives for skilled workers to migrate. Interestingly, they obtain multiple equilibria if migration costs are relatively low.

economy.[14] The incentive to migrate is higher for landless individuals because land rents are received from the home region irrespective of the location decision, whereas income-related migration benefits come from wage differentials only.

3.1 Interregionally Immobile Labor

It turns out that, for all t, the equilibrium levels of all factor inputs per unit of land, $l_t^X \equiv L_t^X/Z$, $l_t^Y \equiv L_t^Y/Z$, $m_t \equiv M_t/Z$, $k_t \equiv K_t/Z$, $x_t \equiv X_t/Z$, are independent of total land supply Z. Before entering the numerical analysis in Section 4, we characterize the long-run equilibrium analytically. Denote the long-run equilibrium value *before* labor market integration of any variable y by $\tilde{y}$ and long run TFP values by A and B. All proofs are relegated to the Appendix.

Proposition 1. *In an interior long run equilibrium before labor market integration,*

(i) an increase in population density, D, raises factor inputs per unit of land, $\tilde{l}^X$, $\tilde{l}^Y$, $\tilde{m}$, $\tilde{k}$, $\tilde{x}$, the price of housing services, $\tilde{p}^H$, and the rental rate of land, $\tilde{p}^Z$, whereas the wage rate, $\tilde{w}$, and the price of structures, $\tilde{p}^X$, do not depend on D;

(ii) an increase in the tradable goods sector's TFP level, A, raises capital inputs $\tilde{k}$, $\tilde{x}$, as well as the input of materials, $\tilde{m}$, the price of housing services, $\tilde{p}^H$, the rental rate of land, $\tilde{p}^Z$, the wage rate, $\tilde{w}$, and the price of structures, $\tilde{p}^X$, whereas labor inputs $\tilde{l}^X$, $\tilde{l}^Y$ remain unaffected;

(iii) an increase in the non-tradable goods sector's TFP level, B, raises $\tilde{x}$, lowers both the price of housing services, $\tilde{p}^H$, and the price of structures, $\tilde{p}^X$, while the rental rate of land, $\tilde{p}^Z$, the wage rate, $\tilde{w}$, and inputs $\tilde{l}^X$, $\tilde{l}^Y$, $\tilde{m}$, $\tilde{k}$ remain unaffected.

An increase in population density D leads to higher employment in both sectors, in turn stimulating investments in both physical capital and structures. The long run price of housing services, $\tilde{p}^H$, is increasing in D despite a higher stock of residential structures.

[14] Conversely, if landless individuals are indifferent whether or not to migrate although wages are higher in the region of birth (but the price of housing services is so low that some landless individuals migrate anyway), all landowners migrate. Although this is a theoretical possibility, wages in East Germany were lower than in West Germany for the entire post-reunification period. Thus, we will not consider this case.

The result reflects a dilution effect of higher population density with respect to the fixed factor (land) when producing housing services, associated with an increase in the long run rental rate of land, $\tilde{p}^Z$.[15]

In the absence of interregional labor mobility, the allocation of labor is independent of productivity parameters, A and B. Higher productivity in the tradable goods sector, A, means higher output of the tradable good for given inputs, and thus a higher relative price of housing services, p^H. Consequently, it spurs accumulation of both physical capital and structures. A higher p^H is also positively associated with a higher rental rate of land, p^Z, and a higher value of the marginal product of labor in the housing sector. This explains why both the long run wage rate, $\tilde{w}$, and the long run price of structures, $\tilde{p}^X$, are increasing in A. Because of lower demand for housing services associated with a higher $\tilde{p}^H$, the long run allocation of labor across sectors is independent of A.

Higher productivity in the housing sector, B, leads to higher supply of structures, thus being negatively associated with the price for housing services, p^H. At the same time, an increase in B means that the marginal product of inputs in the housing sector is higher for a given p^H. This explains why physical capital formation, the rental rate of land and the wage rate are independent of B in the long run.

3.2 Integrated Labor Markets

Denote the long run equilibrium value *after* labor market integration of any variable y by $\hat{y}$.

Proposition 2. *Under integrated labor markets, the long run equilibrium population density, $\hat{D}$, is proportional to the foreign population density, D^*, and increases in the*

[15] These comparative-static results have interesting welfare implications. If and only if the land estate of an individual is sufficiently high, the positive welfare effect of immigration via higher income from land ownership 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 from labor market integration, whereas those with $z(i) < \bar{z}$ lose. If there is emigration, the result is reversed. These insights give potentially rise to polarization of attitudes towards immigration in a heterogenous population, similar to the political economy perspective of Benhabib (1996). In Benhabib (1996), individuals differ along capital holdings and develop different attitudes depending on the fact whether the capital-labor ratio rises or falls in response to immigration.

relative productivity level across regions in both sectors, A/A^* and B/B^*.

The higher the foreign population density, D^*, the higher is the (long run) price of housing services in the foreign economy, p^{H*}, reducing its attractiveness (part (i) of Proposition 1). This explains why more individuals want to live in the domestic economy. An increase in the relative productivity across regions of the tradable goods sector, A/A^*, has two counteracting effects on the steady state population density of the domestic economy when labor is interregionally mobile. First, before labor market integration, an increase in A/A^* raises the long run wage rate of individuals in the domestic relative to the foreign economy, $\tilde{w}/w^*$ (part (ii) of Proposition 1) such that the domestic economy becomes more attractive for workers. Second, for a given population density, it also raises the long run price for housing services in the domestic region relative to the foreign region, $\tilde{p}^H/p^{H*}$, lowering the attractiveness of the domestic economy. The first effect dominates the second one. By contrast, an increase in the relative productivity of the non-tradable goods sector, B/B^*, has no effect on $\tilde{w}/w^*$ (part (iii) of Proposition 1), but lowers $\tilde{p}^H/p^{H*}$ for given labor inputs, making the domestic economy more attractive. Thus, $\hat{D}$ rises.

4 Numerical Analysis

We now turn to numerical analysis in order to investigate the role of initial conditions and the evolution of TFP for the evolution of migration flows in response to labor market integration.[16] The key is to understand the dynamic interaction of migration flows on the one hand and the evolution of the wage rate, the price for housing services, the formation of physical capital and structures on the other hand. We will argue that the model can explain why migration *outflows* and positive net investments in both physical capital and structures may occur at the same time, while the *causal* effect of higher migration *inflows* on investments is positive. Most importantly, we will show that migration flows can be reversed over time if the integration shock happens in a

[16] We apply the relaxation algorithm for our numerical analysis (Trimborn, Koch and Steger, 2008). Mathematica codes used in this section are available upon request.

capital-poor economy (possibly also characterized by low TFP levels), such as in East Germany shortly after the fall of the iron curtain.

4.1 Calibration

We shall emphasize that, despite implementing a reasonable model calibration, our goal is to characterize transitional dynamics qualitatively rather than quantitatively. On the one hand, for a quantitative analysis, our two-period overlapping-generations structure is too stylized. On the other hand, the simplicity allows us to gain solid intuitions into the underlying economic mechanisms.

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 (15). Empirical evidence points to a budget share on housing of about one third (e.g. Johnson, Rogers and Tan, 2001), which suggests $\chi = 2/3$. Moreover, we set $\delta^X = 0.25$ and $\delta^K = 0.5$ which reflects an annual depreciation rate of about two percent in the housing sector and four percent in the tradable goods sector, respectively.

We also employ the standard quadratic specification of capital adjustment costs, which means that we set $\eta = 1$. In addition, we assume $\theta = 0.5$ which implies that, in a steady state with $I^K/K = \delta^K = 0.5$, one unit of gross investment in physical capital requires $1 + \theta \cdot \left(I^K/K\right)^\eta = 1.25$ units of the tradable good.

Since all quantities can be expressed relative to land endowment Z, we set $Z = 1$ without loss of generality. For output elasticities in the housing sector, we set $\beta = \gamma = 0.5$. Finally, we normalize $D^* = 1$ and assume that without labor market integration population densities are the same across regions; that is, with $Z = 1$, we assume $L_{-1} = 0.5$. Thus, we abstract from effects that come from initially different population densities across regions.

4.2 Labor Market Integration Effects

We display the dynamic effects of labor market integration on the labor force, wage rate and the price for housing services, whereas for the sake of brevity the evolution of the other variables are relegated to the Online Appendix. We focus on the case that captures the initial conditions of East Germany at the time of the re-unification with West Germany. Suppose that initial stocks of both physical capital and structures (in 1990) are below the (hypothetical) long run values without labor market integration, i.e. $K_0 < \tilde{K}$ and $X_0 < \tilde{X}$. Moreover, the domestic TFP levels in $t = 0$ do not exceed the foreign ones ($A_0 \leq A^*$, $B_0 \leq B^*$). To isolate the role of initial capital stocks, the first experiment (Fig. 3 below) assumes time-invariant TFP parameters that are equal to the foreign economy ($A_0 = A^*$, $B_0 = B^*$). The second experiment (Fig. 4 below) then allows for time-dependent TFP levels (A_t, B_t) that start below the foreign levels ($A_0 < A^*$, $B_0 < B^*$). We view this case as a plausible description of East Germany vis-à-vis West Germany (or, more generally, Eastern Europe vis-à-vis Western and Northern Europe) at the time of the fall of the iron curtain. In 1990, both capital stocks were lower than their hypothetical steady state levels without integrated labor markets ($\tilde{K}$, $\tilde{X}$) even though prior to that TFP levels in East Germany were much lower (as were $\tilde{K}$ and $\tilde{X}$), reflecting bad institutions and inferior technology of a non-market economy. East German TFP levels increased after adoption of West German institutions and have risen thereafter due to technology transfers (Burda and Severgnini, 2015)

Denote by $\tilde{y}_t$ and $\hat{y}_t$ the equilibrium level of a variable y in period $t \geq 0$ for initial values (K_0, X_0, L_{-1}) without and with an integrated labor market, respectively, and (with a slight abuse of notation) continue to denote (as in section 3) by $\tilde{y}$ and $\hat{y}$ the corresponding steady state levels. According to (18), by definition, we have

$$V(\hat{w}_t, \hat{p}_t^H, \hat{p}_{t+1}^H) = \mathcal{V}^* \text{ for } t \geq 0. \tag{21}$$

First, in order to illustrate the implications of low initial capital stocks in isolation, Fig. 3 displays the transitional dynamics for the case where $A_t = A^*$ and $B_t = B^*$ for all t. Because TFP is the same as in the foreign economy, steady state values before and after labor market integration coincide with foreign values, $\tilde{w} = \hat{w} = w^*$, $\tilde{p}^H = \hat{p}^H = p^{H*}$, $\hat{L} = L^* = L_{-1} = \tilde{L}$, $\tilde{K} = \hat{K} = K^*$, $\tilde{X} = \hat{X} = X^*$. The dotted lines

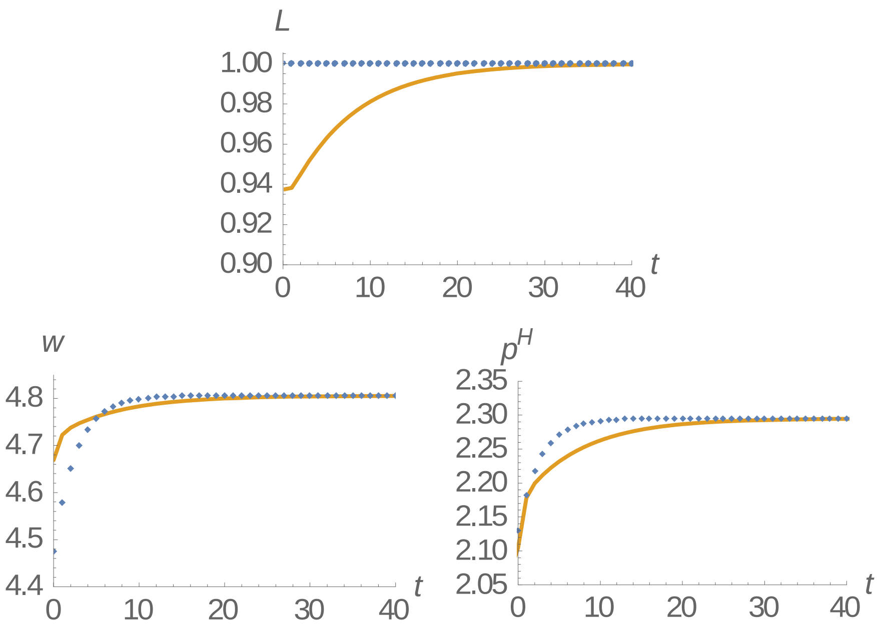

Figure 3: Transitional dynamics for an initially capital-poor economy assuming labor market integration at $t = 0$ (solid lines) and assuming that labor markets remain closed (dotted lines). Parameter configuration: $A = A^* = B = B^* = 5$, $K_0 = 0.8\tilde{K}$, $X_0 = 0.8\tilde{X}$.

show the transitional dynamics that occur without integrated labor markets, whereas the solid lines illustrate transitional dynamics when the labor market is opened up at time $t = 0$. Because the economy is initially capital-poor ($K_0 < \tilde{K}$, $X_0 < \tilde{X}$), before labor market integration, the marginal product of labor (and thus the wage rate) is initially lower than the foreign level ($\tilde{w}_0 < w^*$). In response to labor market integration, this triggers off emigration on impact ($\hat{L}_0 < L_{-1}$), associated with a drop in sectoral labor inputs, L^X and L^Y (see Online Appendix), and an associated increase in the wage rate compared to the pre-integration case, $\tilde{w}_0 < \hat{w}_0$, despite the price for housing being initially lower than in the foreign economy. Emigration further reduces housing costs. In sum, $\hat{p}_0^H < \tilde{p}_0^H < p^{H*}$. The low initial housing costs also imply that migration does not equalize wages across regions, $\hat{w}_0 < w^*$. Also notably, despite emigration, there is accumulation of both physical capital and residential structures, given our assumption that both stocks are initially below steady state and TFP levels are at the foreign level. Because emigration reduces the investment incentives compared to the pre-integration case, both types of capital accumulate more slowly than in the pre-integration case, as displayed in the Online Appendix. That is, the causal effect of emigration is to lower investment in both sectors. Over time, and after the initial drop of population density, the size of the workforce rises along with rising wage rates that are triggered off by accumulation of physical capital and structures from $t = 1$ onwards. The price of housing services rises over time because of increased demand for housing that is associated with increasing wages and (for the solid line) the reversal of the migration flows to immigration. The transition to the steady state level $\tilde{p}^H = \hat{p}^H$ is slower than without labor market integration.

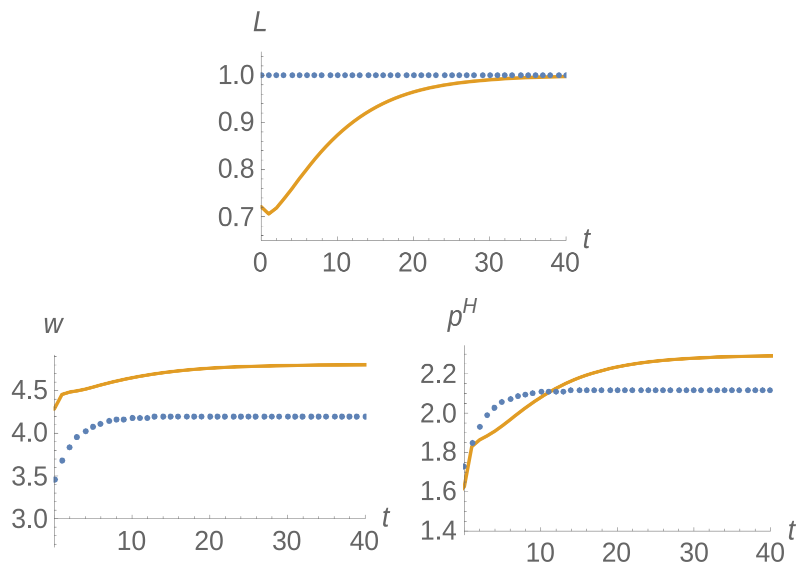

Figure 4: Transitional dynamics for an economy that initially is capital-poor and has low TFP levels assuming labor market integration at $t = 0$ (solid lines) and assuming that labor markets remain closed (dotted lines). Parameter configuration: $A_0 = 0.96A^* = 4.8$, $B_0 = 0.96B^* = 4.8$, $K_0 = 0.55\tilde{K}$, $X_0 = 0.85\tilde{X}$. A and B increase according to a logistic function to 100 percent of the foreign TFP level only in the case of labor market integration (solid lines).

The experiment displayed in Fig. 4 does not only assume that initial state variables start below the pre-integration steady state values ($K_0 < \tilde{K}$, $X_0 < \tilde{X}$), but also that domestic TFP parameters start below the foreign levels ($A_0 < A^*$, $B_0 < B^*$). These border conditions capture the economic fundamentals of the East German economy at the time of the reunification most accurately. We also assume that TFP levels converge gradually to 100 percent of the foreign level ($\lim_{t\to\infty} A_t = A^*$, $\lim_{t\to\infty} B_t = B^*$) when labor markets are integrated, whereas they remain at initial levels without labor market integration. Increasing TFP levels over time are certainly plausible for the post-reunification transition in East Germany because of technology transfers and institutional improvements from advanced economies to East Germany (particularly from West German firms that opened plants in the New Laender after 1990). Physical capital and structures decumulate for a while shortly after labor market integration, whereas the stocks accumulate in the pre-integration case (as displayed in the Online Appendix). When TFP levels become sufficiently high, there is again a reversal of migration flows in parallel with rising wage rates, a rising price for housing services and rising capital stocks. This is the reversed migration phenomenon we observe in East Germany, according to Fig. 1 and 2, particularly in cities that are the economically most active regions.

Only if TFP levels remain sufficiently low also in the long run, it is possible that $\tilde{K} > K_0 > \hat{K}$ and $\tilde{X} > X_0 > \hat{X}$. In this case, emigration and decumulation of capital occurs at the same time and there is no reversed migration. In the case of East Germany, however, there was technology transfer from advanced regions, foremost West Germany, along with capital accumulation. Hence, the premises underlying Fig. 4 are more plausible.

4.3 Digging Deeper Into Reversed Migration

What is the economic intuition behind the reversal of migration flows over time? To address this question, we disentangle, for each period of time, the overall migration incentive. Subsequently, it is shown that the existence of a non-tradable goods sector is necessary for a reversal of net migration flows in experiments that underlie Fig. 3 and Fig. 4.

4.3.1 Migration Incentives

We introduce a measure for the incentives that govern net migration flows in each period. Consider the difference in life-time utility between the domestic and the foreign economy, assuming that, for given initial conditions equal to the respective equilibrium value of state variables under integrated labor markets until period t $(\hat{K}_t, \hat{X}_t)$, the equilibrium labor force of the previous period under integrated labor markets will prevail from period t onwards, i.e. $L_t = \hat{L}_{t-1}$ for all $t \geq 1$.[17] Denote the wage rate and the price for housing services in period $s \geq t$ that results when holding labor supply in period t constant at its open economy equilibrium level in the previous period $t-1$ by $\breve{w}_{s|t}$ and $\breve{p}^H_{s|t}$, respectively. We assume the same parameter configuration as in the case of integrated labor markets, displayed in Fig. 4.[18]

Figure 5: Migration incentives measured by the life-time utility difference $V(\breve{w}_{t|t}, \breve{p}^H_{t|t}, \breve{p}^H_{t+1|t}) - \mathcal{V}^*$ and its decomposition into a "wage component" and a "housing cost component". The experiment assumes, in each period t, that (a) the economy starts with initial conditions equal to the respective equilibrium value of state variables under integrated labor markets until period t $(\hat{K}_t, \hat{X}_t)$, taken from the experiment displayed in Fig. 4, and (b) the equilibrium labor force of the previous period under integrated labor markets will prevail from period t onwards, i.e. $L_t = \hat{L}_{t-1}$ for all $t \geq 1$. Parameter configuration as in the case of integrated labor markets in Fig. 4.

[17] For $t = 0$, we consider the utility difference to the foreign economy for given initial values of state variables (K_0, X_0) and population size held constant at $L_t = L_{-1}$ for all $t \geq 0$ (i.e. the labor market never integrates).

[18] In particular, TFP levels are gradually increasing over time, in contrast to the case *without* labor market integration in Fig. 4.

Fig. 5 displays $V(\check{w}_{t|t}, \check{p}^H_{t|t}, \check{p}^H_{t+1|t}) - \mathcal{V}^*$ for $0 \leq t \leq 30$, capturing the sequence of life-time utility differentials that measure, for each period, the migration incentive. For period 0, like in Fig. 3 and Fig. 4, wage rates are lower and housing costs are higher without labor market integration. Formally, as $V(\hat{w}_0, \hat{p}^H_0, \hat{p}^H_1) = \mathcal{V}^*$, according to (21), we have $\tilde{w}_0 = \check{w}_{0|0} < \hat{w}_0$, $\tilde{p}^H_0 = \check{p}^H_{0|0} > \hat{p}^H_0$, $\tilde{p}^H_1 = \check{p}^H_{1|0} > \hat{p}^H_1$, and thus, $V(\check{w}_{0|0}, \check{p}^H_{0|0}, \check{p}^H_{1|0}) < \mathcal{V}^*$. Consequently, there is emigration ($\hat{L}_0 < L_{-1}$), as displayed in Fig. 4. Similarly, for period 1, we have $V(\check{w}_{1|1}, \check{p}^H_{1|1}, \check{p}^H_{2|1}) < \mathcal{V}^*$, implying an outward migration flow also in period 1. From period 2 onwards, the life-time utility differential – represented by the black bars in Fig. 5 – is positive, i.e. $V(\check{w}_{t|t}, \check{p}^H_{t|t}, \check{p}^H_{t+1|t}) > \mathcal{V}^*$ for $t \geq 2$, indicating a net incentive for inward migration. Again, this observation is consistent with inward migration from period 2 onwards in Fig. 4.

To gain a deeper intuition, it is instructive to decompose the life-time utility differential into a component that is caused by relative wage rates and a component that results from relative prices for housing services (contemporaneously and in the next period). According to (17), the "wage component" is given by $(1+\rho)\log(w_t/w^*)$, while the "housing cost component" reads $-(1-\chi)\left[\log(p^H_t/p^{H*}) + \rho\log(p^H_{t+1}/p^{H*})\right]$. Both components are also shown in Fig. 5. The wage component is negative throughout and provides an emigration incentive, whereas the housing cost component is positive throughout and provides an immigration incentive. In periods 0 and 1, the wage component dominates, whereas from period 2 onwards the housing cost component dominates. Both components become smaller over time when the economy converges to the foreign economy. As wage gains from emigration are declining more quickly than losses from higher housing costs abroad, migration flows do actually reverse over time.

4.3.2 The Role of the Housing Sector for Reversed Migration

We have just seen why reversed migration may occur in our two-sector economy with a non-tradable good such that (indirect) life-time utility depends on the relative price for housing services in addition to relative wages across regions. If both goods were freely tradable, the relative price between the two consumption goods would equalize across regions and migration incentives would depend on the wage component only, as in a one-sector model.

One could then ask whether a reversal of migration flows is possible in a one-sector model with a tradable good. We therefore analyze the special case $\chi = 1$ (i.e. $L_t^X = 0$ and $L_t^Y = L_t$ for all t), where the no-arbitrage condition $\mathcal{V}_t = \mathcal{V}^*$ that, under integrated labor markets, makes workers indifferent between migrating and staying boils down to wage rate equalization. That is, $\hat{w}_t = w^*$ for all $t \geq 0$, according to (17).

The full analysis of the one-sector model is relegated to the Appendix. To summarize the results, as the wage rate equals the marginal product of labor, it holds for all $t \geq 0$ that $A_t \cdot (K_t/L_t)^{1-\alpha} = A^* \cdot (K^*/L^*)^{1-\alpha}$. Again suppose $L_{-1} = L^*$, $K_0 < K^*$, $A_0 \leq A^*$. In period 0, when labor markets integrate, the labor force jumps downward to $L_0 = K_0(A_0/A^*)^{\frac{1}{1-\alpha}} L^*/K^* \equiv \hat{L}_0 < L_{-1}$ on impact. If $A_t = A^*$ for all $t \geq 0$ (as in Fig. 3), one can show that $\hat{L}_t = \hat{L}_0$ and $\hat{K}_t = K_0$ for all $t \geq 0$, sustained by gross investments equal to $\delta^K K_0$. In other words, the economy – that may have been on a transition path with gradual capital accumulation before labor market integration – jumps into the steady state by adjusting the amount of workers through emigration at the time of labor market integration. A reversal of migration flows over time cannot occur, unlike in Fig. 3.[19] In the case where $A_0 < A^*$ and TFP level A_t rises over time to the foreign level (as in Fig. 4), the capital stock shrinks over time and there is further emigration along the transition to the stationary equilibrium. Again, net migration flows do not reverse.

5 Empirical Evidence: The Case of East Germany

In this section, we argue that the reversed migration scenario displayed in Fig. 3 and Fig. 4 is consistent with the evidence on net migration flows, the evolution of wages and the evolution of housing costs in the New German Laender after the fall of the Berlin Wall. Details on the data construction and robustness checks are relegated to

[19] In the one-sector models of Rappaport (2005) and Burda (2006), there are exogenous limits to labor force adjustments each period such that emigration is stretched over time until wage rates have converged. A reversal of migration flows cannot occur either.

the Online Appendix.

5.1 Net Migration Flows

Fig. 1 and 2 in the introduction are based on a new data set on net migration flows for the period 1991-2014 at the district level in East Germany. So far, the data were not publicly available for any district in the New Laender before 1995 and were also not available for most districts after 2007.[20]

The migration data set used for Fig. 1 and Fig. 2 is based on net migration balances, accounting for movements across the borders of administrative districts (NUTS 3 units in the EUROSTAT typology for all five New Laender in Germany). The districts in the New Laender were subject to numerous border reforms between 1991 and 2014, reducing their number considerably. To get consistent data over the entire period 1991 to 2014, one territorial status was chosen and reconstructed for the periods with differing district borders. The longest period not marked by significant territorial reforms lasted from 1995 to 2006. Thus, we selected the territorial boundaries during that period of time. For the periods before (1991-1994) and after the reference period (2007-2014), the municipalities (corresponding to LAU2 units) were assigned to the districts to whom they belonged during the reference period and their net migration balances were added up to reconstruct the data at the district-level.

To sum up the discussion in the introduction, we see a reversal of migration flows particularly in East German cities. Fig. 4 based on the theoretical model suggests that outflows are highest early in the transition, whereas Fig. 1 and 2 shows that migration outflows was higher in the second half than in the first of the 1990s. This may not only reflect a kind of behavioral inertia of workers, especially in more rural areas (Burda, 1993), but may also reflect massive public investment in the early 1990s in East Germany ("Aufbau Ost"), as discussed in OECD (2001). Overall, Fig. 3 and Fig. 4 are consistent with the evidence on the decline in emigration flows and an eventual

[20] The reason for this limited data availability up to now were subsequent changes in county borders resulting from administrative reforms. We worked with the Statistical Offices of the New Laender to complete the data set. Their collaboration with us is gratefully acknowledged.

reversal to net inflows.

5.2 Wages

Fig. 3 and Fig. 4 also suggest that the reversed migration pattern is associated with gradual increases in both wage rates and rental rates of housing that are pronounced in the early transition phase. According to Fig. 5, the average wage income per worker in all the New Laender shows incomplete convergence to the West German level.

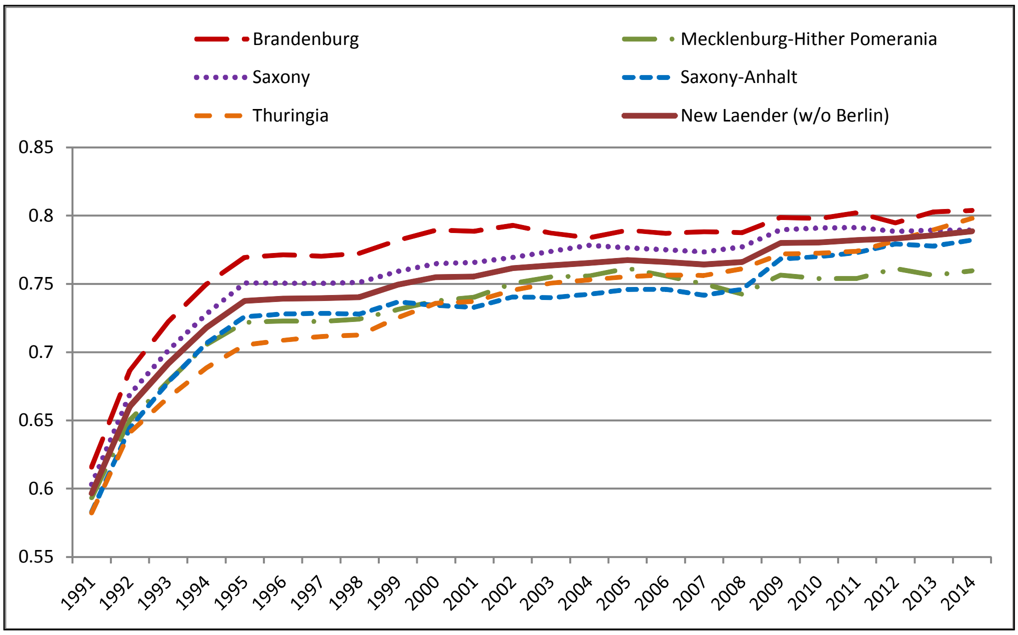

Figure 6: Real wage income per worker relative to West Germany (without Berlin) in the New Laender, 1991-2014. Data: Federal Ministry of Finance, Germany.

Wages increased particularly fast in the 1990s. Not all of that was market-driven, as trade unions pushed to harmonize wages in Germany. This was associated with comparatively high unemployment rates in East Germany. Consistent with the theoretical considerations, however, wages in the Eastern Laender relative to the Western German wage level continued to increase (along with a decline in unemployment rates) in the 2000s as well, suggesting that TFP levels do not yet coincide.

5.3 Rental Rates for Housing

Finally, we relate the evolution of rental rates for housing over time in the New Laender to our model, by constructing a comprehensive data set on rental housing in East Germany that has not yet been used elsewhere (for West Germany, see Fitzenberger and Fuchs, 2016). The data on housing costs come from the German Socio-Economic Panel Study (SOEP), a representative annual household panel survey that offers detailed information on rental housing from the perspective of tenants. The final data set consists of 107,514 private households who live in rental apartments between 1984 and 2014 in West Germany and 34,248 private households who live in rental apartments between 1990 and 2014 in East Germany.

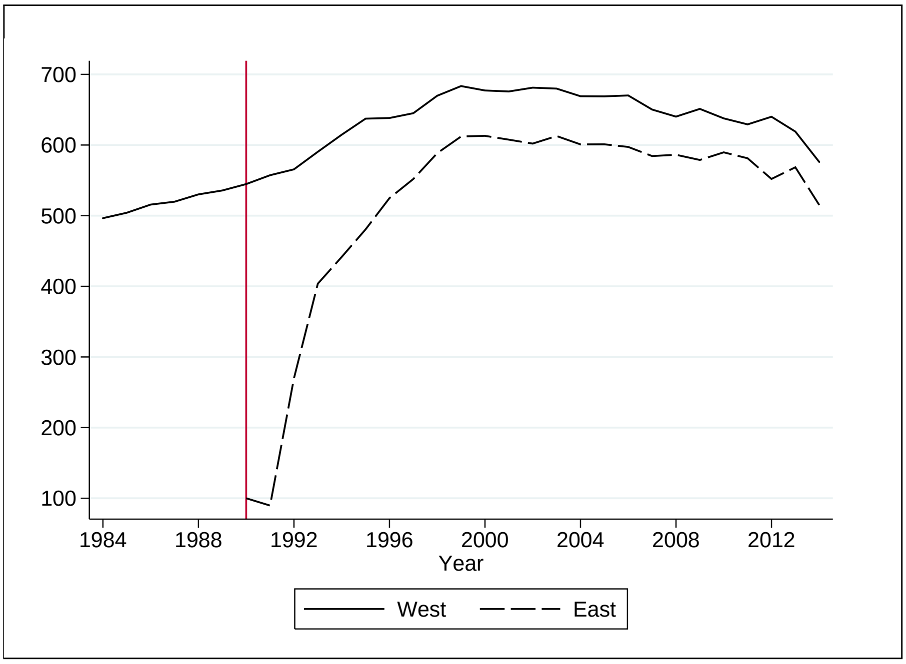

Figure 7: Evolution of raw average rental payments per square meter per month in East Germany vs. West Germany. Note: Index with the average rent in East Germany in year 1990 as basis value (= 100). Data: German Socio-Economic Panel (SOEP), version 31.

Fig. 6 visualizes the evolution of the "raw" average monthly rental payments per square metre for East Germany (since 1990) and West Germany (since 1984) over time, employing the full sample. While West German rental rates show no trend since the early 1990s (consistent with a steady state), the price for housing services increased fast in East Germany in the 1990s. In the 2000s it was six times as high as in 1990. As for wages, we observe incomplete convergence to West German levels.[21]

Figure 8: Evolution of quality-adjusted average rental payments per square meter in the New Laender. Note: Index with the average rent in East Germany in year 1990 as basis value (= 100). Data: German Socio-Economic Panel (SOEP), version 31.

Fig. 7 shows the evolution of average rental payments per square metre for the New Laender (including East Berlin) based on a standard hedonic pricing model that accounts for variation in apartment quality. We control for the year of construction, the type of location area (new residential, old residential, mixed or other), the general apartment condition, and whether the apartment is equipped with a garden, a balcony/terrace, central heating and a basement. Because of the panel structure of the data, we are also able to control for fixed effects at the apartment level.[22] Comparing

[21]The speed of the increase in the 1990s was certainly slowed down by regulations that limited upward rent adjustments, especially but not exclusively for those already living in the same apartment before October 1990 (Neumann and Schaper, 2008). These special regulations ended in January 1998 after which the regulations coincided with those in West Germany (i.e. rental rates for housing must not exceed a certain percentage of the local average for comparable apartments).

[22]The Online Appendix describes the underlying estimation procedure and the data in detail. We also present further results that demonstrate robustness.

Fig. 7 to Fig. 6 shows that the evolution of quality-adjusted housing costs is similar to the raw average in East Germany in Fig. 6 across all New Laender (including East Berlin).

The evolution of p^H in Fig. 3 and Fig. 4, based on the reversed migration case of the theoretical model, is qualitatively consistent with Fig. 6 and Fig. 7, particularly for the 1990s where we see gradual increases in rental rates for East Germany. The reason why rental rates have been rather flat during the 2000s (while the theoretical model would predict further increases) may be rooted in new rental price regulation policy, beside slow economic growth in Germany as a whole during the 2000s. In a study for the Old Laender, Fitzenberger and Fuchs (2017) show that the tenancy law reform act in 2001 reduced apartment rents significantly for new leases. The negative reform effect diminishes with the duration of a tenancy. Thus, households who live in tenancies that are affected by the reform benefit less from being sitting tenants than households in tenancies that started before September 2001. However, there are also regulations that limit rental rate increases for sitting tenants in Germany. These regulations may have contributed to slow growth of rental rates after 2001 for reasons that are not captured in our simple theoretical model.

6 Concluding Remarks

This paper has examined the impact of labor market integration on migration, capital formation, wages, the rental rate of land, and the price for housing services in an intertemporal model with a tradable goods sector and a housing sector. Our framework is capable to explain that net migration flows reverse like, for instance, in (urban) East Germany in the aftermath of the sudden fall of the iron curtain (and the Berlin wall) in 1989. The pattern is driven by low initial capital stocks and possibly also by low productivity levels that are increasing over time. The mechanism which acts as a drag on migration flows and prevents wage equalization, once free movement of labor is implemented, is that in an economy with a non-tradable good like housing, differences in housing costs across regions determine interregional utility differences, in addition to wage differences. Once labor productivity is rising over time via capital accumulation, the net migration flow may reverse along with rising wage rates and rising housing costs. This evolution of wages and rental rates of housing is consistent with the evidence for post-unification East Germany, exploiting the unique case of complete labor market integration and institutional harmonization across regions and the fact that East Germany was capital-poor at the time the iron curtain fell.

More generally, we have examined how initial conditions (i.e. initial levels of population density, productivity levels, and capital stocks) affect the direction of migration flows over time along with other key variables. We have demonstrated that capital inflows and emigration can occur at the same time, leading to a reversal of migration flows in the aftermath. Our analysis also suggests that, nevertheless, the causal effect of immigration on capital investments and housing costs is unambiguously positive. It is thus useful for empirical analyses of the interaction between migration, the price for housing services, and residential capital investment by helping to address potential endogeneity biases.[23]

Under alternative initial conditions, the model could imply continuous immigration or continuous emigration in response to labor market integration. For instance, consistent with our framework, there were massive net immigration flows to Switzerland (a high-productivity economy with a high capital-to-labor ratio) along with rising prices for housing services in the aftermath of the bilateral agreement with the European Union on the free movement of labor.[24] We focussed on the German case after 1989, however, because this historical episode was shaped by a unique experiment that allows us to better understand the dynamic general equilibrium mechanics of migration and capital accumulation in general and the reversed migration phenomenon in particular.

[23]Empirical studies have emphasized the role of wage differences across regions (e.g. Grogger and Hanson, 2011) and the role of migrant networks (Beine, Docquier and Ozden, 2011) for migration flows. We emphasize the need to account for differences in housing costs as well.

[24]The agreement was signed in 2002 and came into full effect (with respect to 17 EU countries, excluding Eastern Europe) in 2007. The case of Switzerland is discussed in detail in the working paper version of this paper (Grossmann, Schäfer and Steger, 2013). Inflows of similar magnitudes along with rising housing costs and a residential construction boom has been observed for Spain after introduction of the Euro as currency (Gonzalez and Ortega, 2013). The construction boom in Spain ended with the financial crises in 2008.

Future research may exploit our setup to study the political economy side of migration policy.[25] Heterogeneity in the ownership of land may be important for 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 when migration inflows have negligible effects on the domestic labor market.[26]

Appendix

Derivation of (17). We omit household index i and solve the household problem in two steps. In the first step, the intertemporal consumption problem is solved. Define a Cobb-Douglas consumption index, $C := c^{\chi}h^{1-\chi}$ such that instantaneous utility is given by $\log \mathcal{C}$, according to (13). Consumption expenditure in a given period can be expressed as

$$P \cdot C = c + p^H h, \tag{22}$$

where P denotes an appropriately defined price index (see below). Life-time utility of an individual born in t reads as $U_t = \log C_{1,t} + \rho \log C_{2,t+1}$, with intertemporal budget constraint $P_{2,t+1}C_{2,t+1} = (1+r)(W_t - P_{1,t}C_{1,t})$, according to (14). Solving the intertemporal household problem implies

$$P_{1,t}C_{1,t} = \frac{1}{1+\rho}W_t, \tag{23}$$

[25] See e.g. Benhabib (1906) for an important study based on heterogeneity of capital holdings of both natives and immigrants. De 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 raise 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.

[26] Switzerland 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. However, the main discussion in Switzerland centered on rising prices for housing services.

$$\frac{P_{2,t+1}C_{2,t+1}}{1+r} = \frac{\rho}{1+\rho}W_t. \tag{24}$$

In the second step, we analyze the static problems. Given the amount of first-period consumption expenditure in (23), the household solves

$$\max_{c_{1,t}^T, c_{1,t}^N} \log\left[(c_{1,t})^\chi (h_{1,t})^{1-\chi}\right] \quad \text{s.t.} \quad \frac{1}{1+\rho}W_t = c_{1,t} + p_t^H h_{1,t}. \tag{25}$$

Hence,

$$c_{1,t} = \frac{\chi}{1-\chi}p_t^H h_{1,t}, \tag{26}$$

which combined with the first-period budget constraint in (25) implies

$$c_{1,t} = \frac{\chi}{1+\rho}W_t, \quad h_{1,t} = \frac{1-\chi}{1+\rho}\frac{W_t}{p_t^H}. \tag{27}$$

Similarly, given the amount of second-period consumption expenditures in (24), the household solves

$$\max_{c_{2,t+1}, h_{2,t+1}} \log\left[(c_{2,t+1})^\chi (h_{2,t+1})^{1-\chi}\right] \quad \text{s.t.} \quad \frac{\rho(1+r)}{1+\rho}W_t = c_{2,t+1} + p_{t+1}^H h_{2,t+1}. \tag{28}$$

Hence, we get

$$c_{2,t+1} = \frac{\chi}{1-\chi}p_{t+1}^H h_{2,t+1} \tag{29}$$

which combined with $(1+r)\rho = 1$ and the second-period budget constraint in (28) leads to

$$c_{2,t+1} = \frac{\chi}{1+\rho}W_t, \;\; h_{2,t+1} = \frac{1-\chi}{1+\rho}\frac{W_t}{p_{t+1}^H}. \tag{30}$$

Inserting (27) and (30) into the intertemporal utility function (12) confirms (17). It remains to be shown that there exists a price index as used above. Using $C = c^\chi h^{1-\chi}$, the price index P may be expressed as

$$P = \frac{c + p^H h}{C} = \left(\frac{c}{h}\right)^{1-\chi} + p^H\left(\frac{h}{c}\right)^\chi. \tag{31}$$

Noting that $\frac{c}{h}=\frac{\chi}{1-\chi}p^H$ one gets

$$P=\left(p^H\right)^{1-\chi}\left[\left(\frac{\chi}{1-\chi}\right)^{1-\chi}+\left(\frac{1-\chi}{\chi}\right)^{\chi}\right]. \tag{32}$$

This concludes the proof. ■

Proof of Proposition 1. We consider (i) the optimization problems of firms, (ii) market clearing in the non-tradable consumption good, (iii) the dynamic system, and (iv) the long run equilibrium from which we derive comparative static results.

Ad (i): Denote by q^K the shadow price of physical capital in numeraire sector, i.e. the multiplier to capital accumulation constraint (3) in the profit maximization problem (2) of firms in the numeraire goods sector. The associated Lagrangian function is given by

$$\begin{aligned}\mathcal{L}^Y \equiv & \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t\left(A_t\cdot\left(L_t^Y\right)^{\alpha}\left(K_t\right)^{1-\alpha}-w_tL_t^Y-\right.\\ & \left. I_t^K\left[1+\theta\left(\frac{I_t^K}{K_t}\right)^{\eta}\right]+q_t^K\cdot\left[I_t^K+\left(1-\delta^K\right)K_t-K_{t+1}\right]\right). \end{aligned} \tag{33}$$

The associated first-order conditions $\frac{\partial\mathcal{L}^Y}{\partial L_t^Y}=\frac{\partial\mathcal{L}^Y}{\partial I_t^K}=\frac{\partial\mathcal{L}^Y}{\partial K_{t+1}}=0$ imply

$$\alpha\cdot A_t\cdot\left(\frac{K_t}{L_t^Y}\right)^{1-\alpha}=w_t, \tag{34}$$

$$\frac{I_t^K}{K_t}=\left(\frac{q_t^K-1}{(\eta+1)\,\theta}\right)^{\frac{1}{\eta}}, \tag{35}$$

$$(1-\delta^K)q_{t+1}^K+(1-\alpha)\cdot A_{t+1}\cdot\left(\frac{L_{t+1}^Y}{K_{t+1}}\right)^{\alpha}+\theta\eta\left(\frac{I_{t+1}^K}{K_{t+1}}\right)^{\eta+1}=(1+r)q_t^K. \tag{36}$$

Combining and (35) with (36) leads to

$$(1-\delta^K)q_{t+1}^K+(1-\alpha)\cdot A_{t+1}\cdot\left(\frac{L_{t+1}^Y}{K_{t+1}}\right)^{\alpha}+\frac{\eta}{\theta^{\frac{1}{\eta}}}\left(\frac{q_{t+1}^K-1}{\eta+1}\right)^{\frac{\eta+1}{\eta}}=(1+r)q_t^K, \tag{37}$$

whereas combining (3) and (35) implies

$$\frac{K_{t+1}}{K_t} = \left(\frac{q_t^K - 1}{(\eta+1)\,\theta}\right)^{\frac{1}{\eta}} + 1 - \delta^K. \tag{38}$$

According to (9), we have the following first-order conditions of the representative housing services firm:

$$\gamma p_t^H \left(\frac{X_t}{Z}\right)^{\gamma-1} = p_t^X, \tag{39}$$

$$\frac{X_t}{Z} = \left(\frac{p_t^Z}{(1-\gamma)p_t^H}\right)^{\frac{1}{\gamma}}. \tag{40}$$

Combining (39) and (40) yields

$$p_t^X = \gamma (p_t^H)^{\frac{1}{\gamma}} \left(\frac{1-\gamma}{p_t^Z}\right)^{\frac{1-\gamma}{\gamma}} \tag{41}$$

Denote by q^X the shadow price of structures, i.e. the multiplier to constraint (6) in the profit maximization problem (7) of construction firms. The associated Lagrangian function is given by

$$\begin{aligned} \mathcal{L}^X \equiv & \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t \left(p_t^X X_t - w_t L_t^X - M_t + \right. \\ & \left. q_t^X \cdot \left[B_t \cdot \left(L_t^X\right)^{\beta}(M_t)^{1-\beta} + \left(1-\delta^X\right)X_t - X_{t+1}\right]\right). \end{aligned} \tag{42}$$

The associated first-order conditions $\frac{\partial \mathcal{L}^X}{\partial L_t^X} = \frac{\partial \mathcal{L}^Y}{\partial M_t} = \frac{\partial \mathcal{L}^Y}{\partial X_{t+1}} = 0$ imply

$$q_t^X \cdot \beta \cdot B_t \cdot \left(\frac{L_t^X}{M_t}\right)^{\beta-1} = w_t, \tag{43}$$

$$q_t^X = \frac{1}{B_t \cdot (1-\beta)}\left(\frac{M_t}{L_t^X}\right)^{\beta}, \tag{44}$$

$$p_{t+1}^X + (1-\delta^X)q_{t+1}^X = (1+r)q_t^X. \tag{45}$$

Combining (43) with (44) and using (34) implies

$$\alpha \cdot A_t \cdot \left(\frac{K_t}{L_t^Y}\right)^{1-\alpha} = \frac{\beta}{1-\beta}\frac{M_t}{L_t^X}. \tag{46}$$

Combining (44) with (45) and using (41) implies

$$B_t \cdot (1-\beta)\,\gamma(p_{t+1}^H)^{\frac{1}{\gamma}}\left(\frac{1-\gamma}{p_{t+1}^Z}\right)^{\frac{1-\gamma}{\gamma}} + (1-\delta^X)\left(\frac{M_{t+1}}{L_{t+1}^X}\right)^{\beta} = (1+r)\left(\frac{M_t}{L_t^X}\right)^{\beta}. \tag{47}$$

Ad (ii): The market clearing condition for non-tradables reads as

$$H_t = \int_0^{L_t} h_{1,t}(i)\mathrm{d}i + \int_0^{L_{t-1}} h_{2,t}(i)\mathrm{d}i. \tag{48}$$

Using (11) and (15) in (27) and (30), demand functions for the non-tradable good of a young and an old individual i in period t are given by

$$h_{1,t}(i) = \frac{1-\chi}{1+\rho}\frac{w_t + \rho p_{t+1}^Z z(i)}{p_t^H},\ h_{2,t}(i) = \frac{1-\chi}{1+\rho}\frac{w_{t-1} + \rho p_t^Z z(i)}{p_t^H}, \tag{49}$$

respectively. Substituting both (8) and (49) into (48) yields

$$\left(\frac{X_t}{Z}\right)^{\gamma} = \frac{1-\chi}{1+\rho}\frac{w_t\frac{L_t}{Z} + w_{t-1}\frac{L_{t-1}}{Z} + \rho(p_{t+1}^Z + p_t^Z)}{p_t^H}. \tag{50}$$

Using (40) in (50) leads to

$$p_t^Z = \frac{(1-\chi)(1-\gamma)}{1+\rho}\left[w_t\frac{L_t}{Z} + w_{t-1}\frac{L_{t-1}}{Z} + \rho\cdot(p_{t+1}^Z + p_t^Z)\right]. \tag{51}$$

Ad (iii): Recall notation $l^X = L^X/Z$, $l^Y = L^Y/Z$, $m = M/Z$, $k = K/Z$ and $x = X/Z$. Also let $l \equiv L/Z$. Prior to labor market integration, for a given sequence of cohort sizes per unit of land, $\{l_t\}_{t=-1}^{\infty}$, the sequences of quantities $\{l_t^X, l_t^Y, m_t, k_{t+1}, x_{t+1}\}_{t=0}^{\infty}$ and prices $\{w_t, p_t^X, p_t^Z, p_t^H, q_t^K, q_t^X\}_{t=0}^{\infty}$ are given by

$$x_{t+1} = B_t \cdot \left(l_t^X\right)^{\beta}(m_t)^{1-\beta} + (1-\delta^X)x_t. \tag{52}$$

$$l_t^X + l_t^Y = l_t, \tag{53}$$

$$w_t = \alpha \cdot A_t \cdot \left(\frac{k_t}{l_t^Y}\right)^{1-\alpha}, \tag{54}$$

$$(1-\delta^K)q_{t+1}^K + (1-\alpha)\cdot A_{t+1}\cdot\left(\frac{l_{t+1}^Y}{k_{t+1}}\right)^{\alpha} + \frac{\eta}{\theta^{\frac{1}{\eta}}}\left(\frac{q_{t+1}^K - 1}{\eta+1}\right)^{\frac{\eta+1}{\eta}} = (1+r)q_t^K, \tag{55}$$

$$\frac{k_{t+1}}{k_t} = \left(\frac{q_t^K - 1}{(\eta+1)\,\theta}\right)^{\frac{1}{\eta}} + 1 - \delta^K, \tag{56}$$

$$x_t = \left(\frac{p_t^Z}{(1-\gamma)p_t^H}\right)^{\frac{1}{\gamma}}. \tag{57}$$

$$p_t^X = \gamma(p_t^H)^{\frac{1}{\gamma}}\left(\frac{1-\gamma}{p_t^Z}\right)^{\frac{1-\gamma}{\gamma}} \tag{58}$$

$$q_t^X = \frac{1}{B_t\cdot(1-\beta)}\left(\frac{m_t}{l_t^X}\right)^{\beta}. \tag{59}$$

$$\alpha\cdot A_t\cdot\left(\frac{k_t}{l_t^Y}\right)^{1-\alpha} = \frac{\beta}{1-\beta}\frac{m_t}{l_t^X}, \tag{60}$$

$$B_t\cdot(1-\beta)\,\gamma(p_{t+1}^H)^{\frac{1}{\gamma}}\left(\frac{1-\gamma}{p_{t+1}^Z}\right)^{\frac{1-\gamma}{\gamma}} + (1-\delta^X)\left(\frac{m_{t+1}}{l_{t+1}^X}\right)^{\beta} = (1+r)\left(\frac{m_t}{l_t^X}\right)^{\beta}, \tag{61}$$

$$p_t^Z = \frac{(1-\chi)\,(1-\gamma)}{1+\rho}\left[w_t l_t + w_{t-1}l_{t-1} + \rho(p_{t+1}^Z + p_t^Z)\right], \tag{62}$$

according to (6), (10), (34), (37), (38), (40), (41), (44), (46), (47), (51), respectively.

Ad (iv): In long-run equilibrium, the values of quantities $\{l^X,\ l^Y,\ m,\ k,\ x\}$ and prices $\{w,\ p^Z,\ p^H,\ p^X,\ q^X,\ q^K\}$ are time-invariant. According to (56), we obtain the long run shadow values of physical capital as

$$\tilde{q}^K = 1 + \theta\,(\eta+1)\left(\delta^K\right)^{\eta}. \tag{63}$$

Using (63) in (55) gives us

$$\frac{\tilde{k}}{\tilde{l}^Y} = \left(\frac{(1-\alpha)\cdot A}{r+\delta^K+\theta r\,(\eta+1)\left(\delta^K\right)^{\eta}+\theta\left(\delta^K\right)^{\eta+1}}\right)^{\frac{1}{\alpha}}. \tag{64}$$

Substituting (64) into (54) and (46) leads to

$$\tilde{w} = \Omega \cdot A^{\frac{1}{\alpha}}, \tag{65}$$

$$\frac{\tilde{m}}{\tilde{l}^X} = \frac{1-\beta}{\beta} \Omega \cdot A^{\frac{1}{\alpha}}, \tag{66}$$

respectively, where

$$\Omega \equiv \alpha \left(\frac{1-\alpha}{r + \delta^K + \theta r \left(\eta + 1\right) \left(\delta^K\right)^{\eta} + \theta \left(\delta^K\right)^{\eta+1}} \right)^{\frac{1-\alpha}{\alpha}}. \tag{67}$$

Using (66) in (59), we find

$$\tilde{q}^X = \beta^{-\beta} \left(1-\beta\right)^{-(1-\beta)} \Omega^{\beta} \cdot \frac{A^{\frac{\beta}{\alpha}}}{B}. \tag{68}$$

Without interregional labor mobility, $l_t = l = L_{-1}/Z$ for all $t = -1, 0, 1, ...$ and population density reads as $D = 2l$. Substituting (65) into (62), we obtain the long run rental rate of land as

$$\tilde{p}^Z = \frac{\left(1-\chi\right)\left(1-\gamma\right)}{1+\rho-2\rho\left(1-\chi\right)\left(1-\gamma\right)} \Omega \cdot A^{\frac{1}{\alpha}} \cdot D. \tag{69}$$

Using (66) and (69) into (61), in long run equilibrium,

$$\tilde{p}^H = \left(\frac{r + \delta^X}{\gamma \beta^{\beta} \left(1-\beta\right)^{1-\beta} \cdot B} \right)^{\gamma} \left(\frac{\left(1-\chi\right) \cdot D}{1+\rho-2\rho\left(1-\chi\right)\left(1-\gamma\right)} \right)^{1-\gamma} \Omega^{1-\gamma(1-\beta)} \cdot A^{\frac{1-\gamma(1-\beta)}{\alpha}}. \tag{70}$$

Using (69) and (70) in (41) and (57), we obtain

$$\tilde{p}^X = \left(r + \delta^X\right) \beta^{-\beta} \left(1-\beta\right)^{-(1-\beta)} \Omega^{\beta} \cdot \frac{A^{\frac{\beta}{\alpha}}}{B}, \tag{71}$$

$$\tilde{x} = \frac{\beta^{\beta}\left(1-\beta\right)^{1-\beta} \gamma \left(1-\chi\right)}{1+\rho-2\rho\left(1-\chi\right)\left(1-\gamma\right)} \frac{\Omega^{1-\beta}}{r + \delta^X} \cdot A^{\frac{1-\beta}{\alpha}} \cdot B \cdot D, \tag{72}$$

respectively. Moreover, according to (52) and (66),

$$\tilde{l}^X = \frac{\delta^X \tilde{x}}{B\left(\frac{1-\beta}{\beta}\Omega \cdot A^{\frac{1}{\alpha}}\right)^{1-\beta}} = \frac{\beta\gamma(1-\chi)}{1+\rho-2\rho(1-\chi)(1-\gamma)} \frac{\delta^X}{r+\delta^X} \cdot D, \quad (73)$$

where the latter follows after substituting (72).[27] Substituting (73) into (53), we find

$$\tilde{l}^Y = l - \tilde{l}^X = \left(1 - \frac{2\beta\gamma(1-\chi)}{1+\rho-2\rho(1-\chi)(1-\gamma)} \frac{\delta^X}{r+\delta^X}\right) \cdot \frac{D}{2}. \quad (74)$$

With these expressions, it is easy to confirm comparative-static results. ■

Proof of Proposition 2. With integrated labor markets, recalling $\Delta = 0$, equilibrium condition (18) that governs migration holds, i.e.

$$\log\left(\frac{w_t}{w^*}\right) = (1-\chi) \cdot \frac{\log\left(\frac{p_t^H}{p^{H*}}\right) + \rho \log\left(\frac{p_{t+1}^H}{p^{H*}}\right)}{1+\rho}, \quad (75)$$

according to (17), where w^* and p^{H*} are the wage rate and price for housing services in the foreign economy. Recall that the foreign economy is in steady state by assumption and may differ from the domestic economy in TFP parameters (A^*, B^*) and population density D^* only. Thus, according to (65) and (70), we have

$$\frac{\tilde{w}}{w^*} = \left(\frac{A}{A^*}\right)^{\frac{1}{\alpha}}, \quad (76)$$

$$\frac{\tilde{p}^H}{p^{H*}} = \left(\frac{A}{A^*}\right)^{\frac{1-\gamma(1-\beta)}{\alpha}}, \quad (77)$$

respectively. Let us denote the long run population density with integrated labor mar-

[27] For an interior long run equilibrium to exist, it must hold that $\tilde{\ell}^X < l$, i.e.

$$\frac{\beta\gamma(1-\chi)}{1+\rho-2\rho(1-\chi)(1-\gamma)} \frac{\delta^X}{r+\delta^X} < \frac{1}{2}.$$

kets by $\hat{D}$. Using (76) and (77) in (75), we obtain

$$\frac{\hat{D}}{D^*} = \frac{\left(\frac{A}{A^*}\right)^{\frac{\chi+\gamma(1-\chi)(1-\beta)}{\alpha(1-\gamma)(1-\chi)}}}{\left(\frac{B^*}{B}\right)^{\frac{\gamma}{1-\gamma}}}. \tag{78}$$

This confirms comparative-static results. ■

Comparison to one-sector model (section 4.3.2). The absence of the non-tradable goods sector is implied by $\chi = 1$. Thus, $L_t^Y = L_t$ and, with an integrated labor market, the equilibrium wage equalizes to that of the foreign region, $\hat{w}_t = w^*$ for all $t \geq 0$. Thus, under integrated labor markets,

$$L_t = \left(\frac{A_t}{A^*}\right)^{\frac{1}{1-\alpha}} \frac{L^*}{K^*} K_t \text{ for all } t \geq 0, \tag{79}$$

according to (34). According to (38), we have

$$K_{t+1} - K_t = \left[\left(\frac{q_t - 1}{(\eta+1)\,\theta}\right)^{\frac{1}{\eta}} - \delta\right] K_t. \tag{80}$$

We now denote the shadow price of capital and the depreciation rate by q and δ, respectively. In the foreign economy, the shadow value of capital is at its steady state level by assumption, i.e. $q^* = 1 + \theta\,(\eta+1)\,\delta^\eta$, according to (80). Thus, analogously to (64), we find that the equilibrium capital stock in the foreign economy, K^*, is given by

$$K^* = \left(\frac{(1-\alpha)A^*}{r + \delta + r\theta\,(\eta+1)\,\delta^\eta + \theta\delta^{\eta+1}}\right)^{\frac{1}{\alpha}} L^*. \tag{81}$$

Inserting (79) into (37) and using (81) implies

$$\begin{aligned} q_t &= \frac{(1-\delta)q_{t+1} + \left(\frac{A_{t+1}}{A^*}\right)^{\frac{1}{1-\alpha}} \left[r + \delta + r\theta\,(\eta+1)\,\delta^\eta + \theta\delta^{\eta+1}\right] + \frac{\eta}{\theta^{1/\eta}} \left(\frac{q_{t+1}-1}{\eta+1}\right)^{1+1/\eta}}{1+r} \\ &\equiv F(q_{t+1}, A_{t+1}). \end{aligned} \tag{82}$$

We assume that $K_0 < K^*$. Note that function F is increasing in both arguments,

$F(q^*, A^*) = q^*$, $F(1, A^*) > 1$, and $F_q(q, A) < 1$ for all $q \leq q^*$. Let us denote by $\bar{q}(A)$ a level of q that solves $F(\bar{q}, A) = \bar{q}$. Thus, for $A < A^*$, $\bar{q}(A) < q^*$.

According to (81) and (82), a stationary equilibrium in the domestic economy under integrated labor markets with economic activity requires $\lim_{t\to\infty} A_t = A^*$. We now discuss two scenarios where full TFP convergence holds, (i) TFP is time-invariant at the foreign level (as for Fig. 3) and (ii) $A_t < A^*$ eventually converges to the foreign level (as for Fig. 4 and Fig. 5).

Ad (i): If $A_t = A^*$ for all $t \geq 0$, we have $\hat{q}_t = q^* \, [= \bar{q}(A^*)]$ for all $t \geq 0$, according to (82). That is, the equilibrium shadow value of capital with integrated labor market jumps to the foreign steady state level. Thus, $\hat{K}_t = K_0$, according to (80), implying $\hat{L}_t = \hat{L}_0$ for all $t \geq 0$, according to (79), i.e. reverse migration cannot occur.

Ad (ii): If $A_{t+1} < A^*$, then $\hat{q}_t < q^*$ and thus $\hat{K}_{t+1} < \hat{K}_t$ and $\hat{L}_{t+1} < \hat{L}_t$, according to (80) and (79). Hence, both the capital stock and the labor force are shrinking over time. If A_t converged to the foreign level, factor outflows would stop, but there cannot be reverse migration.

References

[1] Abel, Andrew B. (1982). Dynamic Effects of Permanent and Temporary Tax Policies in a q Model of Investment, *Journal of Monetary Economics* 9, 353–373.

[2] Armenter, Roc and Francesc Ortega (2011). Credible Redistribution Policies and Skilled Migration. *European Economic Review* 55, 228-245.

[3] Beine, Michel, Frédéric Docquier and Caglar Ozden (2011). Diasporas, *Journal of Development Economics* 95, 30-41.

[4] Benhabib, Jess (1996). On the Political Economy of Immigration, *European Economic Review* 40, 1737-1743.

[5] Borjas, George (2003). The Labor Demand Curve Is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market, *Quarterly Journal of Economics* 118, 1335–1374.

[6] Braun, Juan (1993). Essays on Economic Growth and Migration, Cambridge MA, Harvard University, Ph.D. Dissertation.

[7] Burda, Michael C. (1993). The Determinants of East-West German Migration, *European Economic Review* 37, 452-461.

[8] Burda, Michael C. (2006). Factor Reallocation in Eastern Germany after Reunification, *American Economic Review* 96, 368-374.

[9] Burda, Michael C. and Battista Severgnini (2015). TFP Convergence in German States since Reunification: Evidence and Explanations, SFB 649 Discussion Paper 2015-054.

[10] Chambers, Matthew, Garriga, Carlos and Schlagenhauf, Don E. (2009a). Accounting for Changes in the Homeownership Rate, *International Economic Review* 50, 677-726.

[11] Chambers, Matthew, Garriga, Carlos and Don E. Schlagenhauf (2009b). Housing Policy and the Progressivity of Income Taxation, *Journal of Monetary Economics* 56, 1116-1134.

[12] Davis, Morris A. and Jonathan Heathcote (2005). Housing and the Business Cycle, *International Economic Review* 46, 751-784.

[13] De la Croix, David and Frédéric Docquier (2014). An Incentive Mechanism to Break the Low-Skill Immigration Deadlock, Université catholique de Louvain, mimeo.

[14] Degen, Kathrin and Andreas M. Fischer (2017). Immigration and Swiss House Prices, *Swiss Journal of Economics and Statistics*, forthcoming.

[15] Dustmann, Christian, Francesca Fabbri and Ian Preston (2005). The Impact of Immigration on the British Labour Market, *Economic Journal* 115, F324–F341.

[16] Faini, Riccardo (1996). Increasing Returns, Migration and Convergence, *Journal of Development Economics* 49, 121-136.

[17] Favilukis, Jack, Sydney Ludvigson and Stijn Van Nieuwerburgh (2015). The Macroeconomic Effects of Housing Wealth, Housing Finance, and Limited Risk Sharing in General Equilibrium, *Journal of Political Economy*, forthcoming.

[18] Felbermayr, Gabriel, Volker Grossmann and Wilhelm Kohler (2015). Migration, International Trade and Capital Formation: Cause or Effect?, in: Barry R. Chiswick and Paul W. Miller (eds.), *The Handbook on the Economics of International Migration*, Volume 1B, Elsevier, Ch. 18.

[19] Fitzenberger, Bernd and Benjamin Fuchs (2017). The Residency Discount for Rents in Germany and the Tenancy Law Reform Act 2001: Evidence from Quantile Regressions, *German Economic Review* 18, 212–236.

[20] Friedberg, Rachel M. (2001). The Impact of Mass Migration on The Israeli Labor Market, *Quarterly Journal of Economics* 116, 1373-1408.

[21] Gonzalez, Libertad and Francesc Ortega (2013). Immigration and Housing Booms: Evidence from Spain, *Journal of Regional Science* 53, 37-59.

[22] Grogger, Jeffrey and Gordon H. Hanson (2011). Income Maximization and the Selection and Sorting of International Migrants, *Journal of Development Economics* 95, 42-57.

[23] Grossmann, Volker, Andreas Schäfer and Thomas Steger (2013). Migration, Capital Formation, and House Prices, CESifo Working Paper No. 4146.

[24] Grossmann, Volker and Thomas Steger (2017). Das House-Kapital: A Long Term Housing & Macro Model, IMF Working Paper 17/80.

[25] Hayashi, Fumio (1982). Tobin's Marginal q and Average q: A Neoclassical Interpretation, *Econometrica* 50, 213–224.

[26] Jeanty, P. Wilner, Mark Partridge and Elana Irwin (2010). Estimation of a Spatial Simultaneous Equation Model of Population Migration and Housing Price Dynamics, *Regional Science and Urban Economics* 40, 343-352.

[27] Johnson, David S., John M. Rogers and Lucilla Tan (2001). A Century of Family Budgets in the United States, *Monthly Labor Review* 124 (5), 28-45.

[28] Knoll, Katharina, Moritz Schularick and Thomas Steger (2017). No Price Like Home: Global House Prices, 1870–2012, *American Economic Review* 105, 331-353.

[29] Neumann, Lother F. and Klaus Schaper (2008). Die Sozialordnung der Bundesrepublik Deutschland, Campus Verlag, Frankfurt a.M.

[30] Nygaard, Christian (2011). International Migration, Housing Demand and Access to Homeownership in the UK, *Urban Studies* 48, 2211-2229.

[31] O'Rourke, Kevin H. and Jeffrey G. Williamson (1999). Globalization and History: The Evolution of a Nineteenth Century Atlantic economy, Cambridge, Mass.: MIT Press.

[32] Ottaviano, Gianmarco I.P. and Giovanni Peri (2012). Rethinking the Effect of Immigration on Wages, *Journal of the European Economic Association* 10, 152–197.

[33] Piazzesi, Monica and Martin Schneider (2016). Housing and Macroeconomics, Elsevier, Handbook of Macroeconomics, John B. Taylor and Harald Uhlig (eds.), Vol. 2, chapter 19, pp. 1547-1640.

[34] Rappaport, Jordan (2005). How Does Labor Mobility Affect Income Convergence?, *Journal of Economic Dynamics and Control* 29, 567-581.

[35] Reichlin, Pietro and Aldo Rustichini (1998). Diverging Patterns with Endogenous Labor Migration, *Journal of Economic Dynamics and Control* 22, 703-728.

[36] Roback, Jennifer (1982). Wages, Rents, and the Quality of Life, *Journal of Political Economy* 90, 1982, 1257-1278.

[37] Saiz, Albert (2003). Room in the Kitchen for the Melting Pot: Immigration and Rental Prices, *Review of Economics and Statistics* 85, 502–521.

[38] Saiz, Albert (2007). Immigration and Housing Rents in American Cities, *Journal of Urban Economics* 61, 345-371.

[39] Schäfer, Andreas and Thomas Steger (2014). Journey into the Unknown? Economic Consequences of Factor Market Integration under Increasing Returns to Scale, *Review of International Economics* 22, 783–807.

[40] Trimborn, Timo, Karl-Josef Koch and Thomas Steger (2008). Multi-Dimensional Transitional Dynamics: A Simple Numerical Procedure, *Macroeconomic Dynamics* 12, 301–319.