Trade and Towns:
Heterogeneous Adjustment to a Border Shock[*]

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October 12, 2015

Abstract

We study the effects of changes in trade openness on wages and employment of different-sized towns. To this end, we develop a multi-region model of intra-national adjustment to trade shocks. In equilibrium, small towns have more elastic labor-force responses than large towns. We test this prediction using fine-grained regional data for Austria and the fall of the Iron Curtain as a quasi-experimental setting for the exploration of trade-induced spatial effects. We find improved access to foreign markets to boost both employment and nominal wages, but large towns tend to have larger wage responses and smaller employment responses than small towns. The welfare gains of immobile factors are estimated to be 40% higher in border towns compared to interior towns.

JEL Classification: F15, R11, R12
Keywords: trade liberalization, city size, spatial adjustment, natural experiment
All tables and figures at end

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1 Introduction

We estimate the effects of trade liberalization on employment and wage growth of different-sized towns within a country. To guide our analysis, we develop a multi-region model of intra-national adjustment to trade. Towns are heterogeneous in their exposure to trade and in their relative endowments of fixed and mobile factors. Intra-national adjustment takes place via labor migration: workers move in search of the highest real wage, with immobile housing and production factors acting as dispersion forces. The model sets up our structural triple-difference empirical strategy and predicts that trade liberalization will trigger a stronger wage increase but weaker employment increase in larger towns.

We confront these predictions with fine-grained regional data for Austria, arguing that the fall of the Iron Curtain in 1990 represents a large and fully exogenous trade shock to the Austrian economy. We define eastern border regions as the treatment group and the rest of Austria as the control group.[1] Access to foreign markets is found to boost both factor quantities and prices, as wages and employment on average grew more strongly post-1990 in treatment regions than in control regions. However, we find significant heterogeneity in these responses across the size distribution of towns. Larger towns are characterized by larger nominal wage responses and smaller employment responses than smaller towns. Hence, local labor supply is found to be less elastic in large towns than in small towns. In terms of aggregate income responses, the two effects cancel out: we find no statistically significant differences in the effects of trade liberalization on the wage bills of small and large towns. This, too, is in line with our theoretical predictions.

An alternative mechanism consistent with our findings is skill heterogeneity, e.g. with border towns hosting more skill-intensive sectors than interior towns, or with bigger towns being populated by more skilled workers. We test for effects related to sector and skill compositions by matching border to interior towns based on industrial structure and by focusing on blue collar workers only. Our qualitative results are robust to these as well as to a number of additional variations on the baseline empirical model.

Heterogeneous spatial effects of openness shocks have been researched carefully before, but our paper innovates on four counts at least. First, we estimate wage as well as employment effects of such shocks. Employment responses are relatively well understood following the seminal paper on the effects of German division and reunification by Redding and Sturm (2008) and subsequent research, but the Austrian data are unique in containing also wages at a fine level of spatial disaggregation. We establish that wages respond to changes in trade exposure qualitatively differently from employment. Second, while German episodes of partition and re-unification implied joint trade and migration shocks, the experience of Austria pre- and post-1990 is much closer to a pure trade shock, as trade was liberalized swiftly after the

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[1]Hence, the three differences are (i) before vs after 1990, (ii) border vs interior towns, and (iii) large vs small border towns. In a robustness check, we define western border regions as a placebo treatment group. While the effects of the trade shock likely extended beyond the border towns to our 'control group' of interior towns, those towns were affected with demonstrably smaller intensity than the border towns.

collapse of the socialist regimes but cross-border migration continued to be tightly controlled well into the early 2000s. Third, the existing literature focuses on the average effect of increased trade exposure. We shift our attention to the heterogeneous response of small and large towns following the trade shock. Finally, our structural approach enables us to estimate differential welfare effects of town-level exposure to international trade. It also points to the sometimes forgotten distinctions between places and people and between quantity and price effects: our model suggests that places that gain the most jobs are those that gain the least in terms of the average wellbeing of their residents. Indeed, migration evens out the heterogeneous consequences of the trade shock across the country, arbitraging away a large fraction of town-specific gains and losses in terms of jobs. Conversely, large towns experience relatively large wage swings and relatively small adjustments in terms of employment: the welfare changes for its immobile residents are thus relatively large.

Our results are also relevant to economic policy. Policy makers commonly expect international trade to benefit urbanized regions more than rural regions.[2] For this reason, trade reforms are often accompanied by transfer schemes designed to compensate rural regions.[3] In contrast to this dominant policy view, we show below that according to the available empirical evidence based on employment or population, international trade appears to favor the growth of smaller towns disproportionally. In terms of labor quantities, therefore, trade would seem to promote spatial convergence. We argue that such an analysis falls short as it fails to consider factor price effects, and we find that large towns experience proportionally larger wage gains, offsetting the equalizing patterns of employment growth. This might offer an explanation for the apparent contradiction between prior empirical findings and the predominant view held by policy makers.

Our paper is organized as follows. In Section 2, we offer a brief review of the literature. Section 3 presents a multi-town model of spatial adjustment to structure our analysis. Section 4 derives our structural triple-difference estimation strategy from the model. Our empirical setting and estimation strategy are presented in Section 5, and the results are reported in Section 6. Section 7 provides concluding remarks.

2 Literature background

2.1 Theory

The question we address can be formulated as follows: does a given change in external market access affect employment, wages and welfare differently in small and large towns? We can

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[2]According to the World Bank (2008, p. 12), for instance, "openness to trade [...] makes subnational disparities in income larger and persist for longer. [...] Economically dense places do better."

[3]The European Union's regional policy is the best known example. Conditional cash transfer (CCT) schemes in developing countries are often motivated by trade reforms and typically targeted at rural households (Fiszbein and Schady, 2009).

distinguish essentially two theoretical approaches to this question.[4]

One approach focuses on demand-side differences between small and large towns. Their very size allows large towns to produce a larger range of differentiated goods and hence to be economically more self-contained, whereas small towns are comparatively more open to trade with the rest of the economy. Thus, a given reduction in international trade costs will have a bigger impact on small towns, as they rely more on trade than large towns. This is the mechanism identified by Redding and Sturm (2008) and developed by Helpman (1998). Importantly, as long as local labor supply is neither perfectly elastic nor perfectly inelastic, this mechanism implies that, after trade liberalization, small towns will experience stronger increases in both employment and nominal wages than large towns.[5] However, this positive correlation between employment and wage changes is rejected by our estimations, which strongly point towards employment effects falling with town size while wage effects rise with town size. An alternative mechanism therefore seems to be at play, at least in our data.

The obvious alternative approach is to focus on (factor) supply-side differences instead of demand-side differences between small and large towns. We are unaware of any prior attempt at modelling such a configuration formally. Combes, Duranton and Overman (2005) capture the essence of this effect through graphical analysis. By considering the possibility of an imperfectly elastic local labor supply they highlight the importance of local supply conditions in determining the wage and employment effects of a given trade shock. In contrast to models relying on demand-side differences, this approach opens up the possibility that employment and nominal wages respond differentially across different types of towns. While, to our knowledge, no direct evidence exists on the link between local labor supply elasticities and town size, it has been shown that housing supply is more elastic in areas that are less dense and therefore have more available land (Hilber and Mayer, 2009; Saiz, 2010; Hsieh and Moretti, 2015). If housing supply is less elastic in larger, denser towns, then this would plausibly lead to larger towns having less elastic labor supplies as well. Our model formalizes

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[4]We abstract from exogenously determined comparative advantage across towns and countries (though we shall take this possibility into account in the empirics). In Henderson (1982), for example, trade liberalization is found to increase the number of towns that are specialized in the comparative advantage goods. Since towns specialized in capital-intensive sectors are bigger in equilibrium, trade liberalization will favor the growth of larger towns in capital abundant countries and of smaller towns in capital scarce countries. In this model, welfare is equalized across towns. In a similar vein, Autor, Dorn and Hanson (2013), Monte (2015) and Dix-Carneiro and Kovak (2015) explore the impact of growing import penetration respectively in the United States and Brazil, taking initial industry specialisation as the regional trade exposure measure and abstracting from town size. Another recent literature explores responses to external opening of goods and factor markets, considering intra-national spatial frictions (e.g. Atkin and Donaldson, 2015; Cosar and Fajgelbaum, 2015; Fajgelbaum and Redding, 2014; and Ramondo, Rodríguez-Clare and Saborío-Rodríguez, 2014). We instead abstract from the differential intensity of the liberalization shock across locations (except in the form of our distinction between treatment and control regions), and we focus on differential responses to a pure trade shock of given intensity. Finally, our empirical setting does not allow us to distinguish between trade liberalization in intermediate and final goods, which can have important distributional effects, though not necessarily across regions (De Loecker, Goldberg, Khandelwal and Pavcnik, 2015).

[5]The same qualitative result is found, among others, in Krugman and Livas Elizondo (1996) and Behrens, Gaigné, Ottaviano and Thisse (2007).

such a mechanism in a way that allows for structural estimation and some welfare analysis.

2.2 Empirics

Existing empirical work on the city-level effects of trade opening exclusively focuses on employment or population. This evidence strongly points toward spatially equalizing effects of trade.

Cross-country panel regressions suggest that trade reduces urban primacy (see e.g. Ades and Glaeser, 1995; Henderson, 2003), but measurement and identification are challenging at that level. Redding and Sturm (2008) identify causal effects by focusing on the quasi-experimental setting offered by post-War German partition and subsequent national reunification. Of particular interest to us is the distinction they draw between initially larger and smaller West German border cities (the treatment sample), and their observation that German partition had a more severe impact on population growth of smaller cities than on comparable larger cities. This result corroborates the central finding from the cross-country literature: access to foreign markets disproportionately promotes the growth of smaller cities.

Due to data limitations, these studies could not track the effect of trade liberalization on city-level wages. Ahlfeldt, Redding, Sturm and Wolf (2015) explore spatial effects of the Iron Curtain using data on employment, wages, land prices and travel times. Their analysis, however, focuses on adjustment at the intra-city level (within Berlin). Hanson (1997) and Kovak (2013) estimate effects of trade liberalization on regional wages, but their papers do not differentiate regions by size, density or urbanization. Simultaneous wage and employment effects are estimated in a precursor paper (Brülhart, Carrère and Trionfetti, 2012), but that paper does not investigate the heterogeneous effects that interest us here, nor does it offer a theory that leads formally to the empirical model.

To the best of our knowledge, this is the first study to analyze jointly what happens to wages and employment across different-sized towns as external trade is liberalized.

3 A multi-town model of spatial adjustment

3.1 Building blocks

Consider a small open economy endowed with a mass Λ of individuals and a discrete number of towns denoted by $j \in \{1, ..., J\}$, each endowed with an exogenously given stock of housing, H_j, and an endogenous population/labor force, Λ_j. Individuals are imperfectly mobile across towns.[6] We capture mobility frictions in the following parsimonious way: a subset L of individuals are perfectly mobile and move in search of the highest utility, while the remaining individuals are perfectly immobile. We denote the exogenous mass of immobile individuals in town j by N_j (mnemonic for 'not mobile'). Therefore, $\Lambda_j \equiv L_j + N_j$.

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[6]Most recent theories of spatial labor allocation assume free intra-national mobility (e.g. Michaels, Rauch and Redding, 2012; Allen and Arkolakis, 2014; Desmet, Nagy and Rossi-Hansberg, 2015).

Production. Each individual supplies one unit of labor inelastically and each town produces an intermediate good Y_j combining both types of labor with a Cobb-Douglas technology:[7]

$$Y_j = L_j^\alpha N_j^{1-\alpha}. \tag{1}$$

Intermediates are then exported abroad, where they are assembled into a homogeneous final consumption good, Y. This sector is perfectly competitive. Its output is freely traded, which makes it a natural choice for our numeraire. We assume that technology is linear:

$$Y = \sum_{j=1}^{J} \frac{Y_j}{\tau_j}, \tag{2}$$

where τ_j is a town-specific iceberg trade/transportation cost that is inversely related to j's access to foreign markets.[8] Trade is balanced by virtue of equation (2): the economy exports the Y_j's for assembly and it imports the processed final good, Y.

Note that here lies a key difference between our model and geography models such as Helpman (1998): in our model, all output is traded, whereas in geography models a fraction of output is consumed locally. Since, in geography models, the locally consumed fraction of output is smaller in small towns, small towns are affected more strongly by a given change in trade costs. In our setting, however, the change in trade costs affects all towns equally, and differential responses have their origin on the supply side.

Preferences. Individuals consume two goods, the numeraire Y and housing H. We assume that individuals spend a constant share $1 - \mu$ of their income on housing. Specifically,

$$u(y, h) = \left(\frac{y}{\mu}\right)^\mu \left(\frac{h}{1-\mu}\right)^{1-\mu}, \tag{3}$$

where y and h denote per capita consumption of Y and H, respectively.

We denote the unit price of housing as r_j.

3.2 Equilibrium characterization

We define an equilibrium as a tuple $\{p_j, w_j, v_j, r_j, L_j, Y_j, Y, u\}$ such that firms minimize costs, consumers and mobile workers maximize utility, and markets clear.

The vector of prices (p_j, w_j, v_j, r_j) is defined in what follows. Let p_j denote the price of Y_j. Perfect competition in Y and our choice of numeraire together yield $1 = \min\{p_1\tau_1, ..., p_J\tau_J\}$. That is,

$$p_j = \frac{1}{\tau_j} \tag{4}$$

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[7]We need N and L to be imperfect substitutes in production in order to make our concept of modelling mobility frictions operational. Our choice of a Cobb-Douglas production function is for analytical convenience only and does not affect the properties of the equilibrium that we bring to the data. This assumption is consistent with the empirical evidence of e.g. Ottaviano and Peri (2012) and Ottaviano, Peri and Wright (2013), who find that (international) migrants tend to be complements, not substitutes, for local workers.

[8]Thus, the Y_j's are perfect substitutes. We impose this assumption to simplify the analysis. Replacing this production function with a finite and constant elasticity of substitution technology (Armington) does not add any insight for our purpose.

holds for all towns. The producer price prevailing in town j is inversely related to τ_j, i.e. it is positively related that town's overall access to markets. Henceforth, we equate an *improvement* in j's access to markets to a *rise* in p_j.

Let w_j and v_j denote the factor rewards of L_j and N_j, respectively. Perfect competition in the production of intermediates and in labor markets yields

$$w_j = \alpha p_j \left(\frac{N_j}{L_j} \right)^{1-\alpha}, \tag{5}$$

and

$$v_j = (1 - \alpha) p_j \left(\frac{L_j}{N_j} \right)^{\alpha}. \tag{6}$$

Wages of each type of labor are increasing in market access and in the intensity with which the complementary factor is used in production. Combining (5) and (6) yields $w_j^\alpha v_j^{1-\alpha} = \alpha^\alpha (1 - \alpha)^{1-\alpha} / \tau_j$, namely, the j-specific weighted (geometric) average of the prices of factor engaged in the production of the tradable good are increasing in the market access of town j as in e.g. Redding and Venables (2004).

Following an established tradition in the urban economics literature, we assume that landowners are 'absent'. This is without loss of generality for our purposes.[9] Maximizing equation (3) with respect to h subject to individual income, and aggregating among residents gives us the demand for housing in j, $H_j = (1 - \mu) p_j Y_j / r_j$. Equating housing supply with housing demand in value terms yields

$$r_j H_j = (1 - \mu) p_j Y_j. \tag{7}$$

The indirect utility of mobile workers associated with our Cobb-Douglas utility function (3) is equal to $u_j = w_j r_j^{-1+\mu}$. At a spatial equilibrium, no mobile worker wants to change location. That is to say, all towns with a positive mobile population in equilibrium offer the same real wage to those mobile workers, $u_j = u$, some $u > 0$, all j. Hence, the utility of mobile workers is given by

$$u = \frac{w_j}{r_j^{1-\mu}}. \tag{8}$$

Towns that pay low wages have a more affordable housing stock in equilibrium.

Finally, full employment of mobile workers yields

$$L = \sum_{j=1}^{J} L_j. \tag{9}$$

Firms established in towns with good market access can afford to pay high wages. This attracts mobile workers, which, in turn, increases housing demand and thus housing prices. At a spatial equilibrium, high wages in towns with good market access exactly compensate

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[9]More generally, let $\kappa \in [0, 1]$ denote the share of landowners that reside locally. In this case, the housing market equilibrium condition implies $r_j H_j [1 - \kappa(1 - \mu)] = (1 - \mu) p_j Y_j$. Imposing $\kappa = 0$, as we do henceforth, is without relevant loss of generality: qualitatively, the equilibrium expressions are equivalent. Quantitatively, the relative welfare changes are unchanged if we relax this assumption. We provide details in Appendix A3.

for the higher cost of living. Real wages are equalized. By the same token, towns endowed with a large amount of immobile resources (housing and immobile workers) tend to have low housing prices and high wages out of equilibrium. These attract mobile workers, and the spatial equilibrium is achieved when this in-migration has resulted in higher housing prices (by a demand effect) and lower nominal wages (through decreasing returns to labor) in a way that exactly matches the real wages that prevail in the rest of the domestic economy.

We summarize the key properties of the equilibrium in the following proposition.

Proposition 1 (equilibrium existence and properties) *(a) The equilibrium exists and is uniquely characterized by equations (1)-(9). (b) A town's equilibrium population Λ_j, its wage bill $p_j Y_j$, and its average wage $\omega_j \equiv p_j Y_j / \Lambda_j$ are increasing in its market access p_j.*

Proof. See Appendix. ∎

In order to characterize the properties of this unique equilibrium, note first that $p_j = 1/\tau_j$ by (4). We then use the spatial equilibrium condition in (8) as well as (1), (5), and (7) to write L_j as a function of $p_j = 1/\tau_j$ and of the exogenous variables, H_j and N_j, *conditional on u*:

$$L_j = \left(\frac{p_j^\mu A_j}{u}\right)^{\frac{1}{1-\alpha\mu}} N_j, \quad \text{where} \quad A_j \equiv \frac{\alpha}{(1-\mu)^{1-\mu}} \left(\frac{H_j}{N_j}\right)^{1-\mu} \tag{10}$$

is increasing in the town-specific per-immobile worker housing stock and plays a role similar to that of amenities (towns with high A are relatively abundant in housing and therefore more attractive). The share of mobile workers in j, $L_j/L = \left(p_j^\mu A_j\right)^{1/(1-\alpha\mu)} N_j / [\sum_i \left(p_i^\mu A_i\right)^{1/(1-\alpha\mu)} N_i]$, is increasing in own market access p_j and in the local stock of immobile complementary factors N_j and housing services H_j relative to those of other towns.

Finally, in the empirical section of the paper, we use town size and town density. It it thus useful to show how these two metrics relate to one another. The equilibrium town size is equal to

$$\Lambda_j \equiv L_j + N_j = N_j \left[1 + \left(\frac{p_j^\mu A_j}{u}\right)^{\frac{1}{1-\alpha\mu}}\right], \tag{11}$$

where the second equality follows from (10). The *population* density of j is the population divided by the area of developable land. Assuming that *physical* density, defined as housing divided by the area of developable land, is constant throughout the country (we henceforth normalize this physical density to unity by choice of units), equilibrium population density in j, which we label as d_j, is equal to

$$d_j \equiv \frac{\Lambda_j}{H_j} = \frac{N_j}{H_j} \left[1 + \left(\frac{p_j^\mu A_j}{u}\right)^{\frac{1}{1-\alpha\mu}}\right], \tag{12}$$

where the second equality follows from equation (11).

Town size and density are both increasing in a town's access to foreign markets by inspection of (11) and (12), respectively. Equilibrium town size and town density are also increasing in the local housing stock, in line with intuition.

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3.3 Normative properties of equilibrium outcome

We derive the well-being of individuals first and then compute the real wages at the town and country levels.

Individual equilibrium utility levels. We start with the nationwide well-being of mobile workers, which is subsumed in u. Solving expression (10) for L_j, summing across all towns, and using the full-employment condition (9) for mobile workers, yields

$$u = \left[\frac{1}{L} \sum_{j=1}^{J} \left(p_j^{\mu} A_j \right)^{\frac{1}{1-\alpha\mu}} N_j \right]^{1-\alpha\mu}. \tag{13}$$

Two aspects of expression (13) are noteworthy. First, u is a generalized average of the equilibrium value of a town's endowment (the term inside the square bracket on the right-hand side of (13)), which includes both the complementary factor of production, N_j, and the stock of housing, H_j. Second, *nation-wide* mobile workers are better off if access to markets increases in *any* town j, that is, $\partial u/\partial p_j > 0$, all j. Intuitively, raising market access somewhere raises wages there on impact and then wage rises diffuse everywhere by out-migration from other towns and decreasing returns to mobile labor (the latter effect also attenuates the impact effect on wages in the town whose market access has improved).

Turning to the well-being of immobile workers, let $\nu_j \equiv v_j/r_j^{1-\mu}$ denote the indirect utility of N_j. Making use of equations (5), (6), (8), and (10) yields

$$\nu_j = \frac{1-\alpha}{\alpha} \left(\frac{p_j^{\mu} A_j}{u^{\alpha\mu}} \right)^{\frac{1}{1-\alpha\mu}}. \tag{14}$$

Two properties of expression (14) are worth stressing. First, ν_j is increasing in the per-immobile-worker housing stock: a lower population density implies larger consumption of dwelling space for all. Second, it is increasing in own market access ($\partial \nu_j/\partial p_j > 0$) – a direct effect that operates via higher labor productivity in value and thus higher wages – and decreasing in overall market access by $\partial \nu_j/\partial u < 0$ and equation (13) – an indirect effect that operates via the migration of mobile workers.

Our focus is on the differential welfare effects of a trade shock of given intensity on large versus small towns. Let $\hat{x} \equiv dx/x$, any variable x. Totally log-differentiating expression (14) yields the following expression for the percentage change for the equilibrium well-being of immobile factor owners:

$$\hat{\nu}_j = \frac{\mu\hat{p}_j - \alpha\mu\hat{u} + (1-\mu)\hat{A}_j}{1-\alpha\mu}.$$

The first term on the right-hand side above represents the direct and idiosyncratic effect of an improvement of j's market access; the second term represents the indirect general-equilibrium effect of the overall improvement of the country's access to foreign markets; the third term establishes that the equilibrium return to immobile labor is positively associated with the local endowment of housing H_j and decreasing in the local stock of immobile labor N_j ($\hat{A}_j = 0$ in our empirical application). Note that these three effects are additively separable. This implies

that the welfare effects of trade liberalization on the immobile factor owners are independent of town size (market access and local endowments do not interact).

Aggregate equilibrium utility. Summing together the well-being of immobile workers across the country yields $\alpha \sum_j N_j \nu_j = (1-\alpha)Lu$ by equations (5), (6) and (8). Using this and equation (13), we obtain a metric for economy-wide welfare, which we denote by U:

$$U \equiv Lu + \sum_{j=1}^{J} N_j \nu_j = \frac{Lu}{\alpha}. \tag{15}$$

U readily borrows the properties of u by equation (13). It thus follows that aggregate welfare is increasing in market access and in the relative abundance of the housing stock: $\partial U / \partial p_j > 0$ and $\partial U / \partial A_j > 0$, any j.

Equilibrium utility of towns. Let $\ell_j \equiv L_j/\Lambda_j$ denote the share of mobile workers in town j and let $\bar{u}_j \equiv \ell_j u + (1-\ell_j)\nu_j$ denote the average real wage of workers residing in town j: mobile workers enjoy u irrespective of j and immobile workers enjoy ν_j. Using equation (14), we obtain the following expression for $\bar{u}_j$:

$$\bar{u}_j = \frac{\ell_j u}{\alpha}. \tag{16}$$

The properties of this expression are inherited from the Cobb-Douglas structure of the production function (1): α is the share of revenue that accrues to mobile workers (measured either in nominal or in real terms). Thus, the average well-being in j is larger than the well-being of mobile workers if and only if the well-being of immobile workers in j is larger than u, i.e. $\nu_j > u$. Given the fixed splitting rule induced by the Cobb-Douglas production function, this is possible if and only if the share of mobile workers in town j is larger than the share of mobile workers in production, i.e. $\ell_j > \alpha$.

The average welfare effects of trade liberalization depend on town size. Indeed, totally log-differentiating expression (16) yields

$$\hat{\bar{u}}_j = \hat{\ell}_j + \hat{u}.$$

The indirect, general equilibrium effect works through $\hat{u}$ as for $\hat{\nu}_j$. The novelty is in the idiosyncratic effect, $\hat{\ell}_j$. As we shall see in Subsection 4.2, an improvement in j's market access raises ℓ_j and this positive effect is decreasing in town size and density.

Taken together, these two results imply that differential welfare changes subsequent to trade liberalization are the outcome of a composition effect: an improvement in j's market access raises prices and thus wages of both mobile and immobile workers, which in turn attracts mobile workers. This in-migration of mobile workers raises the productivity of immobile workers, who thus get an extra fillip. If the proportion of immobile workers is positively correlated with town size in equilibrium, this composition effect works in favor of large towns.[10]

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[10]These results also hold when land is locally owned; see Appendix A.3.

4 Comparative statics and triple differencing

The empirical model of Sections 5 and 6 will be firmly grounded in our tractable theory. Specifically, we use a triple-difference estimation strategy to estimate and identify the differential effect of trade liberalization on small and large towns.

4.1 'Structural' triple difference

We are interested in the effects of variations in market access on town sizes, wages, and composition. As we explain in the empirical section below, we exploit the exogenous and unanticipated fall of the Iron Curtain around 1990 as the source of exogenous variation in market access across Austrian towns. The first *difference* of our empirical strategy is thus before versus after 1990. Not all towns were similarly affected, however. Towns close to the Austria's eastern border enjoyed a larger increase in access to formerly closed markets than interior Austrian towns; this is the second *difference* of our empirical strategy. Finally, large and small towns are not affected in the same way; this distinction is at the core of our third *difference* below. It turns out that this triple difference empirical strategy arises structurally from our model.

Henceforth, we keep the endowments of immobile workers and housing fixed, i.e. $\hat{N}_j = \hat{H}_j = \hat{A}_j = 0$, all j. Let $\omega_j \equiv \ell_j w_j + (1 - \ell_j)v_j$ denote the average wage in town j. Using equations (5) and (6) as well as the definitions of Λ_j and ℓ_j, we may write $(1 - \alpha)\ell_j w_j = \alpha(1 - \ell_j)v_j$. This implies that the equilibrium average wage is equal to

$$\omega_j = \frac{\ell_j w_j}{\alpha}.$$

First difference: before/after 1990. Here we interpret $\hat{p}_j$ as $\hat{p}_j = (p_j^{t<1990} - p_j^{t\geq1990})/p_j^{t<1990}$, where t denotes the year. It follows from the expression above that $\hat{\omega}_j = \hat{w}_j + \hat{\ell}_j$, which is equal to

$$\hat{\omega}_j = \frac{(1 - \mu\ell_j)\hat{p}_j + (\ell_j - \alpha)\hat{u}}{1 - \alpha\mu}. \tag{17}$$

That is, improved market access for town j raises producer prices (recall that $p_j = 1/\tau_j$) and, as a result, wages too; in symbols, $\partial\hat{\omega}_j/\partial\hat{p}_j > 0$.[11] The ambiguous effect of $\hat{u}$ on $\hat{\omega}_j$ arises from the fact that this variable captures the country-wide average welfare effect of an *overall* better market access: on the one hand, the increase in mobile workers' wages increases the average wage of all towns. On the other hand, improved market access in other towns attracts workers from town j and this reduces the wage of local immobile workers because these factors are complements in production. If town j's initial share of mobile workers is larger than the share of mobile workers in the value of production, then the former positive effect dominates and town j's average wages increase.

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[11]To obtain the result in (17), differentiate the expression above to get $\hat{\omega}_j = \hat{\ell}_j + \hat{w}_j = \hat{\ell}_j + \hat{p}_j - (1 - \alpha)\hat{L}_j$, where the second equality follows from (5). In turn, total differentiation of (23) below yields $\hat{\ell}_j = (1 - \ell_j)\hat{L}_j = (\mu\hat{p}_j - \hat{u})(1 - \ell_j)/(1 - \alpha\mu)$. With some additional manipulations, these equations together yield (17).

Differentiating (11) and (12) using (23), we find that population size and population density evolve according to

$$\hat{\Lambda}_j = \hat{d}_j = \frac{\ell_j(\mu\hat{p}_j - \hat{u})}{1 - \alpha\mu}, \tag{18}$$

namely, the size and density of town j are increasing in own market access and decreasing in country-wide market access. Finally, the wage bill evolves according to

$$\hat{\Lambda}_j + \hat{\omega}_j = \frac{\hat{p}_j + \alpha\hat{u}}{1 - \alpha\mu} \tag{19}$$

by equations (17) and (18). The wage bill of any town is increasing in both its own and the nationwide market access. The latter effect arises because improvements in the nationwide market access increase the wage of mobile workers everywhere.

Second difference: border/non-border towns. We do not observe $\hat{u}$ in the data; we thus use a difference-in-difference empirical strategy to purge $\hat{u}$ from our estimations. Specifically, we identify the differential effect of increased market access using differential geography. Consider two towns, b and n, that are identical in all respects (population size in particular) except one: b is a border town (it is part of the *treatment group*) while n is a non-border town (it is part of the *control group*).[12] Let $\hat{p}_b = \hat{p} + \Delta$ ('treatment') and $\hat{p}_n = \hat{p}$ ('control'), where $\hat{p}$ is the shock common to all Austrian towns and Δ is the extra fillip that benefits border towns. Then, normalizing $\Delta = 1$ (Δ and $(1 - \alpha\mu)^{-1}$ cannot be separately identified), the differential relative changes in workforces are equal to

$$\hat{\Lambda}_b - \hat{\Lambda}_n = \frac{\mu\ell_j}{1 - \alpha\mu} > 0, \tag{20}$$

$j \in \{b, n\}$. Note that the magnitude of this treatment effect is conditional on the labor composition of each town, ℓ_j. We use town size as a proxy for ℓ_j in the empirical section of the paper (we also interact the treatment effect with town size; more on this below). By the same token, the differential effects on town wages and wage bills are equal to

$$\hat{\omega}_b - \hat{\omega}_n = \frac{1 - \mu\ell_j}{1 - \alpha\mu} > 0 \tag{21}$$

and

$$\left(\hat{\Lambda}_b + \hat{\omega}_b\right) - \left(\hat{\Lambda}_n + \hat{\omega}_n\right) = \frac{1}{1 - \alpha\mu} > 0, \tag{22}$$

respectively. The inequalities in (20)-(22) hold by inspection since all parameters and the share ℓ_j belong to the unit interval.

We test the properties of (20)-(22) in the empirical section and we summarize them in the following proposition:

Proposition 2 (border/non-border towns) *Following the 1990 shock, the population size, the average wage, and the wage bill of border towns increase relative to those of non-border towns.*

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[12]This is a slight abuse of language because all towns are affected, albeit indirectly, as people move in adjusting to a market access shock. Note, however that this indirect effect is the same for all towns so that the diff-in-diff strategy purges it.

Proof. By inspection of (20), (21), and (22), respectively. ∎

Third difference: large/small towns. The interaction of ℓ_j with the border/non-border treatment is positive in the employment equation (20), negative in the wage equation (21), and nil in the wage bill equation (22). That is to say, the magnitudes of the quantity and price effects will depend on the labor *composition* of towns. Using expression (10) and the definition of ℓ_j as the share of mobile workers residing in town j, we obtain an implicit solution for it:

$$\left(\frac{\ell_j}{1-\ell_j}\right)^{1-\alpha\mu} = \left(\frac{L_j}{N_j}\right)^{1-\alpha\mu} = \frac{p_j^\mu A_j}{u}. \tag{23}$$

Neither H_j nor N_j are directly observable in our data, and hence we do not know A_j. We thus impose a relationship between the two so that the system remains over-identified, which enables us to test it. The economically most plausible assumption to make is that H_j and N_j are positively related, that is, the housing stock is larger in towns endowed with more immobile individuals (the fact that the housing stock is increasing in population can easily be micro-founded). In order to guide us and tie our hands further, we build on the empirical regularity whereby human density is increasing in population size across towns and cities. The expression above being log-linear, these considerations lead us to impose

$$H_j = \eta N_j^\lambda, \tag{24}$$

some $\eta, \lambda > 0$, and

$$\left(\frac{\ell_j}{1-\ell_j}\right)^{1-\alpha\mu} = \frac{p_j^\mu}{N_j^{(1-\mu)(1-\lambda)} u} \tag{25}$$

by choice of units (i.e. choosing $\eta \equiv 1 - \mu/\alpha^{1/(1-\mu)}$). In equilibrium, towns endowed with large stocks of immobile factors have a large population as per equation (10), thus the equilibrium relationship (25) implies that ℓ_j is *decreasing* in town size given p_j if and only if $\lambda < 1$.[13] Is this a reasonable assumption? Plugging (25) into (12) and using the definition of ℓ_j yields the following expression for equilibrium density:

$$d_j = \frac{\Lambda_j^{1-\lambda}}{\eta(1-\ell_j)^\lambda},$$

where the second equality uses the definitions of ℓ_j and Λ_j. This implies that population density and population size are positively correlated (conditional on town composition, ℓ_j) if and only if $\lambda < 1$, as is empirically the case.[14] We thus impose $\lambda \in (0,1)$ henceforth.

Combined with equations (20)-(22), these imply the following:

Proposition 3 (large/small towns) *Following the 1990 shock, the population size and density of large border towns fall relative to the size of small border towns; the average wage of large border towns increases relative to small towns; and there is no differential effect on the wage bills of large and small border towns.*

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[13]This is consistent with available evidence for US metropolitan areas. Monras (2015) reports that the (conditional) correlation between in- and out-migration flows and city size are positive but below unity.

[14]In our data for Austrian municipalities, the correlation between total employment and employment density is 0.34.

Proof. See Appendix. ∎

We test the properties of this Proposition in the empirical section.

4.2 Welfare effects

We start by signing the welfare effect of the trade shock on the average worker of town j. Log-differentiating equation (16) yields the following metric for the average welfare gain in j: $\hat{\bar{u}}_j = \hat{\ell}_j + \hat{u}$. Comparing a pair of towns of initially equal population composition and size, one border- and one non-border-town, yields

$$\hat{\bar{u}}_b - \hat{\bar{u}}_n = \hat{\ell}_b - \hat{\ell}_n = (1 - \ell_j)\frac{\mu}{1 - \alpha\mu}, \tag{26}$$

where $(1 - \ell_j)$ is the initial share of immobile workers and where the second equality follows from total differentiation of equation (25) and from $\hat{p}_b - \hat{p}_n = 1$. By the same token, we differentiate equation (14) in order to obtain an explicit expression for the welfare changes of immobile workers, i.e. $\hat{\nu}_j = \hat{\ell}_j - \hat{u}$. Comparing the same pair of otherwise identical border and interior towns yields

$$\hat{\nu}_b - \hat{\nu}_n = \left(\widehat{\frac{\ell_j}{1 - \ell_j}}\right) = \frac{\mu}{1 - \alpha\mu}, \tag{27}$$

$j = b, n$, where the second equality follows from total differentiation of expression (25) and from $\hat{p}_b - \hat{p}_n = 1$.

We conclude from expression (27) that the gains from market access enjoyed by border-town *immobile* workers relative the gains experienced by immobile workers in interior towns are independent of town size: the direct price effect (better market access) is compensated by the indirect price effect (more immigration raises housing prices). This invariance does not hold for the *average* worker. Recalling that the share of mobile workers ℓ_j is decreasing in town size by Proposition 2, it follows from (26) that real wages in large towns benefit more from market access than real wages in small towns. These results are consistent with the fact that the main effect of a change in market access of large towns is a price (wage) effect; see (17). Together, the invariance result for the immobile workers and the size premium for the average worker imply that the dominant welfare effect is a *composition* effect.

5 Empirical setting and estimation strategy

5.1 Austria and the end of Iron Curtain: A case of exogenous trade liberalization

Austria offers a propitious setting, akin to a natural experiment, within which to explore regional responses to changes in trade openness. Austria has long been a very open economy, with exports and imports corresponding to 58 percent of GDP in 1975 and to 93 percent in 2002. It was the OECD's fifth most trade-oriented country in 1990. Despite its geographic centrality, however, post-War Austria had lain at Europe's economic periphery for more than

four decades. In 1976, at the beginning of our sample period, the country still belonged to the eastern edge of democratic, market-oriented Europe. By 2002, which marks the end of our sample period, it had become the geographical heart of a continent-wide market economy. Crucially for our study, the fall of the Iron Curtain in the second half of 1989 triggered a change in trade openness that was large and unanticipated. Similarly importantly, during the period covered by our study, this transformation took the form of an almost pure trade shock: a large change in cross-border openness of goods markets associated with continuing segmentation of cross-border labor markets. As a consequence, by 2002 Austrian trade shares with the country's eastern neighbors had increased by a factor of more than three, while those with its established western neighbors had shrunk by up to 20 percent.[15]

We define 1990 as the moment that marked the general recognition of a lasting economic transformation of the Central and Eastern European countries (CEECs) and of their new potential as trade partners. Actual trade barriers, however, did not fall immediately. Hence, the decade following 1990 was a period of gradual but profound and lasting mutual opening of trade, to an extent that up to the very late 1980s had been largely unanticipated.

Austria's east-west elongated geography accentuates the fact that access to the eastern markets becomes relatively less important than access to western markets as one crosses Austria from east to west. This offers us the required identifying variation for the estimation of trade effects. We compare post- versus pre-1990 trends in eastern Austrian border regions (the treatment group) with post- versus pre-1990 trends in the rest of Austria (the control group). To the extent that no other major exogenous change affected the treatment group over the treatment period, the resulting difference-in-difference estimates can be interpreted as the causal effects of increased trade openness.

5.2 Data

Our key variables are municipality-level employment and wages computed from the Austrian Social Security Database (ASSD). The ASSD reports individual labor-market histories, including wages, for the universe of Austrian workers.[16] These records can be matched to establishments, which allows us to allocate workers to locations. We observe wages and employment at three-month intervals, taken at the mid point of each quarter, yielding 108 measurements from the first quarter of 1976 to the fourth quarter of 2002.

The ASSD assigns every establishment to one of 2,305 municipalities. We treat municipalities as individual locations unless they are included in one of the 33 functional urban areas

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[15]The transition toward free cross-border worker mobility began with EU enlargement in 2004. Throughout our post-liberalization sample period 1990-2002, however, integration between the CEECs and the EU was characterized by very limited labor flows but strong trade integration and increasing capital market integration (OECD, 2001). For additional institutional and statistical details on the trade shock implied for Austria by the fall of the Iron Curtain, as well as for evidence on the intra-national spatial gradient of economic links to neighboring countries, see Brülhart *et al.* (2012).

[16]For a full description, see Zweimüller, Winter-Ebmer, Lalive, Kuhn, Wuellrich, Ruf and Büchi (2009). Due to missing data for public-sector workers and the self-employed, we work exclusively with data pertaining to private-sector employees.

defined by Statistics Austria, in which case they are aggregated as one location. Our "towns" therefore are either a (mostly small) municipality or a group of municipalities that is defined by the statistical office as an integrated urban area. Our data set contains 2,047 towns. In order to minimize distortions from top coding, we construct wages as medians across individuals by town. Wages are recorded on a per-day basis, which means that they are comparable irrespective of whether employment contracts are part-time or full-time. Table 1 provides descriptive statistics.

Our identification strategy will hinge on the relative distances of these towns to eastern markets. We retain two distance measures, both based on road distances in order to account for the mountainous topography of much of Austria:

- the road distance to the nearest border crossing with a CEEC country (see Figure 1),

- the road distance to the nearest CEEC town with a population of at least 50,000 or 20,000 in 1990 (see Figure 2).[17]

Figure 3 illustrates the key relation we exploit for our empirical analysis, by showing the estimated post-1990 growth differential of town-level wage bills against the towns' distance from the eastern border based on natural spline regressions.[18] The plot shows that there is a statistically significantly positive wage-bill effect for municipalities that are located close to Austria's eastern border, whereas there is none for municipalities beyond about 70 kilometres from the border, with Vienna, at 65 kilometres, still significantly affected. The differential effect of post-1990 market opening was thus confined to a relatively narrow band of towns located close to the border.

5.3   Estimation strategy

We exploit our quasi-experimental set-up for triple-difference estimation as derived in Section 4.

Specifically, we estimate the following three equations:

$$\Delta\left(W_{jt} \times E_{jt}\right) = \alpha_1(Fall_t \times Border_j \times Size_j) + \alpha_2(Fall_t \times Border_j) + \alpha_3(Fall_t \times Size_j) + d_j + d_t + \varepsilon_{jt}^{WE},$$
$$(28)$$

$$\Delta W_{jt} = \beta_1(Fall_t \times Border_j \times Size_j) + \beta_2(Fall_t \times Border_j) + \beta_3(Fall_t \times Size_j) + d_j + d_t + \varepsilon_{jt}^{W},$$
$$(29)$$

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[17]Road distances were obtained from Digital Data Services GmbH, Karlsruhe, Germany. Only border crossings allowing for the handling of trucks carrying 3.5 tons or more are considered. These data pertain to measurements taken in the early 1990s. While some cross-border roads have been upgraded after 1990, we are not aware of any significant new border crossings that have been constructed between 1990 and 2002, except for a highway link with Slovenia that was opened in 1991.

[18]The smoothed lines are obtained by creating variables containing a cubic spline with seven nodes of the variable on the horizontal axis (distance to the eastern border) and by plotting the fitted values obtained from an employment-weighted regression of the post-1990 wage-bill growth on the spline variables.

$$\Delta E_{jt} = \gamma_1(Fall_t \times Border_j \times Size_j) + \gamma_2(Fall_t \times Border_j) + \gamma_3(Fall_t \times Size_j) + d_j + d_t + \varepsilon_{jt}^E, \quad (30)$$

where W_{jt} is the nominal wage in town j and period t; $Size_j$ denotes mean-differenced town-level employment averaged over the pre-treatment period 1976-1989; $Border_j$ is a dummy for border (i.e. treatment) regions; $Fall_t$ is a dummy for quarters from 1990 onwards (the treatment period); d_j and d_t are time and town fixed effects, respectively; and ε_{jt}^{WE}, ε_{jt}^{W} and ε_{jt}^{E} are stochastic error terms. Δ denotes year-on-year percentage changes.[19] Hence, unobserved time-invariant heterogeneity in town-specific wage and employment levels are differenced out. Moreover, the town dummies control for any unexplained differences in linear trends, and the time dummies control for nation-wide temporary shocks to wages and employment, including the common impact of the fall of the Iron Curtain on median wages and employment across all of Austria.

Our main interest is in the coefficients on the triple interactions, $\widehat{\alpha}_1$, $\widehat{\beta}_1$ and $\widehat{\gamma}_1$. According to Proposition 3, bigger towns have stronger wage effects ($\beta_1 > 0$) but weaker employment effects ($\gamma_1 < 0$) than smaller towns. The model also predicts that the two effects cancel out, such that the effect of trade liberalization on the total town-level wage bill is invariant with town size ($\alpha_1 = 0$).

In an alternative specification, we seek to control for the possibility that border regions differ systematically from interior regions not only in terms of geography but also in terms of size and industrial composition. We therefore reduce the set of control (i.e. interior) municipalities to those that provide the nearest match to at least one of the treatment (i.e. border) municipalities in terms of the sum of squared differences in sectoral employment levels, measured in 1989. We compute parameter estimates as average treatment effects in a setup where we match municipality-specific differential pre-versus-post-1990 growth rates between pairs of border and interior municipalities with the most similar sectoral employment structures.

Standard errors are clustered by municipality in all of our estimations.

6 Estimation results

6.1 Baseline estimates

Our baseline results are shown in Table 2. We report estimates of equations (28) to (30) for four different definitions of $Border_j$, our indicator variable for the treatment sample. The coefficients on the interaction term ($Fall_t \times Border_j$) are positive throughout and mostly statistically significant. This shows that, compared to interior towns, towns close to Austria's eastern border have experienced stronger growth in both employment and wages after the fall of the Iron Curtain. This effect, however, was unevenly shared across border towns. In line with Proposition 3, our estimated coefficients on the triple interaction ($Fall_t \times Border_j \times Size_j$) are consistently positive and statistically significant for wages and negative and statistically

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[19]ΔW_{jt} is computed as follows: $\Delta W_{jt} = \frac{W_{jt} - W_{jt-4}}{[W_{jt} + W_{jt-4}]\frac{1}{2}}$.

significant for employment. The key prediction of our model is thus confirmed: larger towns seem to have responded to external trade opening mainly through wage rises, whereas small towns responded mainly through employment growth. Also in line with our model, these two effects appear to offset each other: we observe no statistically significantly different effects on small and large towns in terms of total town-level wage bills.

Figure 4 offers a non-parametric illustration of our central finding. In this graph, we plot residuals of equations (29) and (30), not including the triple interaction terms, against the log of pre-1990 town-level employment. It becomes clearly apparent that small towns have stronger employment effects and weaker wage effects than large towns, and that this configuration reverses as one moves up the distribution of town sizes.

Specifications (29) and (30) allow us to estimate effects averaged over the full 1990-2002 treatment period. It is straightforward to document the timing of adjustment by estimating effects separately for each treatment-period year through the interaction of the term term $(Fall_t \times Border_j)$ with year dummies, separately for small and large towns. We illustrate these effects in Tables 5 and 6. The graphs show that our chosen treatment period is long enough: by 2002 employment and wages no longer grew disproportionally in border towns. Moreover, we observe that wage effects, significant only among the large towns, were strongest in the 1995-1998 period, whereas the employment growth of small towns peaked in the 1997-2001 period. The main wage effects therefore preceded the main employment effects by some two years.

6.2 Robustness

In Table 3, we subject the baseline estimates to a range of sensitivity tests. First, we add a dummy variable for the state of Burgenland post-1995, as this economically lagging region became eligible for generous EU subsidies after Austria joined the EU in 1995 and could thereby drive our estimated treatment effects. Second, we estimate the baseline model without including Vienna, to control for a potentially distorting effect of urban primacy in the control group.[20] Third, we truncate our sample at the other end of the size distribution, by dropping the 10 percent smallest towns, as measured by their pre-1990 employment. None of these three changes qualitatively affect our baseline results. The only notable difference is that in the samples without Vienna and without the smallest towns, the total wage-bill effect appears to be significantly stronger in small towns than in large towns.

We also experiment with the definition of $Size_j$. In the fourth robustness test reported in Table 3, we replace the baseline definition by an inversely distance-weighted measure of a town's own employment and that of it neighbours.[21] This measure is designed to take

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[20]See Nagy (2013) for a model of border changes affecting the spatial economy not only through the "local" market access channel we study in this paper but also through a "global" channel determined by changing relative distances to a country's dominant city.

[21]Specifically, we apply the standard centrality measure $Centrality_j = \sum_{m=1}^{M} E_m^{pre-1990} D_{jm}^{-2}$, where D_{jm} denotes the road distance between towns j and m, and $D_{jj} = 0.67\sqrt{area_j/\pi}$ (see e.g. Head and Mayer, 2010).

account of commuting and other spillover mechanisms among real-world towns (see Monte, Redding and Rossi-Hansberg, 2015). In another alternative definition, we compute $Size_j$ as employment density, dividing employment by constructible land area.[22] As shown in rows (D) and (E) of Table 3, our baseline results are robust to these variations in the definition of town size.

In a further sensitivity check, we augment the baseline models (28) to (30) by municipality-level pre-treatment unemployment rates and their interactions with $Fall_t$ and with $Fall_t \times Border_j$.[23] This serves as a test of our theory, as the diagnosed more elastic local labor-supply schedules in smaller towns could conceivably also be explained by higher unemployment rates in smaller towns. This would be an alternative mechanism to that identified in our model. The initial-unemployment mechanism, however, is doubly rejected by the data. First, the raw correlation between pre-treatment unemployment rates and $Size_j$ is in fact weakly positive: 0.04 for both our baseline definition of $Size_j$ and for density. Second, our estimated coefficients on the triple interaction, though slightly reduced in absolute size, retain their signs and statistical significance (Table 3, row F). Hence, different unemployment rates across different-sized towns do not seem to drive our results.

Another conceivable mechanism could be due to different skill compositions across different-sized towns and the associated comparative-advantage effects of trade liberalization. If Austria is skill abundant relative to its eastern neighbors, and large towns are skill abundant compared to small towns, then a standard Heckscher-Ohlin mechanism may give rise to the above-average wage increases in large towns. We therefore re-estimate our model for blue collar workers only.[24] As an additional robustness check, we show this specification estimated with total pre- and post-1990 growth rates instead of the quarterly series used so far. Row (G) shows that this change leaves the baseline estimates essentially unaffected. Finally, row (H) shows that above-average wage effects in large towns are found also when restricting the sample to blue collar workers. This effect is about a third smaller than in the baseline, suggesting that heterogeneous skill compositions may also play some role.

Austria's eastern border regions were and remain economically less developed than most other Austrian regions. Hence, differential wage and employment trajectories between border and interior towns could be due to sector-specific trends rather than the impact of trade lib-

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The correlation between our benchmark measure of $Size_j$ and this centrality measure is 0.315.

[22]Constructible land area is defined as total area minus forest, water and uninhabitable mountain surfaces. The correlation between our benchmark measure of $Size_j$ and this density measure is 0.314. The correlation between the centrality and density measures is 0.991.

[23]We use town-level unemployment counts for 1971 and 1981, divided by town-level populations in those years. Being based on population censuses, these are the closest pre-treatment years for which town-level data are available.

[24]Austrian labor law distinguishes two types of employee contract, "Arbeiter" and "Angestellte", and this distinction is reported in the ASSD. The former contract is used exclusively for low-skill manual workers and thus allows us to restrict the sample to blue collar workers. The latter contract was historically reserved to white collar jobs but has become used more broadly. As a result, the residual category of workers not part of our blue collar category contains a mixture of blue and white collar workers and is therefore uninformative for an analysis by skill group.

eralization. We address this issue by estimating average treatment effects of $Fall_t \times Border_j$ after matching each border town with up to two interior towns that resemble the border town most closely in terms of their pre-treatment employment distributions across primary, secondary and tertiary activities.[25] In the first panel of Table 4, we show that the matching procedure does not undo the detected treatment effects on average border-town wages and employment. In the second and third panels of Table 4, we compute treatment effects separately for large towns and for small towns. It becomes apparent again that the wage bill effect is nearly identical across the two subsamples, but that the wage effect is stronger in large towns while the employment effect is somewhat larger in small towns.

Alternatively, one might suspect that in an era of expanding cross-border trade and rapid European integration, border regions generally fared better than interior regions, and that the effects we attribute to the opening of central and eastern European economies in fact were generic features of border regions in the post-1990 period. We examine this proposition by re-estimating our baseline empirical model augmented by a placebo treatment group, defined as towns within 25 kilometres from the nearest road border crossing with one of Austria's western neighbor countries, Germany, Italy, Switzerland or Liechtenstein. We add this placebo treatment to the baseline specification, and we introduce it on its own, omitting the eastern border towns from the sample. The estimation results are presented in Table 5. Controlling for the placebo group does not qualitatively affect our estimates for the original treatment, and we find no statistically significant coefficients on the triple interaction term in the placebo treatment. We do observe, however, that western border regions experienced significantly below-average employment growth post-1990. This clearly shows that the post-1990 gains in eastern border regions did not reflect a positive employment trend in border regions in general. Hence, our placebo results support the case for interpreting our baseline findings as the causal effects of trade liberalization induced by the fall of the Iron Curtain.

6.3   Inferring welfare effects

The structural link between our empirical and theoretical models allows us to back out certain welfare effects implied by our estimates. More precisely, we can back out the differential effects of border versus interior towns conditional on town size as per equations (26) and (27) (our triple-difference empirical strategy prevents us from estimating the economy-wide welfare change $\hat{u}$).

It would appear natural, given the focus of this paper, to compute such effects separately for small and large border towns. In our model, however, the effect of trade liberalization on individual border-town workers is independent of town size, and differential town-level average effects are driven purely by changes in workforce composition (see Section 4.2).[26]

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[25]The ASSD data also contain information on somewhat more disaggregated sector affiliations, but we found this information to be too noisy to be informative.

[26]As evident from equation (26), these composition effects are determined by towns' initial shares of mobile workers, ℓ_j. Since our model does not allow us to derive an explicit function linking ℓ_j to equilibrium town size Λ_j, we cannot compute the distribution of compositional effects across town sizes implied by the empirical

We can, however, infer the differential welfare effect for immobile workers in border towns relative to immobile workers in interior towns, $\hat{\nu}_b - \hat{\nu}_n$, given by equation (27). The right-hand side of (27) corresponds to μ times the difference-in-difference wage bill effect of equation (22).

Staying as close as possible to (22), we project the 2002 wage and employment level for each municipality based on a linear extrapolation of the trend up to 1990, express these extrapolated values relative to the observed 2002 values, and compute the difference of these differences between border and interior municipalities. Taking the baseline 25-kilometer treatment definition, Table 6 shows that his computation yields a quite precisely estimated value of 0.40, both with OLS and when matching on pre-1990 population size. This implies that, on average and controlling for pre-treatment trends, treatment towns experienced 40% stronger wage-bill growth than control towns.[27]

By equation (22), and considering that we imposed the convenient normalisations $\hat{p}_b - \hat{p}_n = 1$, this estimate corresponds to $(\hat{p}_b - \hat{p}_n)/(1 - \alpha\mu)$ of our model. In order to compute the differential welfare effect $\hat{\nu}_b - \hat{\nu}_n$, we need to multiply this ratio by μ (see eq. 27), the expenditure share of goods other than housing. This expenditure share is very stable in Austria at 77%.[28] Hence, our model and estimates imply a differential welfare boost to immobile border-town residents (workers and landlords) of some 31% (= 0.40 * 0.77).

One way of cross-validating this result is by looking a housing prices. If, as in our model, housing is supplied inelastically, or, more generally, if the elasticity of housing supply is uncorrelated with being a border or interior town conditional on size, then relative changes in housing prices should be of equal magnitude. We therefore track the evolution of housing prices in two similarly sized towns, Klagenfurt in the border region and Innsbruck in the interior region, before and after 1990.[29] Figure 7 tracks relative rental prices for six different apartment types over our sample period. It is evident that a change of fortunes occurred in the early 1990s: while Klagenfurt prices had been falling relative to Innsbruck prices throughout the 1980s, this trend was reversed in the 1990s. This evolution is consistent with our finding that the fall of the Iron Curtain significantly boosted the economies of border towns relatively to interior towns.

We can quantify the relative increase in border-town housing prices through a difference-in-differences comparison of predicted and actual prices at the end of the sample period. Specifically, we take the data shown in Figure 5, compute average annual price growth rates in both towns up to 1991, use these growth rates to project price levels in 1999, and then compare those projected values to the observed 1999 prices.[30] Averaged across the six apartment types,

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estimates.

[27]In Table 6, we also report separate matching estimates for small and large towns. These results are qualitatively equivalent to the matching estimates shown in Table 4.

[28]See series "Verbrauchsausgaben" (household expenditures) by Statistik Austria. This value is very similar to that observed over the same time period in the United States (Davis and Ortalo-Magné, 2011).

[29]Sub-national Austrian house price data for the 1980s and 1990s exist only at the level of eight regional capitals, of which only Klagenfurt is in the border region (see Figures 1 and 2). According to the 1991 census, Klagenfurt was Austria's 6th largest town (population 89,000) and Innsbruck was Austria's 5th largest town (population 118,000).

[30]Because of a break in the data series in 2000, we cannot track housing prices up to 2002. Figure 7, however,

realized Klagenfurt prices were 1.46 times higher in 1999 than those predicted by a linear extrapolation of the trend prior to 1991. The corresponding number for Innsbruck is 1.14. Hence, the cumulative excess price growth in the border town was 32% (=1.46-1.14). This value almost exactly matches the differential income gain of immobile border-town workers, estimated to be 0.31. The evolution of housing prices therefore corroborates the our welfare estimates based on employment and wage changes.

7 Conclusions

We have explored the impact of trade liberalization on employment and wage growth of different-sized towns. Our multi-region model, in which adjustment to external trade liberalization takes place via internal labor migration, implies that local labor supply schedules are more elastic in small than in large towns. The theory therefore predicts that trade liberalization will trigger stronger wage effects in large towns and stronger employment effects in small towns. The model directly leads to triple-difference empirical strategy that we take to regional data for Austria.

The fall of the Iron Curtain in 1990 represents a large and fully exogenous trade shock for the Austrian economy. Eastern Austrian towns being more exposed to this shock than interior towns, we have defined eastern border regions as the treatment group and the rest of Austria as the control group. In line with the theoretical prediction, we detect significant heterogeneity in treatment effects across the size distribution of towns. Larger towns are found to have larger nominal wage responses, but smaller employment responses, than smaller towns. In terms of aggregate wage-bill responses, the two effects cancel out, again in line with our theoretical predictions.

The positive predictions of our model are thus borne out by the experience of Austrian towns. This raises the question of the theory's normative implications. In our model, immobile residents of regions benefiting from improved market access benefit equally across large and small towns, but they gain more than mobile workers. Since large towns attract proportionally fewer mobile workers than small towns, the per-resident gain in large towns turns out to be larger than the per-resident gain in small towns (a composition effect). In other words: at the post-trade equilibrium, mobile workers are indifferent with regard to the town they work in, but immobile workers are better off in a border town - irrespective of the border town's size. A town mayor, however, would rather preside over a large border town than over a small border town, as the sum of welfare gains is larger in larger towns.

The structure of our model allows us to infer the differential welfare boost experienced by owners of immobile factors in border towns relative to immobile factors in interior towns. We estimate that border-town immobile factors enjoyed a liberalization-induced welfare premium of some 40%. This estimate is consistent with the observed magnitude of differential post-1990 increases in housing prices. While neither our model nor the available data on housing prices

suggests that the relative catch-up of Klagenfurt prices culminated around 1998.

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allow us to estimate differential average welfare effects in small and large border towns, the structure of our model is such as to suggest that the differential welfare effects as a function of distance to the border are considerably larger than differential welfare effects as a function of town size. Put simply: for town-level gains from trade proximity to the border matters more than town size.

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A Appendix: Proofs

A.1 Proof of Proposition 1

Proof. Part (**a**). The system is bloc recursive. We solve it in three steps. Step (**i**). Note first that $p_j = 1/\tau_j$ by (4). Second, we use the spatial equilibrium condition in (8) as well as (1), (5), and (7) to write L_j as a function of $p_j = 1/\tau_j$ and of the exogenous variables H_j and N_j, *conditional on u*, namely, $L_j^{1-\alpha\mu} = \alpha(1-\mu)^{-1+\mu}H_j^{1-\mu}N_j^{(1-\alpha)\mu}\tau_j^{-\mu}u^{-1}$. Step (**ii**). We can get all the other endogenous variables conditional on u and the vector $\{L_j\}_{j=1}^J$. First, (1) provides a one-to-one relationship between L_j and Y_j (given N_j). In turn, Y is determined once the whole vector $\{Y_j\}_{j=1}^J$ is known. Second, we obtain w_j and v_j by (5) and (6). Finally, we obtain the vector of housing prices $\{r_j\}_{j=1}^J$ using (7) and the Cobb-Douglas form of the production function in (1): $r_j = v_j(1-\mu)N_j/[(1-\alpha)H_j]$. Step (**iii**). We can now sum over all towns, use the full-employment condition (9) and invert the resulting expression to write

$$u = \frac{\alpha}{(1-\mu)^{1-\mu}}\left\{\frac{1}{L}\sum_{j=1}^{J}\left[\frac{H_j^{1-\mu}N_j^{\mu(1-\alpha)}}{\tau_j^{\mu}}\right]^{1/(1-\alpha\mu)}\right\}^{1-\alpha\mu},$$

which establishes that there are decreasing returns in the urban system (this was to be expected given that the production of the final output exhibits decreasing returns in the mobile factor and that housing is in fixed supply). Thus, there is a one-to-one relationship between the utility level of mobile workers u that clears all markets and the parameters of the model, α, μ, and $\{\tau_j\}_{j=1}^J$, and the exogenous stocks of L, $\{H_j\}_{j=1}^J$, and $\{N_j\}_{j=1}^J$.

Part (**b**). Town population size Λ_j is increasing in market access p_j by inspection of (11). Town GDP is equal to $p_jY_j = p_jN_jB_j^{\alpha}$ by equations (1) and (10), where

$$B_j \equiv \left[\frac{\alpha}{(1-\mu)^{1-\mu}}\frac{1}{u}p_j^{\mu}\left(\frac{H_j}{N_j}\right)^{1-\mu}\right]^{1/(1-\alpha\mu)}$$

collects terms; p_jY_j is increasing in p_j by inspection. Town average wage is equal to $\omega_j = p_jY_j/\Lambda_j = p_jB_j/[1+B_j^{\alpha}]$ by equations (10) and (11). Log-differentiation yields

$$\frac{\partial \ln \omega_j}{\partial \ln p_j} = \frac{1}{1-\alpha\mu}\left(1 - \mu\frac{B_j}{1+B_j}\right)$$

which is greater then zero by inspection. ∎

A.2 Proof of Proposition 3

Proof. Let $j \in \{B, S\}$, where B is a big, arbitrary border town and S is a small, arbitrary border town, with $\Lambda_B > \Lambda_S$. This requires $N_B > N_S$ by equations (24) and (25). Note that $\hat{p}_B = \hat{p}_S = 1$ holds by assumption; using (17) yields

$$(1-\alpha\mu)(\hat{\omega}_B - \hat{\omega}_S) = (\ell_B - \ell_S)(-\mu + \hat{u}).$$

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Totally differentiating [14] with respect to the vector of market access $\{p_j\}_{j=1}^J$ and using $\hat{p}_j = 1$ for $j \in \mathcal{J}_b$ (the set of border towns) and $\hat{p}_j = 0$ otherwise yields

$$\hat{u} = b\mu, \quad \text{where} \quad b \equiv \frac{\sum_{j \in \mathcal{J}_b} \left[p_j^\mu H_j^{1-\mu} N_j^{(1-\alpha)\mu} \right]^{\frac{1}{1-\alpha\mu}}}{\sum_{j=1}^J \left[p_j^\mu H_j^{1-\mu} N_j^{(1-\alpha)\mu} \right]^{\frac{1}{1-\alpha\mu}}} \in (0,1).$$

Using this expression to substitute for $\hat{u}$ in the equation above yields

$$(1 - \alpha\mu)(\hat{\omega}_B - \hat{\omega}_S) = (-\ell_B + \ell_S)(1 - b)\mu > 0,$$

where the inequality follows from $\ell_B < \ell_S$ by $N_B > N_S$ and (25). By the same token,

$$(1 - \alpha\mu)(\hat{\Lambda}_B - \hat{\Lambda}_S) = (\ell_B - \ell_S)(1 - b)\mu < 0,$$

from (18). The wage bill of large and small border towns move in the same proportion since

$$(1 - \alpha\mu)(\hat{\Lambda}_B - \hat{\Lambda}_S) = -(1 - \alpha\mu)(\hat{\omega}_B - \hat{\omega}_S)$$

so that $(1 - \alpha\mu)(\hat{\omega}_B + \hat{\Lambda}_B - \hat{\omega}_S - \hat{\Lambda}_S) = 0.$ ∎

A.3   Local landowners

In this subsection we assume that a fraction $\kappa \in [0,1]$ of the local housing stock is owned by the local immobile workers (the rest is owned by absentee landowners). The point of this exercise is to establish formally that none of the key equilibrium expressions so far, which hold under the simplifying assumption $\kappa = 0$, is affected in any substantial way. In particular, the generalization to any κ in the unit interval affects neither the welfare analysis nor our later interpretation of the estimated coefficients of the empirical analysis (bar the constant).

Equilibrium of the housing market, (7), becomes $r_j H_j [1 - \kappa(1 - \mu)] = (1 - \mu) p_j Y_j$. This implies that the right hand sides of (10), (13), and (14), as well as the content of the square bracket in (12), all need to be multiplied by the constant factor $[1 - \kappa(1 - \mu)]^{1-\mu}$. Likewise, the well-being of the representative immobile worker-cum-landowner is proportional to the right-hand side of (14), where the factor of proportionality is a positive combination of the parameters α, κ, μ.

The new definition of the well-being of the average town-j resident becomes

$$\bar{u}_j = \ell_j u + (1 - \ell_j)\nu_j \left[1 + \kappa \frac{r_j H_j}{v_j N_j} \right] = \ell_j u + (1 - \ell_j)\nu_j \left[1 + \kappa \frac{1 - \mu}{(1 - \alpha)(1 - \kappa(1 - \mu))} \right],$$

where the second equality follows from the revised expression for the housing market equilibrium in the paragraph above. It follows that we can rewrite (16) as

$$\bar{u}_j = \ell_j u \left\{ 1 + \frac{1 - \alpha}{\alpha} \left[1 + \kappa \frac{1 - \mu}{(1 - \alpha)(1 - \kappa(1 - \mu))} \right] \right\}.$$

By the same token, the right-hand side of (15) has to be multiplied by a positive combination of the parameters α, κ, μ.

All the expressions in Section 4 hold irrespective of the value of $\kappa \in [0,1]$.

Figure 1:   Treatment groups: baseline definition
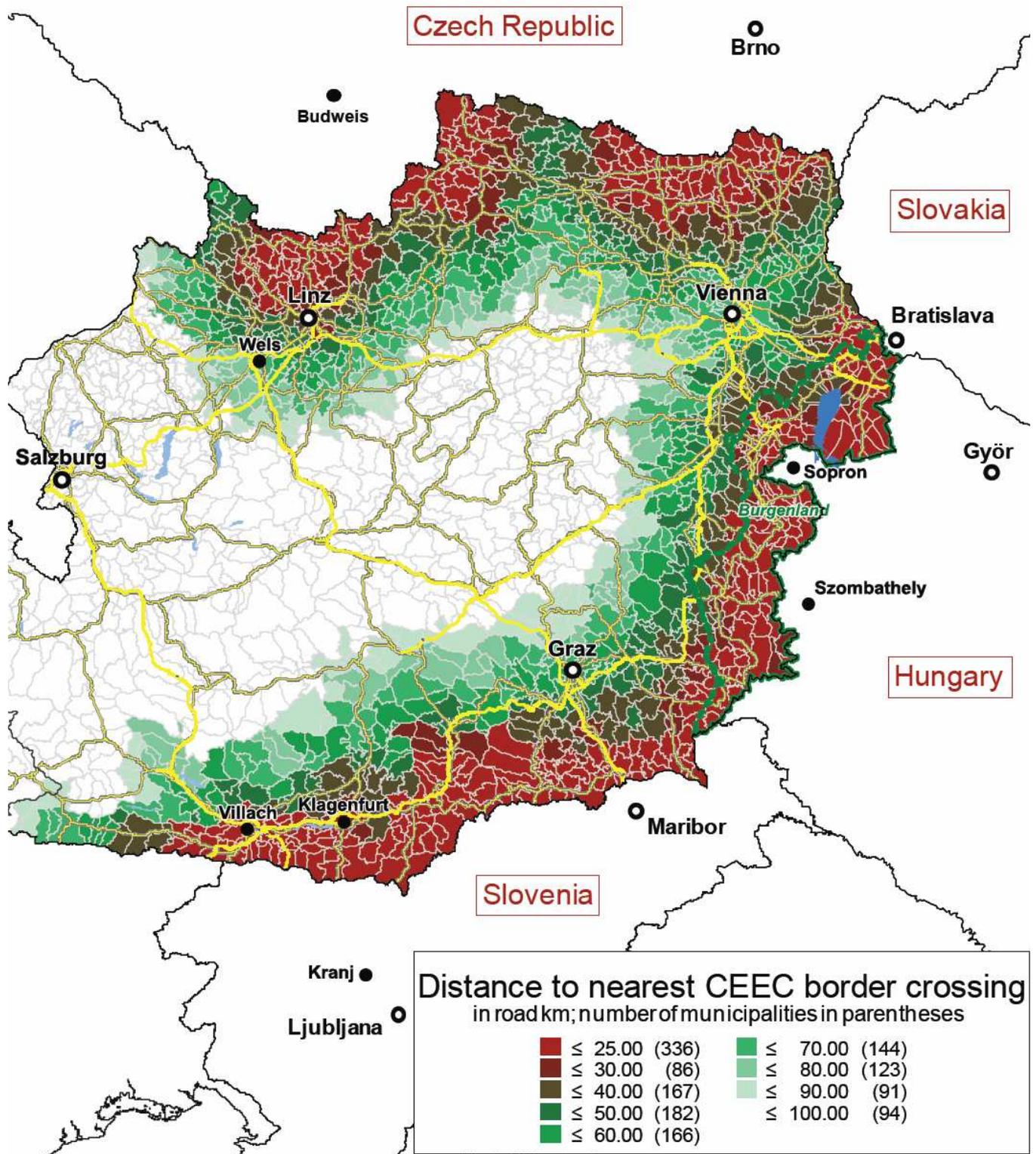
Figure 2:   Treatment groups: alternative definition

Distance to nearest CEEC city with population >50,000
in road km; number of municipalities in parentheses

≤ 25.00 (20)   ≤ 40.00 (68)   ≤ 60.00 (100)   ≤ 80.00 (182)   ≤ 100.00 (127)
≤ 30.00 (20)   ≤ 50.00 (80)   ≤ 70.00 (126)   ≤ 90.00 (143)

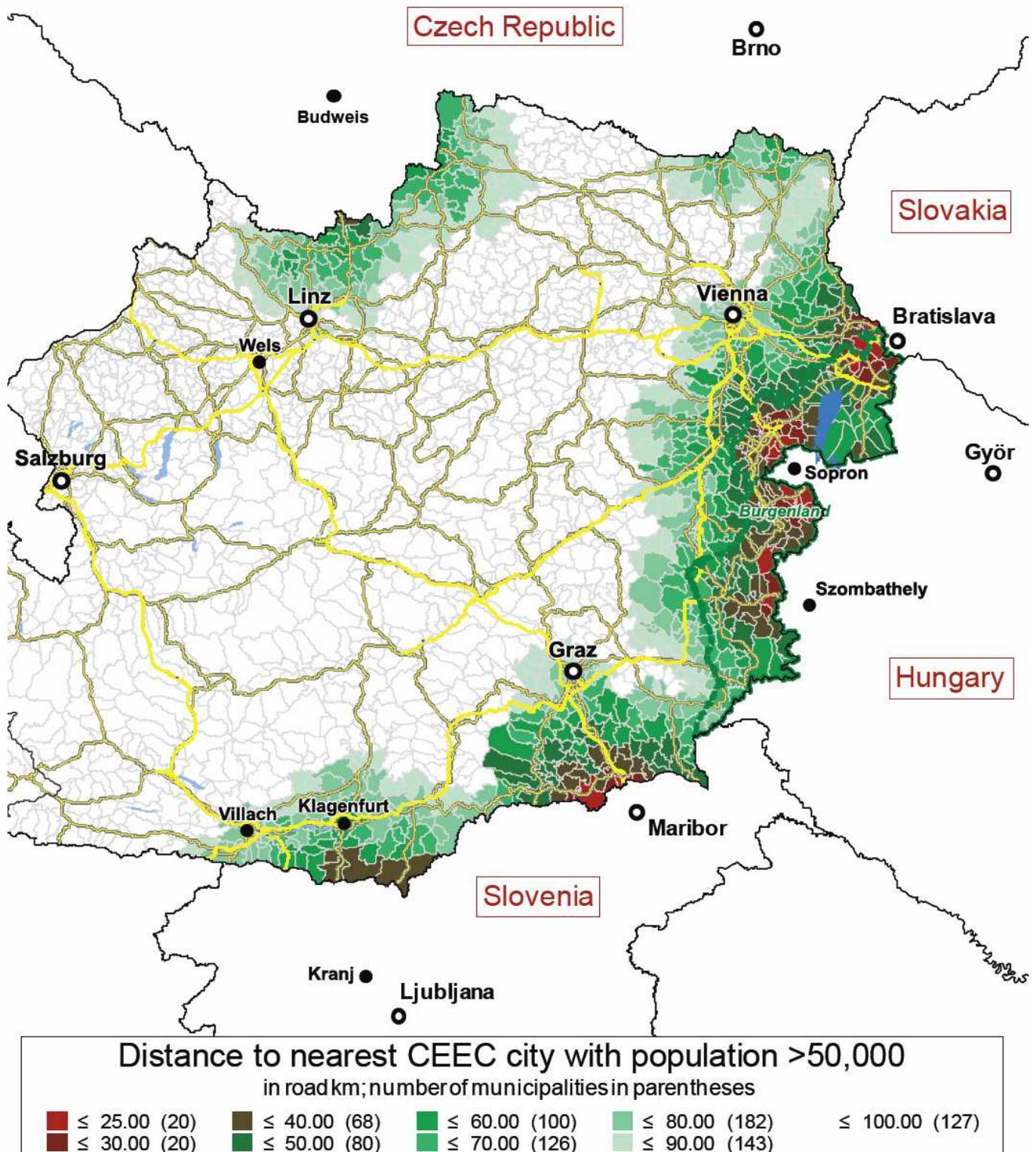**Figure 3:   Distance to border and post-1990 growth of town-level wage bills**
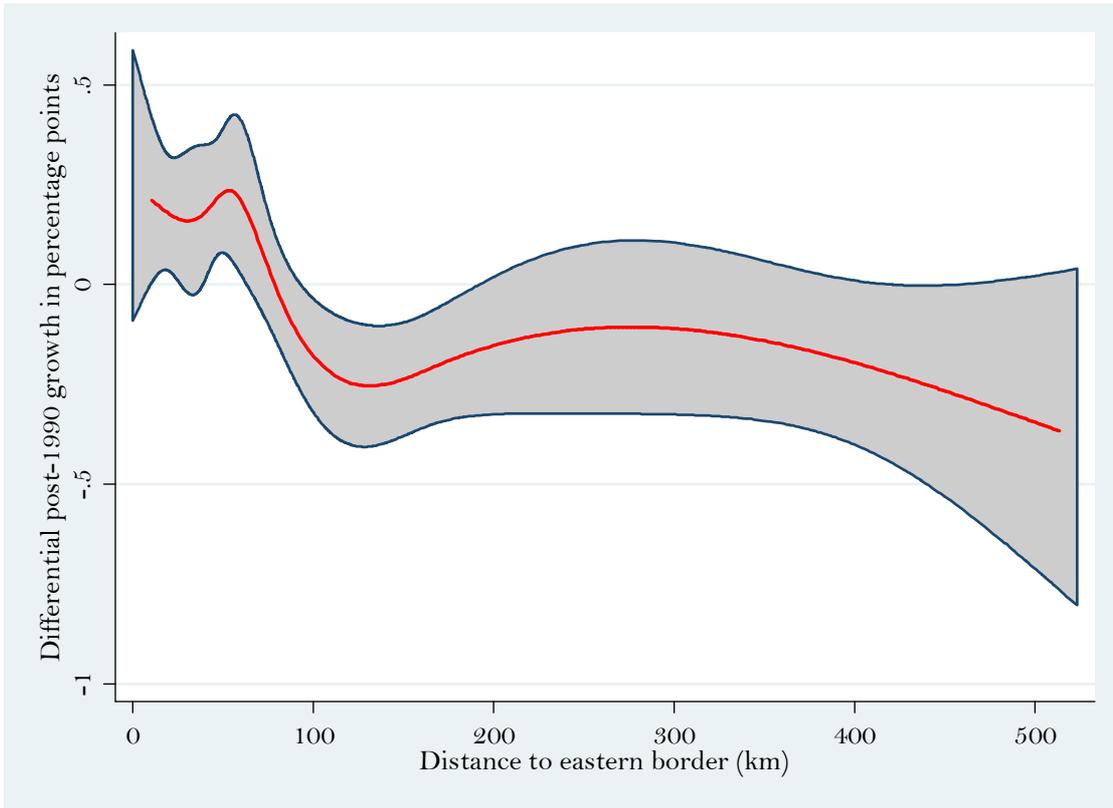

Figure 4:   Wage/employment responses and town size

Figure 5:   Time profile of adjustment in wage and employment – Large towns
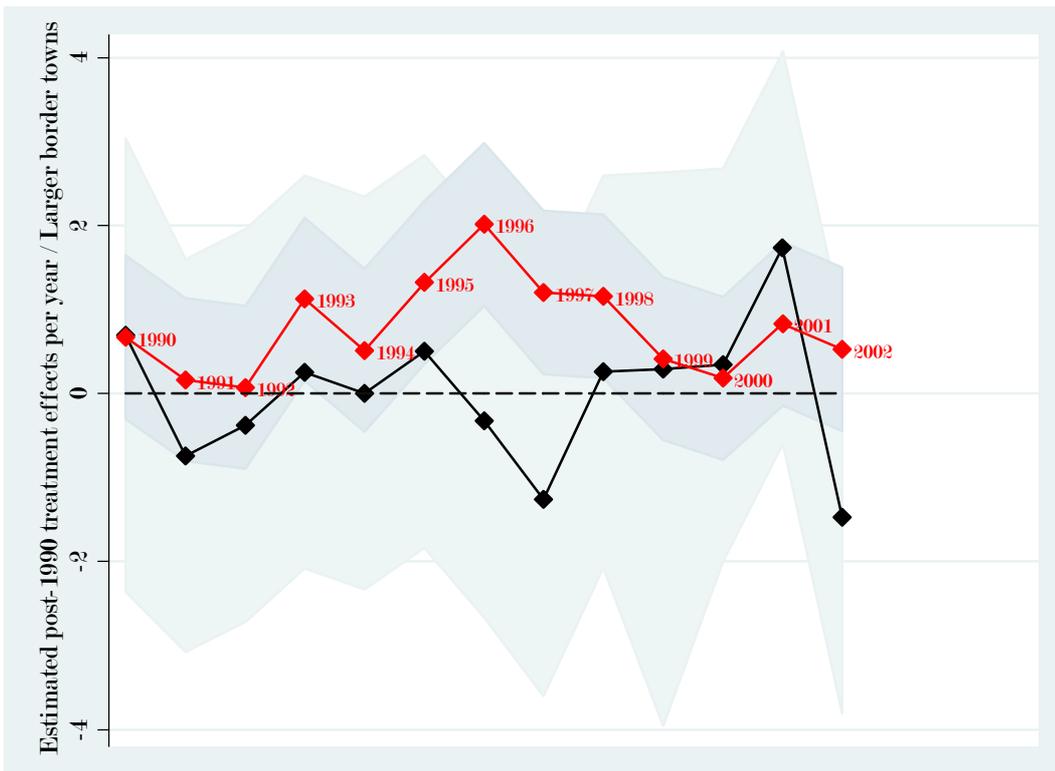
Large towns: > 1000 employees (see Table 4). Points represent estimated annual treatment effects on wages (red line) and on employment (black line). Shaded band represents 90% confidence interval.
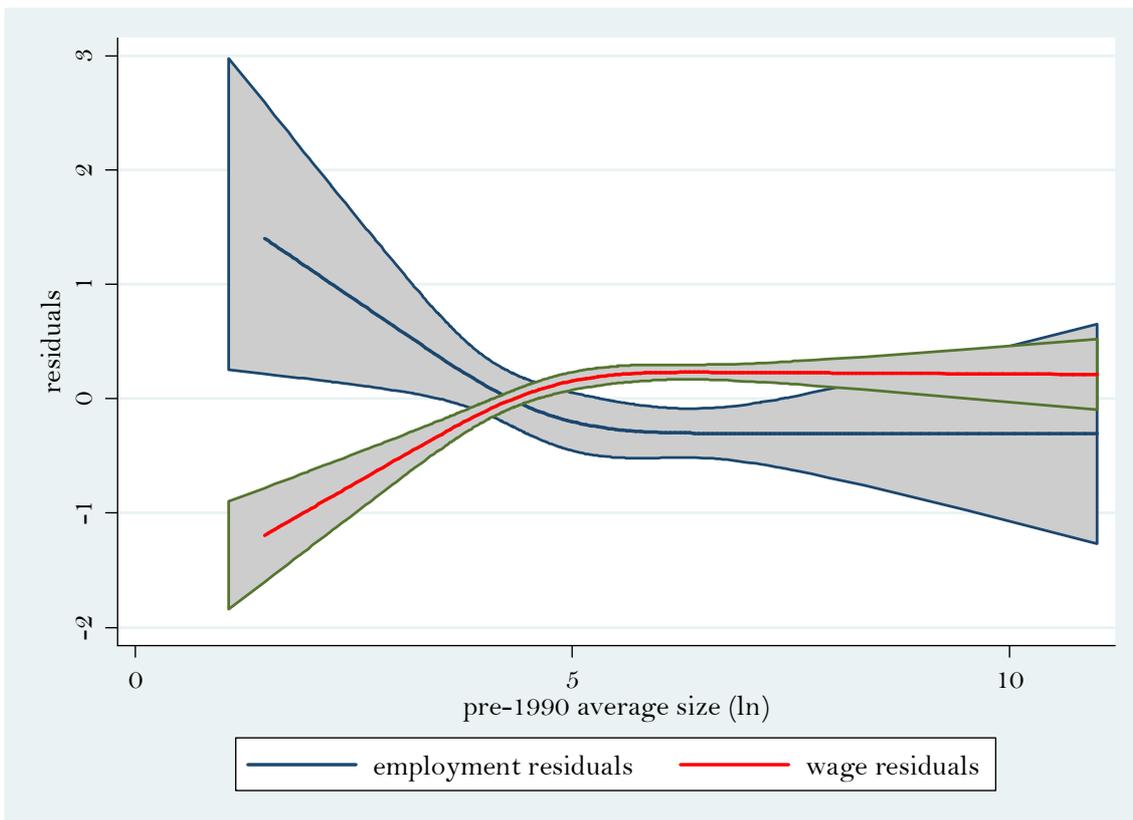
Figure 6:   Time profile of adjustment in wage and employment – Small towns
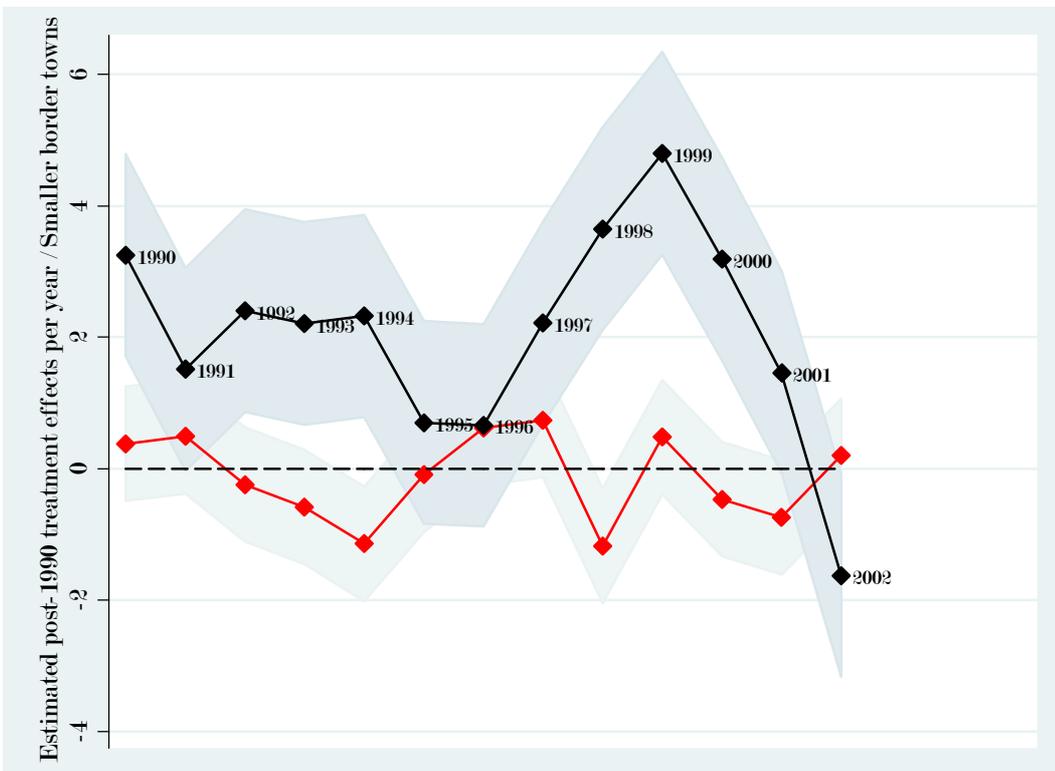
Small towns: ≤ 70 employees (see Table 4). Points represent estimated annual treatment effects on wages (red line) and on employment (black line). Shaded band represents 90% confidence interval.

Figure 7: **Evolution of border-town and interior-town housing prices**

Notes: Klagenfurt = border town, Innsbruck = interior town. Data from Wirtschaftskammer Österreich, series "Immobilien-Preisspiegel".

Table 1:   Summary statistics

Border defined as lying within 25 road kilometers from nearest CEEC border crossing (Czech Republic, Slovakia, Hungary or Slovenia)

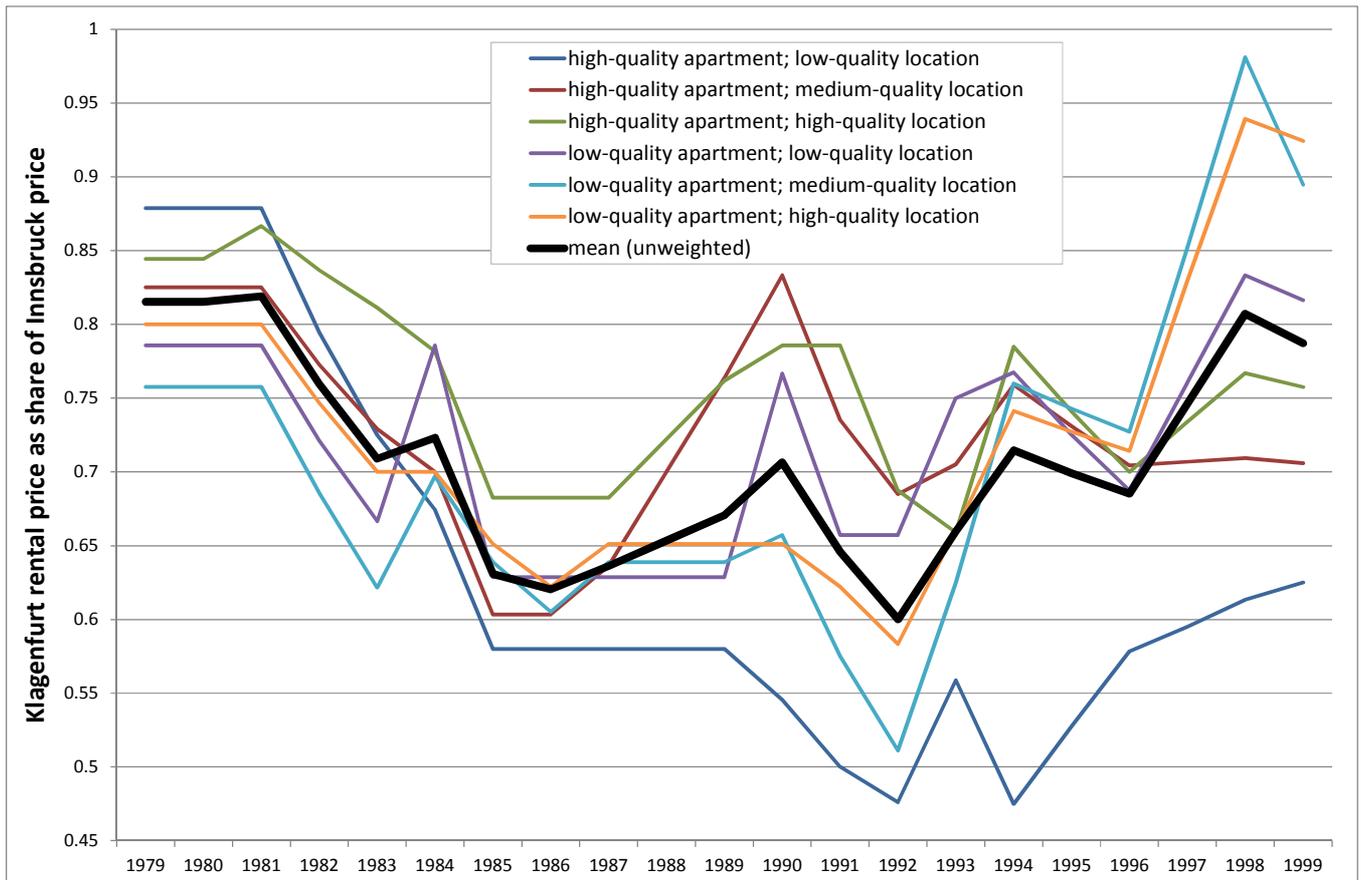| Variables	1976-1989				1990-2002			
	Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Border municipalities (*Border* = 1)	16,484 observations: 52 quarters and 317 towns				17,752 observations: 56 quarters and 317 towns			
Median daily wage (Austrian Schillings)	310.87	92.38	53.10	765.11	608.34	139.88	190.08	1,374.48
Annual growth rate of median wage %, ΔW	6.29	9.73	-103.07	128.01	4.17	8.88	-100.57	81.08
Employment	502	3,492	1	67,239	563	3,798	1	71,739
Annual growth rate of employment %, ΔE	1.12	14.07	-163.19	165.43	1.88	21.38	-178.43	185.90
Minimum road distance to Eastern border (km)	14.90	6.97	0.00	24.91	14.90	6.97	0.00	24.91
Minimum road travel time to Eastern border (min)	21.29	9.71	0.00	48.17	21.29	9.71	0.00	48.17
Interior municipalities (*Border* = 0)	89,960 observations: 52 quarters and 1,730 towns				96,880 observations: 56 quarters and 1,730 towns			
Median daily wage (Austrian Schillings)	337.22	100.72	35.52	950.62	626.61	144.00	111.65	1,660.97
Annual growth rate of median wage %, ΔW	5.97	9.46	-135.23	150.66	3.66	8.85	-121.18	125.14
Employment	1,071	15,153	1	617,433	1,133	15,519	1	642,011
Annual growth rate of employment %, ΔE	1.27	14.75	-179.86	181.54	1.23	19.81	-185.38	184.62
Minimum road distance to Eastern border (km)	128.81	121.48	25.01	523.00	128.81	121.48	25.01	523.00
Minimum road travel time to Eastern border (minutes)	109.76	76.73	17.67	373.33	109.76	76.73	17.67	373.33

Table 2: Baseline estimates

Border$_j$ defined by road distance from nearest CEEC border post or town (Czech Republic, Slovakia, Hungary or Slovenia)

Dependent variable:	Δ(*W*E*)	Δ*W*	Δ*E*	Δ(*W*E*)	Δ*W*	Δ*E*	Δ(*W*E*)	Δ*W*	Δ*E*	Δ(*W*E*)	Δ*W*	Δ*E*
Definition of treatment sample (*Border* = 1)	≤ 25km to nearest border post			≤ 35km to nearest border post			≤ 60km to nearest town ≥ 50,000			≤ 60 km to nearest town ≥ 20,000		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Fall$_t$ x *Border$_j$* x *Size$_j$*	-0.192 (0.117)	0.206** (0.094)	-0.388*** (0.098)	-0.163 (0.146)	0.238** (0.117)	-0.390*** (0.114)	-0.157 (0.121)	0.133** (0.063)	-0.291*** (0.110)	-0.137 (0.124)	0.170*** (0.065)	-0.306*** (0.106)
Fall$_t$ x *Border$_j$*	0.962*** (0.312)	0.207* (0.124)	0.783*** (0.283)	1.005*** (0.286)	0.195* (0.107)	0.859*** (0.253)	0.646* (0.347)	0.115 (0.140)	0.567* (0.308)	0.687** (0.309)	0.024 (0.124)	0.691** (0.273)
Fall$_t$ x *Size$_j$*	0.013* (0.007)	0.014** (0.006)	-0.003 (0.006)	0.016** (0.007)	0.014** (0.006)	0.003 (0.006)	0.011* (0.007)	0.015** (0.006)	-0.002 (0.007)	0.012* (0.007)	0.014** (0.006)	-0.001 (0.007)
No. towns for which *Border$_j$* = 1	317	317	317	522	522	522	325	325	325	393	393	393
R²	0.149	0.056	0.181	0.149	0.056	0.181	0.149	0.056	0.181	0.149	0.056	0.181

Notes: quarterly data, 1976 Q1 - 2002 Q4; 2,047 towns, 221,076 observations; estimation with OLS; town and quarter fixed effects included throughout; standard errors in parentheses: heteroscedasticity consistent and adjusted for municipality-level clustering; * : $p=0.1$, **: $p=0.05$, ***: $p=0.01$; "within" R², conditional on town fixed effects; *W*: nominal wage, *E*: employment; *Size$_j$*: mean-differenced average pre-1990 town-level employment

Table 3:   Robustness

Coefficients on triple interaction term ($Fall_t$ x $Border_j$ x $Size_j$)

Dependent variable:	Δ(*W*E*)	Δ*W*	Δ*E*	obs.
	(1)	(2)	(3)	
repeat from Table 2:				
Baseline estimates (*Size_j*: mean-differenced average pre-1990 town-level employment)	-0.192 (0.117)	0.206** (0.094)	-0.388*** (0.098)	221,076
(A) Baseline, controlling for Burgenland after 1995	-0.186 (0.118)	0.203** (0.093)	-0.380*** (0.098)	221,076
(B) Baseline, dropping Vienna	-0.206* (0.125)	0.161* (0.097)	-0.363*** (0.107)	220,968
(C) Baseline, dropping 10% smallest towns	-0.245** (0.104)	0.143** (0.060)	-0.383*** (0.090)	196,668
(D) *Size_j* defined as centrality (mean-differenced)	-4.555 (4.640)	4.275** (2.069)	-8.347* (4.537)	221,076
(E) *Size_j* defined as density (mean-differenced)	-31.91 (33.70)	30.44** (14.69)	-58.78* (33.53)	221,076
(F) Baseline, controlling for unemployment	-0.164 (0.115)	0.163* (0.086)	-0.317*** (0.093)	221,076
(G) Baseline, long differences	-0.002 (0.006)	0.194*** (0.051)	-0.446*** (0.116)	4,062
(H) Baseline, long differences, blue-collar workers only	-0.004 (0.007)	0.113* (0.059)	-0.798*** (0.295)	4,002

Notes: quarterly data, 1976 Q1 - 2002 Q4; 2,047 towns in total; estimation with OLS; town and quarter fixed effects included throughout; standard errors in parentheses: heteroscedasticity consistent and adjusted for municipality-level clustering; * : $p=0.1$, **: $p=0.05$, ***: $p=0.01$; $Border_j$ =1 if road distance from nearest CEEC border post ≤ 25km (Czech Republic, Slovakia, Hungary or Slovenia); W: nominal wage, E: employment; see text for different definitions of *Size_j* and specification of unemployment controls

Table 4:   Matching

Treatment and control towns matched on pre-1990 primary/secondary/tertiary employment shares

Dependent variable:	Δ(W*E)	ΔW	ΔE
	(1)	(2)	(3)
all towns (2,001 obs.)			
Fall$_t$ x *Border$_j$*	0.899*** (0.206)	0.280*** (0.086)	1.184** (0.208)
large towns (> 1,000 employees pre-1990; 174 obs.)			
Fall$_t$ x *Border$_j$*	1.378*** (0.345)	0.573*** (0.125)	1.305*** (0.558)
small towns (≤ 70 employees pre-1990; 636 obs)			
Fall$_t$ x *Border$_j$*	1.237** (0.440)	0.336 (0.206)	1.834*** (0.698)

<u>Notes</u>: reported coefficients are Average Treatment Effects on pre-1990 and post-1990 average annual growth rates; standard errors in parentheses; * : p=0.1, **: p=0.05, ***: p=0.01; *Border$_j$* =1 if road distance from nearest CEEC border post ≤ 25km (Czech Republic, Slovakia, Hungary or Slovenia); *W*: nominal wage, *E*: employment

Table 5:   Placebo tests

WestBorder$_j$ defined as within 25 km road distance from nearest border point with Italy, Switzerland, Liechtenstein or Germany
Border$_j$ defined as within 25 km road distance from nearest border post with Czech Republic, Slovakia, Slovenia or Hungary

Dependent variable:	$\Delta(W{*}E)$	ΔW	ΔE	$\Delta(W{*}E)$	ΔW	ΔE
Sample:	full sample			without Eastern border towns		
	(1)	(2)	(3)	(4)	(5)	(6)
Fall$_t$ x *Border$_j$* x *Size$_j$*	-0.188	0.206**	-0.385***			
	(0.117)	(0.094)	(0.098)			
Fall$_t$ x *WestBorder$_j$* x *Size$_j$*	0.259	0.071	0.199	0.258	0.0745	0.194
	(0.203)	(0.111)	(0.140)	(0.203)	(0.112)	(0.139)
Fall$_t$ x *Border$_j$*	0.809**	0.215*	0.622**			
	(0.320)	(0.126)	(0.290)			
Fall$_t$ x *WestBorder$_j$*	-0.907***	0.052	-0.958***	-0.907***	0.041	-0.948***
	(0.300)	(0.118)	(0.267)	(0.302)	(0.118)	(0.269)
Fall$_t$ x *Size$_j$*	0.008	0.014**	-0.005	0.008	0.014**	-0.005
	(0.007)	(0.006)	(0.008)	(0.007)	(0.006)	(0.008)
No. towns for which *WestBorder$_j$* = 1	301	301	301	301	301	301
No. towns for which *Border$_j$* = 1	317	317	317	0	0	0
R²	0.149	0.056	0.181	0.149	0.056	0.181

Notes: quarterly data, 1976 Q1 - 2002 Q4; 2,047 towns, 221,076 observations; estimation with OLS; town and quarter fixed effects included throughout; standard errors in parentheses: heteroscedasticity consistent and adjusted for municipality-level clustering; * : p=0.1, **: p=0.05, ***: p=0.01; "within" R², conditional on town fixed effects; W: nominal wage, E: employment; *Size$_j$*: mean-differenced average pre-1990 town-level employment

Table 6:   Counterfactual

The dependent variable is the difference (in %), for each of the 2,107 municipalities, between the extrapolated 2002 wage and employment level (based on the average annual trend up to 1990) and the observed 2002 values.

Dependent variable:	$\Delta(W*E)$	ΔW	ΔE
	(1)	(2)	(3)
OLS estimation			
(2,147 obs.)			
$Fall_t$ x $Border_j$	0.401***	0.059**	0.216***
	(0.035)	(0.026)	(0.101)
Average treatment effect – All towns			
Match on average pre-1990 town-level employment			
(2,001 obs.)			
$Fall_t$ x $Border_j$	0.404**	0.067**	0.214**
	(0.105)	(0.024)	(0.054)
Average treatment effect – Large towns (>1,000)			
Match on average pre-1990 town-level employment			
(174 obs.)			
$Fall_t$ x $Border_j$	0.333**	0.113**	0.176**
	(0.081)	(0.027)	(0.059)
Average treatment effect – Small towns (<70)			
Match on average pre-1990 town-level employment			
(636 obs.)			
$Fall_t$ x $Border_j$	0.573**	0.071	0.310**
	(0.282)	(0.061)	(0.122)

Notes: standard errors in parentheses; * : $p=0.1$, **: $p=0.05$, ***: $p=0.01$; $Border_j$ =1 if road distance from nearest CEEC border post ≤ 25km (Czech Republic, Slovakia, Hungary or Slovenia); W: nominal wage, E: employment