

Trade and Towns: On the Uneven Effects of Trade Liberalization*

Marius Brülhart[†] Céline Carrère[‡] Frédéric Robert-Nicoud[§]
University of Lausanne *University of Geneva* *University of Geneva*

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Abstract

Trade liberalization is often believed to benefit urbanized regions more than rural regions. We explore the effects of trade liberalization on employment and wage growth of different-sized towns within a country. A multi-region model of intra-national adjustment predicts that small towns have more elastic labor-force responses to trade liberalization. We examine this predictions in fine-grained regional data for Austria. The fall of the Iron Curtain in 1990 represented a large exogenous trade shock to the Austrian economy, providing us with 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 tended to have larger wage responses and smaller employment responses than 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.

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All tables and figures at end

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[†]Department of Economics (DEEP), Faculty of Business and Economics, University of Lausanne, 1015 Lausanne, Switzerland; and CEPR, London. (Marius.Brulhart@unil.ch).

[‡]European Institute, University of Geneva, 1204 Geneva, Switzerland; and CEPR, London. (celine.carrere@unige.ch).

[§]Department of Economics, University of Geneva, 1204 Geneva, Switzerland; and CEPR, London. (Frederic.Robert-Nicoud@unige.ch).

1 Introduction

We estimate the effect 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 heterogenous 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 stronger wage growth but weaker employment growth in larger border towns.

We then confront these predictions with fine-grained regional data for Austria. We argue that the fall of the Iron Curtain around 1990 represents a large and fully exogenous trade shock for the Austrian economy. We define eastern border regions as the treatment group and the rest of Austria as the control group (in a robustness check, we define western border regions as a placebo 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 found to have larger nominal wage responses, but smaller employment responses, than smaller towns. Hence, large towns are found to have less elastic local labor supply schedules. 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.

Heterogenous spatial effects of openness shocks have been researched carefully before, but our paper innovates on three counts at least. First, we estimate wage as well as employment effects of such shocks. Employment effects are relatively well understood following the seminal paper 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.² We establish that wages respond to changes in trade exposure qualitatively differently from employment. Second, we study the interaction between a town's size and its exposure to trade. The literature so far, including the paper that uses the same data set as ours (Brühlhart, Carrère and Trionfetti, 2012), focuses purely on the average effect of increased trade exposure. We shift our attention to the heterogenous response of small and large towns following the trade shock. Third, we assess the differential welfare effects

¹Hence, the three differences are (i) before vs after 1990, (ii) border vs interior towns, and (iii) large vs small towns.

²In addition, 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 collapse of the socialist regimes but cross-border migration continued to be tightly controlled well into the early 2000s.

of the exposure of towns to international trade. Our structural approach enables us to estimate the relative welfare effects for different-sized towns. 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 the remaining residents. Indeed, migration smoothens 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 jobs: the welfare gains for its residents are thus relatively large in absolute value.

Our results are relevant to economic policy. Policy makers commonly expect international trade to benefit urbanized regions more than rural regions.³ For this reason, trade reforms are often accompanied by transfer schemes designed to compensate rural regions.⁴ In contrast to this dominant policy view, the consensus result that emerges from the available empirical evidence is that international trade disproportionately favors the growth of smaller towns and cities. In terms of labor quantities, therefore, trade would seem to promote spatial convergence. We argue that this approach falls short as it fails to consider factor price effects, finding that large towns experience proportionally larger wage gains, offsetting the equalizing patterns of employment growth.

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. The data and our empirical setting are presented in Section 5, the estimation strategy in Section 6, and the results are reported in Section 7. Section 8 provides concluding remarks.

2 Literature background

2.1 Theory

The simple question we ask is: how does a given change in external market access affect employment, wages and welfare in small and large towns among which labor is mobile. We can distinguish essentially two theoretical approaches to this question.⁵

³According 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.”

⁴The 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).

⁵We abstract from exogenously determined comparative advantage across towns and countries. In Henderson (1982), for example, trade liberalization is found to increase the number of cities that are specialized in the comparative advantage goods. Since cities specialized in capital-intensive sectors are bigger in equilibrium, trade liberalization will favor the growth of larger cities in capital abundant countries and of smaller cities in capital

One approach focuses on demand-side differences between small and large towns. Their very size allows larger towns to produce a larger range of differentiated goods and hence to be economically more self-contained, whereas smaller 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 smaller towns, as they rely more on trade than larger towns. This is the mechanism identified by Redding and Sturm (2008), based on the model of Helpman (1998). Importantly, as long as local labor supply is neither perfectly elastic nor perfectly inelastic, this mechanism implies that, after trade liberalization, smaller towns will experience stronger increases in both employment and nominal wages than larger towns.⁶

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 a prior attempt at modeling 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 sensitivity of the wage and employment effects of a given shock to local supply conditions. In contrast to models relying on demand-side differences, this approach opens up the possibility of employment and nominal wages responding 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 found that housing supply is more elastic in areas that are less dense and therefore have more available land (Hilber and Mayer, 2009). 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 is an attempt at formalizing such a mechanism in way that allows for structural estimation and welfare analysis.

2.2 Empirics

Existing empirical work exclusively focuses on employment or population effects of external trade opening. 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 is challenging at that

scarce countries. In this model, welfare is equalized across cities. In a similar vein, Autor, Dorn and Hanson (2013) explore the impact of trade with China on US local labor markets, taking initial industry specialisation as the trade exposure measure and abstracting from city size. See Brülhart (2011) for a survey of the literature on intra-national spatial adjustment to international trade.

⁶The same qualitative result is found, among others, in Krugman and Livas Elizondo (1996) and Behrens, Gaigné, Ottaviano and Thisse (2007).

level. Redding and Sturm (2008) proposed to overcome these challenges 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, none of these studies could track the effect of trade liberalization on city-level wages. Kovak (2013), however, avails of a panel of regional wage data for Brazil. He estimated the effects of trade liberalization on regional wages based on a model featuring no interregional labor mobility, thus assuming that regional adjustment occurs entirely through wages. Moreover, he does not differentiate regions by size, density or urbanization.

Ours is thus 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

Consider a small open economy endowed with a mass Λ of individuals and a discrete number of towns denoted by $j \in \{1, \dots, J\}$, 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. 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, and the remaining individuals are perfectly immobile. We denote the exogenous mass of immobile individuals in town j by N_j (mnemonic for ‘not mobile’). We denote the endogenous population of j by $\Lambda_j \equiv L_j + N_j$.

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

$$Y_j = L_j^\alpha N_j^{1-\alpha}. \quad (1)$$

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

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

⁷We need N and L to be imperfect substitutes in production in order to make our concept of modeling 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 migrants tend to be complements, not substitutes, for local workers.

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 .

Preferences. Individuals consume two goods, Y and housing H . In line with empirical evidence (Davis and Ortalo-Magne, 2012), we assume that individuals spend a constant share $1 - \mu$ of their income on housing. Specifically,

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

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

3.1 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 $1 = \min\{p_1\tau_1, \dots, p_J\tau_J\}$. That is,

$$p_j = \frac{1}{\tau_j} \quad (4)$$

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 and N , respectively. Perfect competition in the production of intermediates and in labor markets yields

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

and

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

Wages of each type of labor are increasing in market access and in the intensity use of the complementary factor.

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

⁸Thus, 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 does not add any insight for our purpose.

⁹More 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 any substantial loss of generality: qualitatively, the equilibrium expressions are equivalent. Quantitatively, the relative welfare changes are *unchanged* if we relax this assumption. Subsection 3.3 below provides the details.

respect to h subject to individual income and aggregating among residents yields the housing demand in j , $H_j = (1 - \mu)p_j Y_j / r_j$, where r_j denotes the unit price of housing. Equating housing supply with housing demand in value yields

$$r_j H_j = (1 - \mu)p_j Y_j. \quad (7)$$

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 yield the same real wage to those mobile workers, i.e. $u_j = u$, some $u > 0$, all j . Together, these yield

$$u = \frac{w_j}{r_j^{1-\mu}}. \quad (8)$$

Towns that pay low wages have a more affordable housing stock in equilibrium. Conversely, workers who live in towns with expensive housing are being compensated by higher wages. In turn, intermediate good producers that are able to offer high wages in equilibrium are those that are located in towns with good market access by equation (5). We can thus readily anticipate that towns with favorable market access pay high wages and display high housing prices.

Finally, full employment of mobile workers yields

$$L = \sum_{j=1}^J L_j. \quad (9)$$

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

Proposition 1 (equilibrium existence and properties) *The equilibrium exists and is uniquely characterized by equations (1)-(9). Furthermore, 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 and in its housing stock H_j .*

Proof. See Appendix. ■

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 for the higher cost of living. Real wages are equalized. By the same token, towns endowed with a large amount of non-tradable endowments (housing and immobile workers) tend to have low housing prices and high wages out of equilibrium. These attract a large number of 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 on labour) in a way that exactly matches the real wages that prevail in the rest of the domestic economy.

To see these properties formally, use equations (1), (5), and (7) to rewrite (8) as a function of L_j and of the exogenous variables only; this yields $u = \alpha(1 - \mu)^{-1+\mu} p_j^\mu H_j^{1-\mu} N_j^{(1-\alpha)\mu} L_j^{-1+\alpha\mu}$, or

$$\left(\frac{L_j}{N_j}\right)^{1-\alpha\mu} = \frac{\alpha}{(1-\mu)^{1-\mu}} \frac{1}{u} p_j^\mu \left(\frac{H_j}{N_j}\right)^{1-\mu}. \quad (10)$$

Solving for L_j and dividing by L yields the equilibrium share of mobile workers residing in town j , i.e.

$$\frac{L_j}{L} = \frac{\left[p_j^\mu H_j^{1-\mu} N_j^{(1-\alpha)\mu}\right]^{\frac{1}{1-\alpha\mu}}}{\sum_{i=1}^J \left[p_i^\mu H_i^{1-\mu} N_i^{(1-\alpha)\mu}\right]^{\frac{1}{1-\alpha\mu}}}. \quad (11)$$

This share is increasing in own market access p_j and in the local stock of immobile complementary factors and housing services, N_j and H_j , as was to be shown.

Finally, in the empirical section of the paper, we use town size, town density, and a town's share of mobile workers [NOT THE LATTER!]. It is thus useful to show how these three metrics relate to one another. First, the equilibrium town size is equal to

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

where the second equality follows from (10). Second, we sometimes look at the *population* density of j , defined as 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

$$d_j \equiv \frac{\Lambda_j}{H_j} = \frac{N_j}{H_j} \left\{ 1 + \left[\frac{\alpha}{(1-\mu)^{1-\mu}} \frac{1}{u} p_j^\mu \left(\frac{H_j}{N_j}\right)^{1-\mu} \right]^{\frac{1}{1-\alpha\mu}} \right\}, \quad (13)$$

where the second equality follows from equation (12). Third, we define the share of immobile workers in j as ℓ_j . Using (10) and the definition of Λ_j as the sum of N_j and L_j yields

$$\ell_j \equiv \frac{L_j}{\Lambda_j} = 1 - \left\{ 1 + \left[\frac{\alpha}{(1-\mu)^{1-\mu}} \frac{1}{u} p_j^\mu \left(\frac{H_j}{N_j}\right)^{1-\mu} \right]^{\frac{1}{1-\alpha\mu}} \right\}^{-1}. \quad (14)$$

Town size, town density and the share of mobile workers are all increasing in the town's access to foreign markets by inspection of (12), (13), and (14), respectively. Equilibrium town size and town density are also increasing in the local housing stock. All these are rather intuitive.

3.2 Normative properties of equilibrium outcome

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

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, yield

$$u = \frac{\alpha}{(1-\mu)^{1-\mu}} \left\{ \frac{1}{L} \sum_{j=1}^J \left[p_j^\mu H_j^{1-\mu} N_j^{(1-\alpha)\mu} \right]^{\frac{1}{1-\alpha\mu}} \right\}^{1-\alpha\mu}. \quad (15)$$

Two aspects of expression (15) are noteworthy. First, u is a generalized average of the equilibrium value of a town's endowment (the term inside the square bracket of the RHS above), which includes both the complementary factor of production, N_j , and the stock of the housing good, H_j . Second, *nation-wide* mobile workers are better off if the access to markets increases in *any* town j , that is, specifically, $\partial u / \partial p_j > 0$, all j . Intuitively, raising market access somewhere raises wages there first and then everywhere by out-migration from other towns and decreasing returns to mobile labour (the latter effect also attenuates the impact effect on wages in the town whose market access has improved).

Turning to the wellbeing of immobile workers, let

$$\nu_j \equiv \frac{v_j}{r_j^{1-\mu}}$$

denote the indirect utility of N_j , which we may rewrite as

$$\nu_j = \frac{1-\alpha}{\alpha} u \frac{L_j}{N_j} \quad (16)$$

by equations (5), (6) and (8). Together with equation (10), this yields

$$\nu_j = \frac{1-\alpha}{\alpha} \left[\frac{\alpha}{(1-\mu)^{1-\mu}} \left(\frac{p_j}{u^\alpha} \right)^\mu \left(\frac{H_j}{N_j} \right)^{1-\mu} \right]^{\frac{1}{1-\alpha\mu}}. \quad (17)$$

Two properties of expression (17) 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 labour productivity in value and higher wages – and decreasing in overall market access by $\partial \nu_j / \partial u < 0$ and equation (15) – an indirect effect that operates via the migration of mobile workers.

In this paper, we are especially interested in the differential welfare effects of trade liberalization of large versus small border towns. Let $\hat{x} \equiv dx/x$, any variable x . Totally log-differentiating

expression (17) yields the following expression for the percentage change for the equilibrium well-being of immobile factor owners:

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

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, say, the overall improvement of the country's access to foreign markets; the third term establishes that equilibrium town size is positively associated with the local endowment of housing services H_j and immobile factors N_j as per equation (11). Note that these three effects are additionally separable. This implies that the welfare effect of trade liberalization on the immobile factor owners are independent of town size (market access and local endowments do not interact).

Equilibrium utility of spatial units. Recall that $\ell_j \equiv L_j/\Lambda_j$ 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 (16), we obtain the following expression for \bar{u}_j :

$$\bar{u}_j = \frac{\ell_j u}{\alpha}. \quad (18)$$

The properties of this expression are inherited from the Cobb-Douglas structure of the production function (1): α is the share of revenues 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 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 (18) 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 (and Proposition 3 in particular), an improvement in j 's market access raises ℓ_j and this positive effect is increasing in town size and density.

Taken together, these two results imply that this differential welfare effect is 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 turns attracts mobile workers. This immigration of mobile workers raises the productivity of immobile workers, who thus get an extra fillip. The proportion of immobile workers being increasing in town size, it follows that this composition effect works in favour of large towns.

Aggregate equilibrium utility. Summing the well-being of all immobile workers across all towns yields $\alpha \sum_j N_j \nu_j = (1 - \alpha)Lu$ by equations (5), (6) and (8). Using this and equation (15),

we obtain a metric for the economy-wide welfare, which we denote by U :

$$U \equiv Lu + \sum_{j=1}^J N_j \nu_j = \frac{1}{(1-\mu)^{1-\mu} L^{\alpha\mu}} \left\{ \sum_{j=1}^J \left[p_j^\mu H_j^{1-\mu} N_j^{(1-\alpha)\mu} \right]^{\frac{1}{1-\alpha\mu}} \right\}^{1-\alpha\mu}. \quad (19)$$

It thus follows that aggregate welfare is increasing in market access; using symbols: $\partial U / \partial p_j > 0$, any j .

3.3 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 the 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), (15), and (17), as well as the content of the square bracket in (13), 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 (17), 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 resident in j is

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

where the second equality follows from the revised expression for the housing market equilibrium in the paragraph above. It follows that we may rewrite (18) 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 (19) has to be multiplied by a positive combination of the parameters α, κ, μ .

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

4 Comparative statics and *diff-in-diff-in-diff*

Our empirical work below is firmly grounded in our tractable theory. Specifically, we use a *diff-in-diff-in-diff* estimation strategy to estimate and identify the differential effect of trade liberalization on small and large towns.

4.1 ‘Structural’ *diff-in-diff-in-diff*

We are interested in the effects of variations in market access on town sizes, wages, and composition. As we explain in the empirical section, we exploit the exogenous and unanticipated fall of the iron curtain as the source of exogenous variation in market access. The first *difference* of our empirical strategy is thus before versus after 1990. Not all towns were similarly affected, however. Towns close to the Easter border enjoyed a larger increase in access to Eastern markets than more central or western 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 *diff-in-diff-in-diff* empirical strategy arises structurally from our model.

Henceforth, we keep the endowments of immobile workers and housing fixed, i.e. $\hat{N}_j = \hat{H}_j = 0$, 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 $\hat{p}_j = (p_j^{t < 1990} - p_j^{t \geq 1990})/p_j^{t < 1990}$, 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 (see Appendix for details)

$$\hat{\omega}_j = \frac{(1 - \mu\ell_j)\hat{p}_j + (\ell_j - \alpha)\hat{u}}{1 - \alpha\mu}. \quad (20)$$

That is, a better market access for town j raises producer prices (recall that $p_j = 1/\tau_j$) and, as a result, wages too; in symbols, $\partial\hat{\omega}_j/\partial p_j > 0$. 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: one the one hand, an improvement of nation-wide market access raises wages and this 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. Differentiating (12) and (13) using (14), we find that population size and population density evolve according to

$$\hat{\Lambda}_j = \hat{d}_j = \frac{\ell_j(\mu\hat{p}_j - \hat{u})}{1 - \alpha\mu}, \quad (21)$$

namely, the size and density of town j are increasing in own market access and decreasing in every other town’s. Finally, the wage bill evolves according to

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

by equations (20) and (21). 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 and composition 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*).¹⁰ Let $\hat{p}_b = 1$ (treatment) and $\hat{p}_n = 0$ (control). Then

$$\hat{\Lambda}_b - \hat{\Lambda}_n = \frac{\mu \ell_j}{1 - \alpha \mu} > 0, \quad (22)$$

$j \in \{b, n\}$. Note that the magnitude of this treatment effect depends on the labour composition of each town, ℓ_j . We control for ℓ_j by using town size as a proxy 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 effect on town wages and labor income are equal to

$$\hat{\omega}_b - \hat{\omega}_n = \frac{1 - \ell_j}{1 - \alpha \mu} > 0 \quad (23)$$

and

$$\left(\hat{\Lambda}_b + \hat{\omega}_b \right) - \left(\hat{\Lambda}_n + \hat{\omega}_n \right) = \frac{1}{1 - \alpha \mu} > 0, \quad (24)$$

respectively. The inequalities in (22)-(24) hold by inspection since all parameters and the share ℓ_j belong to the unit interval. Finally, we can use (22) and (23) to obtain an estimate for town j 's labor supply elasticity:

$$\rho_j \equiv \left. \frac{\hat{\Lambda}_j}{\hat{\omega}_j} \right|_{\hat{u}=0} = \frac{\mu \ell_j}{1 - \alpha \mu \ell_j}.$$

We test the properties of (22)-(24) 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.*

Proof. See Appendix. ■

Third difference: large/small towns. The interaction of ℓ_j with the border/non-border treatment is positive in the employment equation (22), negative in the wage equation (23), and

¹⁰This 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.

nil in the wage bill equation (24). That is to say, the magnitudes of the quantity and price effects will depend on the labour *composition* of towns. Using expression (10) and the definition of ℓ_j , we obtain an implicit solution for it:

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

Neither H_j nor N_j are directly observable in our data. We thus impose a relationship between the two so that the system remains over-identified. This 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 empirically 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 $H_j = \eta N_j^\lambda$, some $\eta > 0$ and some $\lambda \in (0, 1]$, which implies

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

by choice of units (i.e. choosing $\eta \equiv 1 - \mu/\alpha^{1/(1-\mu)}$). In equilibrium, towns endowed with large amounts of immobile factors have a large population as per equation (11), thus the equilibrium relationship (25) implies that ℓ_j is *decreasing* in town size given p_j . By the same token, plugging (25) into (13) and using the definition of ℓ_j yield the following expression for equilibrium density:

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

where the second equality uses the definitions of ℓ_j and Λ_j . This implies that population density and population size are positively correlated, as is empirically the case in all countries that report such data.

Combined with equations (22)-(24), 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; there is no differential effect on the wage bills of large and small border towns.*

Proof. See Appendix. ■

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

4.2 Estimating the welfare effects of the fall of the iron curtain

We start by signing the welfare effect of the trade shock on the average worker of town j . Log-differentiating equation (18) yields the following metric for the average welfare gain in j : $\hat{u}_j = \hat{\ell}_j + \hat{u}$. Comparing a pair of towns of initially equal population composition and size, one border- and one non-border-town, yields

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

where $(1 - \ell_j)$, $j = b, n$, is the common 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 (17) in order to obtain an explicit expression for the welfare changes of immobile workers, i.e. $\hat{v}_j = \hat{\ell}_j - \hat{u}$. Comparing the same pair of otherwise identical border and non border towns yields

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

$j = b, n$, 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 trade liberalization of immobile workers residing in a border town relative to immobile workers in a non-border town are independent of town size: the direct price effect (better market access) is compensated by the indirect price effect (more immigration raises housing prices more than they raise the marginal productivity of immobile workers). This invariance does not hold for the average workers: 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 trade liberalization 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 (20). 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

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 recently experienced a large exogenous trade shock. In 1976, at the beginning of our sample period, the country lay on 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. As documented in Brülhart *et al.* (2012), the fall of the Iron Curtain in the second half of 1989 triggered a change in trade

openness that was large and unanticipated. 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. Moreover, trade matters to the relatively small Austrian economy: it was the OECD’s fifth most trade oriented country in 1990.

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.¹¹ 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.

In order to minimize distortions from top coding, we construct wages as medians across individuals by municipality. 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.

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 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. Table 1 provides descriptive

¹¹For 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.

statistics.

Our identification strategy will hinge on the relative distances of these towns to eastern markets. We retain two distance measures:

- 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).¹²

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.¹³ 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 kilometers from the border, with Vienna, at 65 kilometers, still significantly affected. This representation confirms that the differential effect of post-1990 market opening was confined to a relatively narrow band of towns located close to the border.

6 Estimation Strategy

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

Specifically, we estimate the following three equations:

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

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

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

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

¹²Road 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.

¹³The 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.

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 changes.¹⁴ 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 nationwide 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, $\hat{\alpha}_1$, $\hat{\beta}_1$ and $\hat{\gamma}_1$. According to the model of Section 3, bigger towns have stronger wage effects ($\beta_1 > 0$) but weaker employment effects ($\gamma < 0$) 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 ($\alpha_1 = 0$).

The differential effects of trade liberalization on average-sized border towns are captured by $\hat{\alpha}_2$, $\hat{\beta}_2$ and $\hat{\gamma}_2$. The ratio of the estimated employment and wage responses, $\hat{\rho} = \frac{\hat{\gamma}_2}{\hat{\beta}_2}$, provides us with a measure of the relative magnitudes of employment and nominal wage adjustments, and thus of the slope of the labor supply curve of an average-size town.¹⁵

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 (interior) municipalities to those that provide the nearest match to at least one of the treatment (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.

7 Estimation results

7.1 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 suggests that, compared to interior towns, towns close to Austria's eastern border have

¹⁴ ΔW_{jt} is computed as follows: $\Delta W_{jt} = \frac{W_{jt} - W_{jt-4}}{[W_{jt} + W_{jt-4}] * 0.5}$.

¹⁵Since our estimating equations feature identical sets of regressors, estimating them separately by OLS is equivalent to estimating them as a system. Our strategy thus amounts to estimating the slope of the regional labor supply curve, $\hat{\rho}$, via indirect least squares.

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 significant for employment. The key prediction of our model is thus confirmed: larger towns seemed to respond to external trade opening mainly through wage rises, whereas small towns responded mainly through job growth. Also in line with our model, these two effects appear to have offset each other: we observe no statistically 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.

7.2 Robustness

In Table 3, we subject the baseline estimates to a battery 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. Second, we estimate the baseline model without including Vienna, to control for a potentially distorting effect of urban primacy in the control group. 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 its neighbors.¹⁶ This measure is designed to take account of commuting and other spillover mechanisms among real-world towns. In another alternative definition, we compute $Size_j$ as employment density, dividing employment by constructible land area.¹⁷ As shown in rows (D) and (E) of Table 4, our baseline results are robust to these variations in the definition of town size.

¹⁶Specifically, 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). The correlation between our benchmark measure of $Size_j$ and this centrality measure is 0.315.

¹⁷Constructible 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.

As a final sensitivity test, we augment the baseline models (28) to (30) by municipality-level pre-treatment unemployment rates and their interactions with $Fall_t$ and with $Fall_t \times Border_j$.¹⁸ 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. This mechanism, however, is doubly rejected by the data. First, the raw correlation between pre-treatment unemployment rates and $Size_j$ is in fact slightly positive: 0.04 for both our baseline definition of $Size_j$ and for density. Second, our estimated coefficients on the triple interaction are slightly reduced in absolute size but 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.

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 liberalization. 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.¹⁹ In the first panel of Table 4, we show that this 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 was stronger in large towns while the employment effect was somewhat larger in small towns.

Finally, 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 reestimating our baseline empirical model augmented by a placebo treatment group, defined as towns within 25 kilometers from the nearest road border crossing with one of Austria's western neighbor countries Italy, Switzerland, Liechtenstein or Germany. 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 placebo treatment itself. These findings strongly support the case for interpreting our baseline findings as the causal effects of trade liberalization induced by the fall of the Iron Curtain.

¹⁸We 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.

¹⁹The ASSD data also contain information on somewhat more disaggregated sector affiliations, but we found this information to be too noisy to be reliable.

8 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 supported by the experience of Austrian towns. This raises the question of the theory's normative implications. In our model, immobile residents of regions benefitting 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, due to a pure composition effect.

References

- [1] Ades, Alberto F. and Glaeser, Edward L. (1995) Trade and circuses: explaining urban giants. *Quarterly Journal of Economics*, 110: 195-227.
- [2] Autor, David H.; Dorn, David and Hanson, Gordon H. (2013) The China syndrome: local labor market effects of import competition in the United States. *American Economic Review*, 103(6): 2121-2168.
- [3] Behrens, Kristian; Gaigné, Carl; Ottaviano, Gianmarco I.P. and Thisse, Jacques (2007) Countries, regions and trade: On the welfare impacts of economic integration. *European Economic Review*, 51: 1277-1301.

- [4] Brülhart, Marius (2011) The spatial effects of trade openness: a survey. *Review of World Economics*, 147: 59-83.
- [5] Brülhart, Marius; Carrère, Céline and Trionfetti, Federico (2012) How wages and employment adjust to trade liberalization: quasi-experimental evidence from Austria. *Journal of International Economics*, 86: 68-81.
- [6] Fiszbein, Ariel and Norbert Schady (2009) *Conditional Cash Transfers: Reducing Present and Future Poverty*. World Bank Policy Research Report, Washington DC.
- [7] Head, Keith and Thierry Mayer (2010) Illusory Border Effects : Distance Mismeasurement Inflates Estimates of Home Bias in Trade. In Brakman, Steven and Peter van Bergeijk (eds.) *The Gravity Model in International Trade: Advances and Applications*, Cambridge University Press.
- [8] Henderson, J. Vernon (1982) Systems of cities in closed and open economies. *Regional Science and Urban Economics*, 12: 325-350.
- [9] Henderson, J. Vernon (2003) The Urbanization process and economic growth: the so-what question. *Journal of Economic Growth*, 8: 47-71.
- [10] Hilber, Christian A.L. and Christopher Mayer (2009) Why Do Households without Children Support Local Public Schools? Linking House Price Capitalization to School Spending. *Journal of Urban Economics*, 65(1): 74-90.
- [11] Kovak, Brian K. (2013) Regional Effects of Trade Reform: What Is the Correct Measure of Liberalization? *American Economic Review*, 103(5): 1960-1976.
- [12] Krugman, Paul (1991) Increasing returns and economic geography. *Journal of Political Economy*, 99: 483-499.
- [13] Krugman, Paul and Raul Livas Elizondo (1996) Trade policy and the third world metropolis. *Journal of Development Economics*, 49: 137-150.
- [14] Ottaviano, Gianmarco and Peri, Giovanni (2012) Rethinking the effects of immigration on wages. *Journal of the European Economic Association*, 10: 152-197.
- [15] Ottaviano, Gianmarco, Peri, Giovanni and Wright, Greg (2013) Immigration, offshoring and American jobs. *American Economic Review*, 103(5): 1925-1959.
- [16] Redding, Stephen and Sturm, Daniel (2008) The costs of remoteness: evidence from German division and reunification. *American Economic Review*, 98: 1766-1797.

- [17] World Bank (2008) *World Development Report 2009: Reshaping Economic Geography*. Washington DC.
- [18] Zweimüller, Josef; Winter-Ebmer, Rudolf; Lalive, Rafael; Kuhn, Andreas; Wuellrich, Jean-Philippe; Ruf, Oliver and Büchi, Simon (2009) Austrian Social Security Database. *Working Paper #0903*, Austrian Center for Labor Economics and the Welfare State, University of Linz.

Figure 1: Treatment groups: baseline definition

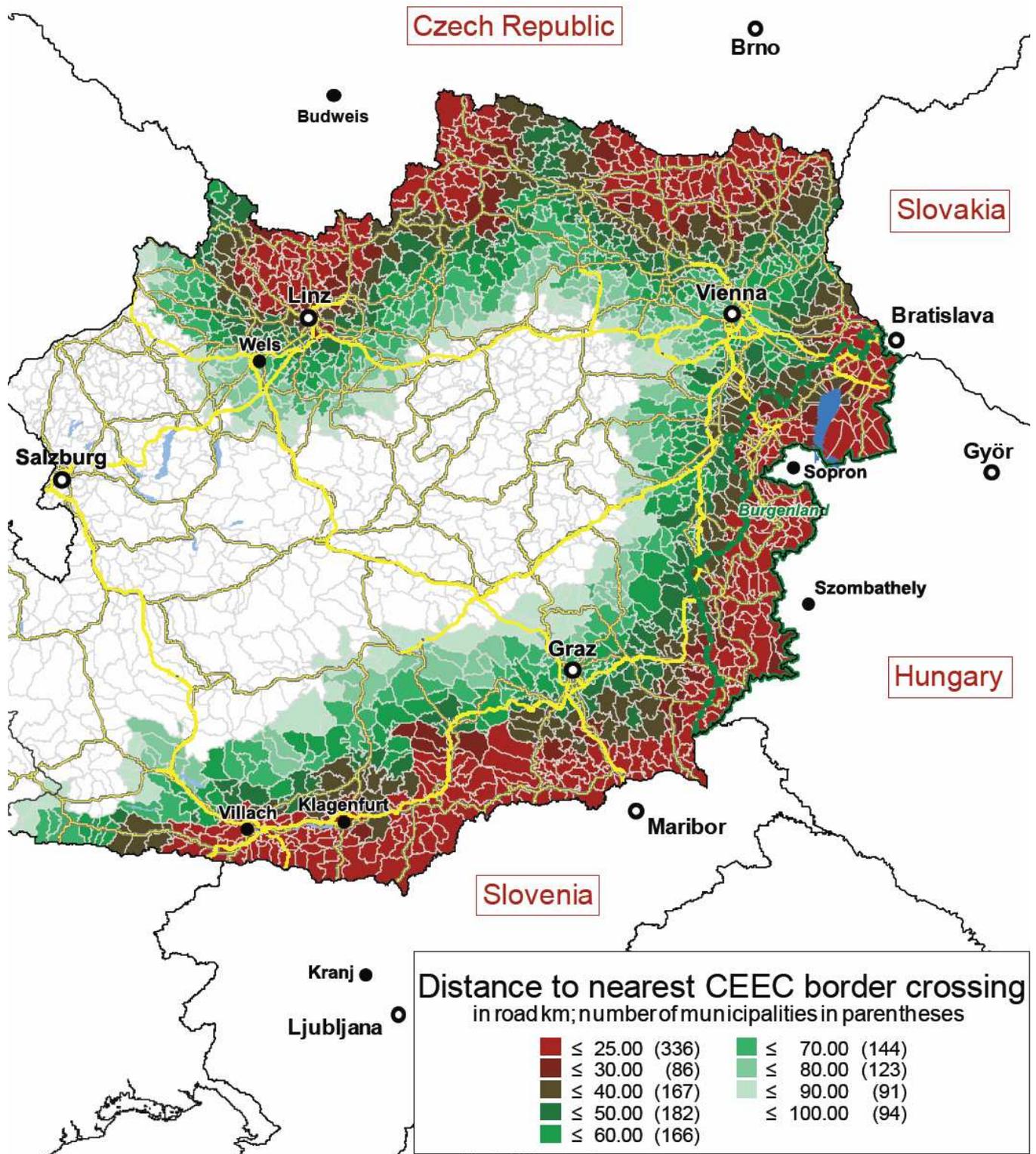


Figure 2: Treatment groups: alternative definition

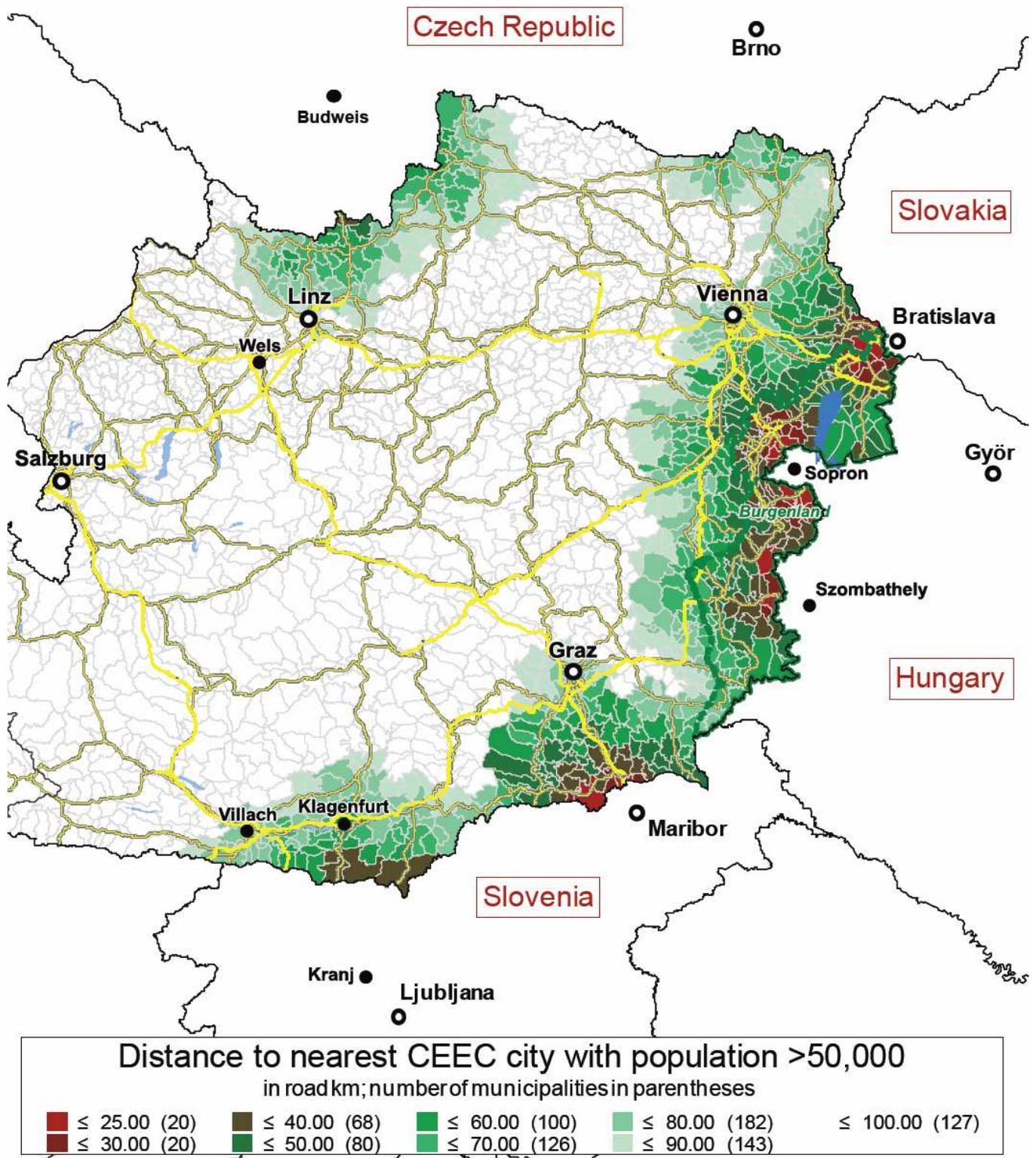


Figure 3: Distance to border and post-1990 growth of town-level wage bills

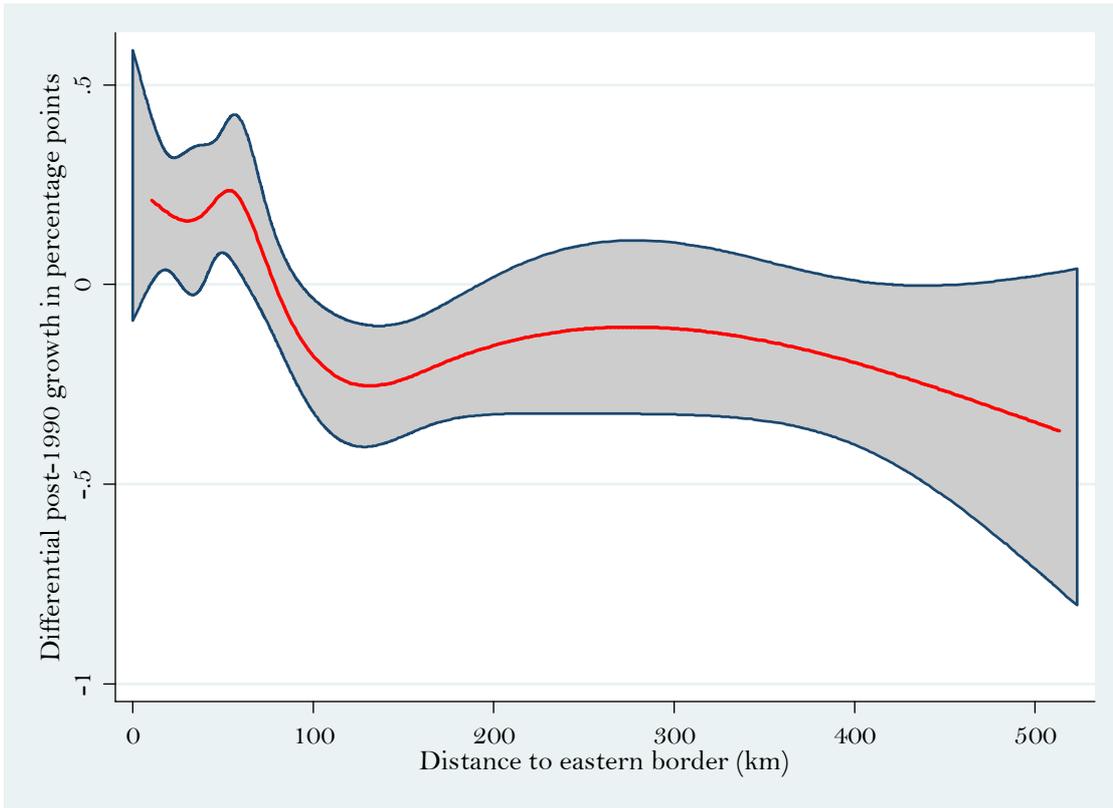


Figure 4: Wage/employment responses and town size

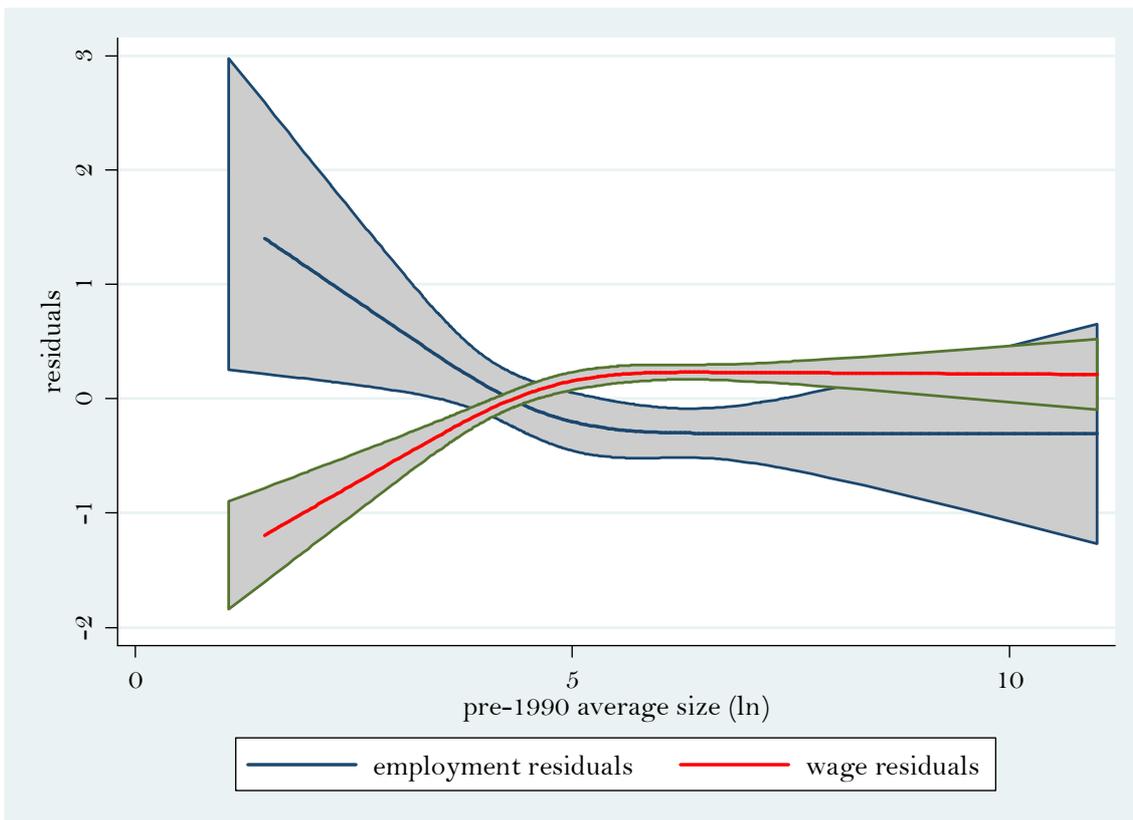


Table 1: Summary statistics*Border* defined as lying within 25 road kilometers from nearest CEEC border crossing (Czech Republic, Slovakia, Hungary or Slovenia)

Variables	1975-1989				1990-2002			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Border municipalities (<i>Border</i> = 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 %	6.2864	9.73	-103.07	128.01	4.1742	8.88	-100.57	81.08
Employment	502.21	3,492.11	1	67,239	563.15	3,798.11	1	71,739
Annual growth rate of employment %	1.1168	14.07	-163.19	165.43	1.8767	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 (<i>Border</i> = 0)	89,960 observations: 52 quarters and 1,730 towns				1,730 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	5.9667	9.46	-135.23	150.66	3.6581	8.85	-121.18	125.14
Employment	1,071.09	15,152.95	1	617,433	1,132.63	15,519.61	1	642,011
Annual growth rate of employment, ΔE	1.2693	14.75	-179.86	181.54	1.2289	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:	$\Delta(W*E)$	ΔW	ΔE	$\Delta(W*E)$	ΔW	ΔE	$\Delta(W*E)$	ΔW	ΔE	$\Delta(W*E)$	ΔW	ΔE
Definition of treatment sample (<i>Border</i> = 1)	$\leq 25\text{km}$ to nearest border post			$\leq 35\text{km}$ to nearest border post			$\leq 60\text{km}$ to nearest town $\geq 50,000$			$\leq 60\text{ km}$ to nearest town $\geq 20,000$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>Fall_t</i> x <i>Border_j</i> x <i>Size_j</i>	-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)
<i>Fall_t</i> x <i>Border_j</i>	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)
<i>Fall_t</i> x <i>Size_j</i>	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 <i>Border_j</i> = 1	317	317	317	522	522	522	325	325	325	393	393	393
R ²	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 ($Fall_t \times Border_j \times Size_j$)

Dependent variable:	$\Delta(W*E)$	ΔW	ΔE	obs.
	(1)	(2)	(3)	
<u>repeat from Table 2:</u>				
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)	219,348
(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* (0.0864)	-0.317*** (0.093)	221,076

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 ≤ 25 km (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:	$\Delta(W*E)$	ΔW	ΔE
	(1)	(2)	(3)
all towns (1,998 obs.)			
<i>Fall_t x Border_j</i>	0.640*** (0.192)	0.213*** (0.076)	0.899** (0.382)
large towns (> 1,000 employees pre-1990; 174 obs.)			
<i>Fall_t x Border_j</i>	0.965*** (0.215)	0.387*** (0.086)	1.375*** (0.497)
small towns (≤ 750 employees pre-1990; 631 obs)			
<i>Fall_t x Border_j</i>	0.976** (0.409)	0.172 (0.185)	1.737** (0.783)

Notes: 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*Border* defined by road distance from nearest border crossing with Czech Republic, Slovakia or Hungary

Dependent variable:	$\Delta(W*E)$	ΔW	ΔE	$\Delta(W*E)$	ΔW	ΔE
	full sample			without Eastern border towns		
Sample:	(1)	(2)	(3)	(4)	(5)	(6)
$Fall_t \times Border_j \times Size_j$	-0.188 (0.117)	0.206** (0.094)	-0.385*** (0.098)			
$Fall_t \times WestBorder_j \times Size_j$	0.259 (0.203)	0.071 (0.111)	0.199 (0.140)	0.258 (0.203)	0.0745 (0.112)	0.194 (0.139)
$Fall_t \times Border_j$	0.809** (0.320)	0.215* (0.126)	0.622** (0.290)			
$Fall_t \times WestBorder_j$	-0.907*** (0.300)	0.052 (0.118)	-0.958*** (0.267)	-0.907*** (0.302)	0.041 (0.118)	-0.948*** (0.269)
$Fall_t \times Size_j$	0.008 (0.007)	0.014** (0.006)	-0.005 (0.008)	0.008 (0.007)	0.014** (0.006)	-0.005 (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
R ²	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; $Border_j = 1$ if road distance from nearest CEEC border post ≤ 25 km (Czech Republic, Slovakia, Hungary or Slovenia); $WestBorder_j = 1$ if road distance from nearest “Western” border post ≤ 25 km (Italy, Switzerland, Liechtenstein or Germany); W : nominal wage, E : employment; $Size_j$: mean-differenced average pre-1990 town-level employment