The Role of Economic Integration for European Cities and Border Regions

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The Role of Economic Integration for European Cities and Border Regions

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Chapter One

Introduction

There are significant disparities in economic activity between countries and regions. To some extent these disparities between locations are due to differences in institutions and natural endowments. Both the inter- and intra-national disparities are typically more significant when the distance between locations is larger and when locations are less integrated. This suggests that geographical barriers and transportation costs, or economic geography in general, also play a role in explaining spatial disparities. It also suggests that the reduction in distance, or transaction costs in general, changes the relative attractiveness of locations/cities. This can be explained by the new economic geography (NEG) literature which emphasizes the importance of market access as well as by the urban economics literature which would point towards changes in the local characteristics (e.g., following increased trade opportunities) in determining such spatial variations.

The present thesis analyses the impact of economic integration on the spatial allocation of people and economic activity and does so in particular for border locations in the European Union (EU). Differentiating between the contributions of each of the factors to spatial economic disparities is difficult. The real challenge here is discovering changes and attributes to the particular factors. The effects of some shocks to urban systems have been studied before. For instance, Davis and Weinstein (2008) as well as Bosker et al., (2007a), studied the exogenous shocks of the destruction of cities in Japan and Germany during World War II (WWII), respectively, and examined the consequence of the reduced population in cities and destroyed economic activities. They ascertained that the cities only returned to their original equilibrium decades after the war was over.

Market access, the concept that is central to the new economic geography literature, can be affected by exogenous "shocks" that alter the accessibility to other markets, especially in geographical proximity. It is well known that national borders significantly add to transportation costs and reduce (international) trade. Few studies, however, isolate the effect of borders on border agglomerations. This is remarkable as it can be expected that, for example, border cities are generally affected by the nearby borders and that sudden changes that are related to these borders are felt especially by the border cities. The work that is most similar in this respect is Redding and Sturm (2008) which analyzes the effects of division and reunification of West and East Germany on population growth of cities near the newly created border. They discovered significant decline following the division and subsequent recovery after reunification. Their study is limited to and examines the West German side of the border and provides an interesting insight. The division of West and East Germany was created within the same territory that used to be same country for few decades. This thesis expands this by addressing whether the same results would hold if the

integration shocks are occurred on actual multiple national borders separating countries for much longer periods of times as well as with different types of integration shocks.

The challenge in addressing these issues is the lack of proper data regarding the economic activities with details of locations. This thesis employs various EU integration shocks as a quasi-natural experiment and addresses this question in various ways. In Europe, there are no adequate data systematically available at city level data on income, jobs, trade and other economic activities. Therefore, in this thesis, we mainly exploit the population data which are generally more accessible as the best proxy measuring the extent of economic activities in cities/towns. In this aspect, the main contributions of this thesis to the literature is that it expands on a wider range of integration shocks mainly in border integration, in transportation infrastructure, and social integration across a geographically wider range of international cities and towns. We employ estimation and simulation approaches and provide a range of new results to the literature and for utilization in policy making.

This thesis consists of five related chapters. Chapter Two explores market access across national borders. It uses data from the oldest EU members and reflects on the importance of market access in geographical proximity as well as the differences between locations near national borders and central locations. Chapter Three investigates the effect of the entire EU integration process on the population of, especially, near border locations. Chapter Four undertakes a similar analysis as in Chapter Three but in a more detailed manner by employing more detailed, but geographically limited, locations. This section separates different sides of the same borders between the two countries under consideration. Chapter Five takes the analysis of the integration process beyond the geographical scope. It investigates individual integration processes between individual cities and towns with cities and towns around the world and not just in the EU area. Chapter Six examines the potential effects of the reduction of transportation barriers within national boundaries.

The objective of Chapter Two is to explicitly compare the market access of border cities to non-border cities with and without border barriers; and the relationship of the wage rates with the market access to the other side of national borders. The analysis in this chapter consists of two main sections. We calculate the market access and estimates the wage model while simulating the opening up of the border restrictions. Redding and Venables (2003), Boulhol et. al. (2008) as well as Boulhol and De Serres (2010) explain how distance (transportation cost) and other restrictions on market access lead to variation in wage structure. In the first section, we exploit data from 1995 to 2006 from 107 cities in three countries (Belgium, Germany and the Netherlands) as these countries were the earliest to abolish their common border barriers in the EU integration process. Furthermore, this sample includes two types of national borders. One is the Netherlands-Belgium border with an historically longer period (since 1948) of free trade and where the same language (Dutch) is spoken on both sides of the border. The other type is the Netherlands-Germany border with a rather more recent history of free trade and where different languages (Dutch in the Netherlands and German in Germany) are spoken across the borders. We demonstrate that the abolition of borders increases the market access for all cities; however, the increase is higher in cities that are located closer to the national borders. The estimation results confirm that the market

access to the neighboring countries market is more significant for the bordering cities than it is for the non-border cities. The results also show that, after more than 50 years from the implementation of the first free trade agreements, the cities that are closer to the national borders still have proportionally lower wage rates throughout the entire sample period. Moreover, we discovered evidence that the two borders are different.

Chapter Three expands on Redding and Sturm (2008) to encompass the entire EU area. We take into consideration several discretionary policy-induced changes or (quasi-) natural experiments of the EU integration process to elucidate the consequences of changes in market access to the population of towns and regions close to the national borders with and without the border barriers. We also investigated other integration shocks such as monetary union or adoption of the EURO single currency. Certain significant destructive shocks such as the allied bombing of Japanese cities (see Davis and Weinstein, 2002) or similar exercises of bombing German cities by allied forces (see Brakman et al., 2004a) during World War II (WWII) demonstrate that the development of cities indeed follows a relatively stable path in the sense that cities tend to return to their pre-shock state following the shock. At the same time, it is possible that the development of cities progresses to another development path, see Bosker et al. (2007a). Some less dramatic experiments or shocks such as changes in the degree of economic integration, as in the EU case or Germany unification, illustrate that the effects, for border cities in particular, can still be substantial. The novelty of this chapter is that the border effects of the multiple stage EU integration process on cities along national borders has not been previously analyzed which is in contrast to studies that emphasize the importance of the border effect on trade in general. We employ the difference-in-difference estimation approach and ascertain that the EU enlargement process leads to additional growth as measured by the growth in population share along the integration borders. This integration effect decreases with distance and, over time, is approximately the same for new and old members and is more significant for large cities and regions. Despite this EU integration effect associated with EU enlargements, being located along a border remains a burden in view of the (larger) general negative border integration effect. We do not find similar border-integration effects as a result of the introduction of the euro.

Chapter Four examines the earlier analysis in more detail employing a similar approach as in the earlier chapter but utilizing a spatially more detailed and longer time dimension dataset of a limited number of the oldest EU member countries, specifically, Belgium, Germany and the Netherlands. The new data allow us to investigate whether borders have two sides; are cities on each side of the borders affected differently? Moreover, we test for structural breaks in the population growth in the border locations following various EU integration shocks. We also assess the possible variation in the (in)direct integration effects on border locations over time as the EU expands to countries that do not involve the sample borders. Using population growth data from municipalities of Belgium, Germany and the Netherlands, our results confirm the existence of asymmetric border effects. We also ascertain different indirect effects from the EU expansion on the non-neighboring countries. Generally, the positive integration effects on the border locations continue for limited periods of time but persist for longer periods for some borders more than others.

In Chapter Five, the analysis focuses on town-twinning (TT). Town-twinnings are special relationships between cities in different countries. These relations vary between letters between school children to more specific economic relations. It can be expected that town-twinning reduces transaction costs between cities that are not related to a border location as such, but still might affect MA. In this chapter , we examine the consequences of town-twinning of cities that are involved in these initiatives. Due to the availability of data and because of the special position of Germany in Town-twinning we focus on German twinning with the rest of the world and ascertain that twinning cities grow faster than non-twinning cities. Using the instrumental variable (IV) estimation approach, we find that there is a causal relationship between population growth and twinning. Town-twinning might facilitate city growth through increased trade or migration, but this is difficult to prove due to lack of data on trade and migration between the town-twinning partners.

Chapter Six focuses on the analysis of the effects of reduced transportation costs within national boundaries through improved transportation links between cities which would subsequently reduce trade cost. Very high or very low trade costs favor the dispersion of economic activities while agglomeration would emerge for intermediate values of these costs once the spatial mobility of workers is low (Fujita and Thisse, 1996). Although dispersion is usually unfavorable when compared to agglomeration (Tabuchi, 1998) or not necessarily beneficial (Baldwin et al., 2003) from a welfare perspective, dispersion necessarily takes place when such policy intervention makes transportation cost sufficiently less (Tabuchi, 1998). We employ the so-called Core-Periphery (CP) model and its extension, the Core-Periphery Congestion (CPC) model of the New Economic Geography, with the interregional factor mobility by Krugman (1991a). Prior to the simulation analysis of improved transportation policy scenarios, we analyze the spreading and agglomeration effects of transportation cost and congestion in a multiple-regions case. We analyze the long-run implications of four different road and railway projects that are intended to improve transportation between the large cities in the west of the Netherlands called Randstad and nearby smaller municipalities. With the simulation analysis, we attempt to answer the following questions. Does this intervention lead to the relocation of firms and workers into the municipalities near the projects at the expense of the other municipalities? Do all municipalities benefit from this intervention, or do only large municipalities gain over small ones in the vicinities of the projects? How do the effects differ across municipalities of different sizes and across municipalities that are at different distances from the project locations? The results are, in general, in accordance with the literature. The spreading or agglomeration effects of the transportation cost and congestion cost in a multiple-regions setting supports the results based on the two-regions setting. The results from the CP model suggest that the reduction in trade cost through reduced travel time, in general, leads to increased agglomeration in the larger municipalities. However, the CPC model, as one would expect, demonstrates the opposite. In the latter, there are dispersions principally from the large municipalities near the project locations to municipalities moderately farther away as well as from bigger to relatively smaller municipalities.

In general the thesis finds that "shocks", and by this we mainly refer to (policy induced) changes in the degree of economic integration reduces barriers between the core and the periphery, and in general reduce transaction costs between cities and regions and this leads to faster

population growth of the locations directly affected. Following abolition border barriers, more firms and workers may prefer to locate near the borders due to access to the markets and jobs on the other side of the border. However, not all economic integration shocks have this effect, notably the introduction of the Euro. Furthermore, economic integration affects cities on two sides of the border differently, and town-twinning facilitates population growth of the participating cities. Improved transportation links potentially lead to dispersion of economic activities from high agglomeration to less populated areas, but this effect reduces with distance. A large scale integration involving several countries in EU brings about several and complex changes such as opening up several pre-integration peripheries to several pre-integration cores. This may create new cores and new peripheries. In future research, the exploitation of additional data regarding employment, migration and trade on a detailed spatial level in the estimations as well as the utilization of a more comprehensive model in the simulation approach would be very beneficial.

Chapter Two

National Borders and Market Access

2.1. Introduction

The size and distribution of cities and the resulting market access are determined by the relative strength of centripetal forces and centrifugal forces, see f.i. Krugman (1991a). Centripetal forces comprise the physical proximity to markets, human capital, infrastructure, variety of consumer goods, and thick labor markets. Centrifugal forces are forces such as excessive traffic congestion, increased living costs as well as considerable transportation costs. The former lead to the concentration of economic activities, whereas the latter stimulate spreading of economic activity (Krugman, 1980, 1991a and 1995; and Fujita et al., 1999). Although a city's individual characteristics such as soaring levels of human capital strongly correlate with cities' growth in both population and income per capita (Glaeser et al., 1992), there is also widespread evidence that increasing market access contributes to growth and raising income levels (Boulhol et al., 2008). An improved access to markets is determined, among other things, by the geographical proximity to other cities, access to inexpensive transportation routes and the absence of artificial obstacles such as border restrictions. Thus, geographical distance and national borders lead to variation in commodity prices, and this subsequently leads to variation in wage rates between cities. The variation of the price is much higher for two cities located in different countries than for two equidistant cities within the same country. Wages tend to be higher in metropolitan areas with greater market access than in areas with minimal market access (Fallah et al., 2010). The (abolitions of) national border barriers affect trade. Changes in the trade due to changes in the border barriers can affect the wages of differently skilled workers differently (see, for example: Feenstra, 2000).

Border barriers negatively affect international trade. McCallum (1995) finds that the presence of the Canada–US border results in, on average, 20 times lower trade across the border than comparable within-country trade. Although subsequent research suggests that this number is too high and should be reduced to a factor 10, border effects remain large (Feenstra, 2004, Anderson and van Wincoop, 2003). Despite these findings of large negative border effects, borders change and so do the border effects. Hanson (2001), for example, finds a positive and strong correlation between NAFTA and Mexican export growth, and Redding and Sturm (2008) find that the construction of the 'Iron curtain' and the subsequent 'Fall of the Wall' within Germany effected border cities significantly. They employ a multi-region version of the geographical economics model by Helpman (1998) to demonstrate how firms' market access (FMA) as well as consumers' market access (CMA) determine the equilibrium on the labor market. Geographical border barriers limit the market access of both firms and consumers and, therefore, agglomeration. We will employ this approach in our analysis in the subsequent chapters.

The main objective of this chapter is to take the initial step in the thesis and lay the groundwork for the assessments of the effects of various forms of integration shocks in the successive chapters. In this aspect, we begin with the assessment of the differences between cities that are located near national borders and those cities that are centrally located in terms of wages and market access. In doing so, we simulate the effects of opening the borders between the Netherlands, Belgium, and Germany on the cities and towns located near the common borders versus those that are centrally located. In contrast to most existing studies on border effects which focus on trade of commodities, we concentrate on wage and market access. We also exploit cities as the units of analysis instead of regions and countries, which are the most often used units of analysis. In this inaugural chapter, we also take the first step in directly modeling the border barriers as a component of market access. Furthermore, we elaborate on the difference in the importance of market access across national borders for two groups of cities, border cities and non-border cities.

This chapter is arranged as follows. In Section 2.2, we discuss related literature. Although the literature we discuss is not exclusively NEG, in this chapter we add to the importance of borders from different points of view. The research methodology and empirical model is introduced in Section 2.3. We employ the New Economic Geography (NEG) equilibrium wage model following Krugman (1991a) accounting for location (being located close to borders) and 'foreignness'. Section 2.4 is devoted to data description. We exploit annual data from three countries (Belgium, Germany, and the Netherlands) encapsulating the periods from 1995 to 2006. The data include average annual per capita income, average annual wage rate, geographical (road) distance between the sample cities, and cities' location relative to national borders. These countries have been selected because they were the first to abolish their economic border barriers in the EU integration process, and possible effects should be evident in the data. In section 2.5, we present the estimation results. Our estimation results confirm that market access to neighboring countries' markets is significantly more important for border cities than for non-border cities. The results also indicate that, after more than 50 years following the implementation of the first free trade agreements, the cities that are nearer to national borders continue to have, in general, proportionally lower wage rates than in centrally located cities throughout the entire sample period. Moreover, we find evidence of asymmetric effects on the two borders, i.e., the negative border effect is more significant and stronger across the Netherlands-Germany border than it is across the Netherlands-Belgium border where the earlier free trade implementation and/or a common language across the border may have been of assistance. Finally, section 2.6 summarizes and concludes.

2.2. National borders, trade, market access and wage

Border barriers have a direct relationship with transportation and trade costs. According to the NEG literature, transportation costs are among the most important factors that affect location of economic activities (see, for instance, Krugman, 1980, 1991b, 1998; Fujita, et al., 1999; Fujita and Krugman, 2004; and Fujita and Mori, 2005). These relationships have been extensively

documented (see for a survey Brakman et al., 2009). Redding and Venables (2003), Boulhol et al., (2008) as well as Boulhol and De Serres (2010). In this chapter we focus on border barriers that, as we emphasize in this chapter, lead to a variation in wages across cities and regions. The impact of distance or transportation cost on the size of cities' have been extensively discussed (for example; Henderson, 1974; Krugman, 1980, 1991a; Tabuchi et al., 2005; Partridge et al., 2008; Redding and Venables, 2003; Boulhol and De Serres, 2010; and Fallah et al., 2010). Border barriers, however, are special, as the international trade literature shows. Using different types of distances[1] such as straight line distance or actual road distances, various studies indicate that intra-national as well as international distances affect trade (see McCallum, 1995; Anderson and van Wincoop, 2003; and Manchin and Pinna, 2009), traded commodity prices (see, for example, Nitsch, 2000; Wolf, 2000; and Hillberry and Hummels, 2003; Redding and Venables, 2004; Asplund et al., 2007; Clemente et al., 2009; Boulhol and De Serres, 2010) and even rural income (example: Partridge and Rickman, 2008). As said, we focus on border barriers which can be expected to be important to explain the growth of border cities.

Although border locations limit competition by shielding a location from outside competition (see Behrens et al., 2006) they in general have several disadvantages. Border barriers cut off the markets within geographical proximity and thus reduce trade and market access which subsequently leads lower (city) growth (see, for example, Redding and Sturm, 2008) relative to non-border locations (see Redding and Venables, 2003 and Fallah et al., 2010). Border barriers add to distance and affect wages negatively. Since distant regions/cities suffer a market access penalty on their sales and also face additional costs on imported inputs, firms in these cities/regions can only afford to pay lower wages relative to central locations (Redding and Venables, 2003; and Boulhol and De Serres, 2010). That creates wage disparity between the border areas and the central locations. Engel and Rogers (1996) demonstrate that the distance between cities explains the significant amount of variation in prices of similar goods in different cities.

In addition, border barriers add to labor immobility by isolating the border regions and cities from nearby foreign markets across the borders. This leads wage variations between the two sides of the national borders. According to Glaeser and Kohlhase (2004), labor immobility is more important factor than transportation costs in explaining the wage differentials between cities. Emphasizing the dramatic decline in transportation costs over recent decades, they imply that wage differentials continue to exist in a world where it is essentially free to move goods because it is more expensive to move people, i.e., labor immobility. National border barriers play a significant role in this aspect by isolating markets across national borders. Thus, national borders and restrictions on the flow of goods and labor forces across national borders have a direct implication for market access (therefore, on trade) and wage rates. As a consequence, economic integration and labour mobility are closely related through a wage channel (see Schöband

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[1] In this chapter, we use actual road distances (see sections 2.3 and 2.4 for more discussion). Road network can be endogenous since bigger cities have better roads than smaller towns. However, this doesn't make much difference in road distances in country with flat topography such as the Netherlands and thus we don't expect this to affect our results.

Wildasin 2007). Opening up borders obviously affects wage rates through different channels including increased market access, labour mobility and trade.

The economic performance of border regions/cities also correlates with the performance of bordering regions/cities of the neighboring countries even with the border barriers still in place. Exploiting data for the 20 Mexican and U.S. border cities over the period 1975 to 1997, Hanson (2001) finds a positive and strong correlation between growth in the manufacturing of export goods in Mexico cities along the US border and employment growth in U.S. cities along the Mexico border over the sample period. Opening or reducing the border barriers increases trade, market access, factor mobility, and incomes across the borders. Thus, to the extent it increases trade between countries, abolition of national borders enhances production and the demand for goods and services, employment, and wage rates across the border regions/cities. It seems that lower border restrictions are more important for growth than lower transportation costs (for instance, see Baier and Bergstrand, 1997). Using the data of the OECD countries during 1958 to 1988, they show that decreasing tariffs were twice as important as decreasing transportation costs for growth in bilateral trade. By opening borders, the resulting increased trade implies higher wages and more employment in production of traded goods and services. However, the effects can be different for various types of workers (Feenstra, 2000).

Importantly negative border effects seem to be persistent, even after formal abolition of border barriers. For instance, when they joined the EU, Central Eastern European Countries (CEECs) traded among themselves more than with other (older) member countries (Manchin and Pinna, 2009). There are factors that reduce the estimated negative border effects but never make them completely disappear (Wolf, 2004). Wolf shows that border effects continued to affect trade flows even after 15 years of the complete removal of the border barriers. Some of these persisting barriers are language and cultural barriers2. National borders are more than just a physical barrier. Even if the national border barriers are removed, following economic integration, some types of trade barriers continue to exist: national borders matter (McCallum, 1995). Regions and nations continue to trade in familiar and 'old' markets (history matters) even after abolition of trade barriers and monetary union.

This chapter departs from (adds to) the existing literature in two ways. First, it focusses on cities rather than regions or countries. Cities are the economic centers of economic activity. Therefore, it is interesting to assess whether or not similar effects exist at a city level as on the region or country level. Second, we focus on city locations at the border itself.

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[2] Exchange rate variability may no longer be a significant factor in countries such as the common currency euro areas, whereas all other factors can still collectively explain the persistence of border effects among the member nations. We will test for the effects of the adoption of the common currency, euro, in Chapter Three.

2.3. The empirical model

Following Harris (1954), researchers use the following simple distance weighted model to calculate market potential of region a (MP_a) in empirical studies: $MP_a = \sum_{i=1;}^{N} \left(M_i \big/ D_{ai} \right)$. N is number of cities; M_i is a measure of the size of economic activity of region i; D_{ai} is a measure of the distance or another proxy of transport costs between region a and region i; and n is the number of regions/cities. Another commonly used geographical distance weighted market potential or Market Access (MA), based on Krugman (1991a) is: $MA_a = \Phi_a^{1/\varepsilon}$ where $\Phi_a = \sum_{i=1; i \neq a}^{N} Y_i I_i^{\varepsilon-1} T^{D_{ai}(1-\varepsilon)}$;

MA_a is the market access of region or city a; Y_i is per capita income; I_i is the price index for manufactured goods; $\varepsilon > 1$ is the elasticity of substitution; T is the transport cost parameter; and D_{ai} is the distance between locations a and i. By equating the wage rate with the MA, we attain the widely used equilibrium wage model of core new economic geography (NEG) model by Krugman (1991a) as presented in equation (2.1)

$$W_a = \Phi^{1/\varepsilon} \text{; and } \Phi_a = \sum_{i=1; i \neq a}^{N} Y_i I_i^{\varepsilon-1} T^{D_{ai}(1-\varepsilon)} \tag{2.1}$$

Our analysis in this chapter is based mainly on this NEG equilibrium wage equation; however, we also use the Harris (1954) approach in the descriptive analysis of changes in the market potential of the border versus non-border cities (see section 2.5). The market access summarizes a city's (or region's) proximity to demand in all markets and determines the highest nominal wage that firms in a city can afford to pay (Redding and Venables, 2004; Hering and Poncet, 2010). Geographical distance or transportation cost T_{ai} affects the cities (economic) size through market access. The demand in market i for city a's varieties depends on the total (labor) income in city i. As the geographical distance or barrier (cost of remoteness) increases, the market access decreases as does the wage rate and the other city's (economic) size and activities. Wage rates are higher when income and demand in surrounding markets are higher and when there is improved access to those markets. For instance, market access is increased with lower transport costs T or shorter geographical distance D_{ai}. Thus the abolition of border barriers is expected to increase the market access (MA), and, as a consequence, the wage rates. We use actual road distance, for our distance data.

The elasticity of substitution, $\varepsilon > 1$, measures the elasticity of substitution between two different varieties, that is, it measures the difficulty in substituting one variety of manufactures for another variety (see Krugman 1979, 1980, 1991a). $\varepsilon = \left(\frac{1}{1-\rho} \right)$; where ρ is love-of-variety effect of consumers. The price index I_i measures the extent of competition from neighboring regions. A low price index reflects that many varieties are produced in nearby regions and are, therefore, not subject to high transportation costs which reduces the level of demand for local manufacturing

varieties. Therefore, a low (high) price index reduces (stimulates) regional wages (Brakman et al., 2004b).

The core NEG model assumes a set of trade and migration equations between just two regions. Over time, the theory and its applications have moved towards reality with more than two regions of different sizes. In their multiple regions analysis, studies on general equilibrium as well as the wage model analysis of multiple regions or cities deal with one individual country at a time assuming that a national economy is independent of other countries including the neighboring countries. However, an economy is not independent of neighboring countries especially in places such as the EU where workers and commodities can freely move across national borders. Thus, it is important to account for the market access to the neighboring country's market in the supply of jobs and demand for consumer goods and services. After accounting for the border location and foreignness, (2.1) takes the following form:

$$W_a = \Phi_a^{1/\varepsilon}; \text{ where } \Phi_a = \sum_{i=1;\, i \neq a}^{N} Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+\phi)]} \text{ and } \phi \text{ measures various physical and}$$

cultural barriers between two countries. In the event of a single country $\phi = 0$; and the model remains the same as in (2.1). We employ two major components of the *barrier term*: b for a border city indicator and B_{rs} for being a foreign city; i.e., $\phi = b + B_{ai}$. Therefore, the model can be rewritten as in (2.2):

$$W_a = \Phi_a^{1/\varepsilon}; \text{ and } \Phi_a = \sum_{i=1;\, i \neq a}^{N} Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b+B_{ai})]} \tag{2.2}$$

b is a border dummy variable which takes the value of one if a city is within a given range of distance from the national border and zero in other instances. B_{ai} is a dummy variable that takes the value of one if city a and city i belong to different countries and zero in other instances. Y_i, I_i, $\varepsilon > 1$, T, and D_{ai} are as defined in (2.1) above. We can rewrite the total market access (MA_a) as the sum of national and foreign market access corrected for the border related barriers.

$$MA_a = \underbrace{\left(\sum_{i=1;\, i \neq a}^{N} Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b+B_{ai})]} \right)^{1/\varepsilon}}_{Total\ MA} = \underbrace{\left(\sum_{i=1;\, i \neq a}^{n} Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b)]} \right)^{1/\varepsilon}}_{National\ MA} + \underbrace{\left(\sum_{i=n+1;\, i \neq a}^{N} Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b+B_{ai})]} \right)^{1/\varepsilon}}_{Foreign\ MA} \tag{2.3}$$

N is total number of sample regions/cities; n is the number of national regions/cities; and ($N-n$) is the number of regions in foreign countries that are in the sample. The first expression on the right hand side is the national market access whereas the second one is the foreign market access. Note that the foreignness barrier B_{ai} does not exist in national market access. There are more and less expensive ways of traveling to and shopping in a city in the same country than traveling to and shopping in a city at the same distance but in other country. Similarly, the B_{ai} is a foreignness barriers term that accounts for other barriers such as differences in languages, culture, and governmental policies. It is easier to procure employment or shop in a city in the same country

than in a foreign city due to language differences, employers' preferences, various governmental policies, and so on. Given $\varepsilon > 1$, and b and B_{ai} are non-negative, the expression $D_{ai}[(1-\varepsilon)(1+b+B_{ai})]$ is always negative. Thus, the use of b and B_{ai} produces a downward effect on the market access for the border and foreignness.

Redding and Sturm (2008) introduce a border or division dummy to account for both distance and border barriers in the analysis of division and reunification of East and West Germany. The dummy variable takes a value of one if city a belongs to the same country as city i, and zero in other instances. In their analysis of freeness of trade between regions, Bosker et al., (2007b) also employ an indicator dummy that takes the value of zero if two regions belong to the same country and one if not. The dummy variable in the former takes a value of one as totally opposite of the latter because of the form of the model in which the dummy variables are used. The dummy was in the numerator of the market potential of the former whereas it is in denominator of the freeness expression in the latter. Therefore, both are used to allow international trade and other cross-border economic activities to differ from intra-national trade and domestic economic activities due to factors other than geographical barriers and transportation cost or due to factors that are beyond geographical barriers and transportation cost including tariffs, differences in language, and culture. The foreignness dummy (B_{ai}) also serves the same purpose in our model. By taking logs and adding a constant and error term, we have:

$$\log(W_a) = \frac{1}{\varepsilon}\log\left(\sum_{i=1;\,i\neq a}^{N} Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b+B_{ai})]}\right) + c + \varepsilon_{at} \tag{2.4}$$

where c is constant and ε_{at} is the error term. We employ model (2.4) for the analysis of the wage structure across border versus non-border cities. We also adopted different scenarios of the distance and different values of the border (b) and the foreignness (B_{ai}) dummies. Moreover, we defined two different distance ranges for border cities. In one of them, cities that are within a 75 kilometer range from the national border are considered to be border cities; whereas, in the other sample, cities that are within an 85 kilometer range from the national borders are considered to be border cities. In both cases, the rest of the cities are categorized as non-border cities. This approach would enable us to achieve the major objective of this chapter, which is to analyze the wage structure of the border versus non-border cities using an empirical model where the geographical distance, the national border, and foreignness are modeled together in such a way that they affect the market access. The results for all of the different samples and measurement options and scenarios are presented and discussed in Section 2.5.

2.4. The data

We use annual data on average annual per capita income and wage rate from three countries (Belgium, Germany and the Netherlands) encompassing the period 1995 to 2006. The use of these three countries sample has special advantages. These countries are the earliest countries to abolish

their common border barriers in the EU integration process. This provides the longest time reference in investigating whether there are remaining border effects or not. For instance, if there are negative border effects across the borders of these countries, it is logical to expect the negative border effect to exist along the borders between relatively newer EU member countries. Moreover, our sample provides two types of national borders for comparative analysis. One of them is the Netherlands-Belgium border with a longer historical period (since 1948) of free trade and where the same language (Dutch) is spoken on both sides of the border. The other is the Netherlands-Germany border with a rather more recent history of free trade and where different languages (Dutch in the Netherlands and German in Germany) are spoken across the border. Belgium and the Netherlands also have a much longer common history.

In this chapter, we use actual geographical (road) distance (D_{ai}) connecting the sample cities. The main task in this chapter is to investigate whether there are differences in the relationship between wage rate and market access among cities that are centrally located and those cities in the border areas. To achieve this objective, we must involve two groups of cities, i.e. the border cities and the non-border cities. In their analysis of population growth in German cities, Redding and Sturm (2008) defined border cities as those cities in a range of 75 kilometers from the border between the former East Germany and West Germany. We also used a similar distance range to divide the cities into border cities and non-border cities for our baseline estimation. Moreover, we have defined another distance range of 85 kilometers which is used to check for stability or robustness of our results.

The number of cities in the sample is limited because of data limitations. We use 107 cities from three countries (20 Belgian cities and regions, 40 German cities, and 47 Dutch cities). See Table 2.1 for the summary of these sample cities and Table 2A.1 for the whole list of the cities. Although we don't anticipate the sample limitation to have effect on the comparative analysis of border versus non-border cities, more comprehensive data covering cities of all size are welcome in future analysis.

Table 2.1: Summary of sample border and non-border cities

Sample Cities	Number of cities
The whole sample cities	107
Within 85 kilometers range (border cities)	47
Outside 85 kilometers range (non-border cities)	60
Within 75 kilometers range (border cities)	38
Outside 75 kilometers range (non-border cities)	69

The list of the entire sample of cities is presented in the appendices. We use actual road distance between cities, implying that the distances of 75 and 85 kilometer ranges identifying a cities close to borders ('as the crow flies' distances to the border are in general smaller). We limit the border samples to these two ranges since using a border range that comprises a range of less than 75 kilometers results in too few cities as border cities, whereas a border range that is greater

than 85 kilometers comprises cities that are close to the center of a country in the border sample. The value of the elasticity of substitution; i.e., epsilon ($\varepsilon = 3$) is estimated through iteration method (see Table 2A.7 in the appendix and the paragraph preceding the table). The price index is normalized to unity due to lack of data at local level. Iceberg transportation cost of 10 percent ($T = 1.10$) is used in the baseline estimations. Using these parameters and the actual data, we calculate the right hand side of equation (2.4) as a measure of market access (*MA*) and then estimate the regression equation. We check for the robustness and stability of our results by changing the parameter values, particularly, the epsilon (ε) and transportation cost (*T*). Further discussion regarding the data and the estimation results continues in the next section and the appendices.

2.5. Estimation results

In this section, we will present the estimation results of the basic wage model. We compare the results for the non-border cities sample and the border cities sample. In our basic result, we estimate one without border and foreign market barriers and one with border and foreign market barriers (scenario_4). First, we present the results for the total market access and then the results where we divide it into national market access and foreign market access. The results for the total market access are presented in Table 2.2. Columns (1) and (4) exhibit the positive and significant relationship between the wage rate and the market access (*MA*) for the combined sample under both scenarios. This implies that the wage rates are proportionally significantly higher in the cities that have greater market access. One of the major objectives in this chapter is to go a step further and investigate whether this relationship varies across sample cities, i.e. border cities versus non-border cities. Columns (2) and (5) depict the results for the non-border cities; whereas columns (3) and (6) show the results for the border cities. The results illustrate that the coefficients are smaller for the border cities under both cases. This means that the percentage change in the wage rate associated with a percentage change in the market access is positive and significant but lower for border cities.

In columns (1) through (3) of Table 2.2 we use no border or foreignness penalty ($b = B_{ai} = 0$); whereas we use ($b = B_{ai} = 1$) in columns (4) through (6). Our estimation results do not directly show the border and/or integration effects since the border effects are accounted for in the market access term. Thus, to understand the results and calculate the border and/or integration effects, we compare the results for the border cities before (column 3) and after (column 6) accounting for the border locations and foreignness. The difference between the results in the columns (1) to (3) and (4) to (6) is derived from the border location and foreignness accounted only in the market access, the right had side of equation (2.2) and (2.4). Column (3) demonstrates that wage rate is 0.125 percent higher for every extra percent of market access without accounting for the border effects. However, after correcting for the market access with the border effects, the wage rate is higher by 0.2 percent (see column 6) for every extra percent in the market access. Without accounting for border effects, the 0.2 percent extra in the wage rate requires a 1.6 percent increase in the market

access, 1.6 = (0.200/0.125). Otherwise stated, the market access is lower by [(0.200/0.125) − 1 = 0.6] percent due to the border penalties.

Table 2.2: The wage rate and the total market access

VARIABLES	$b = B_{ai} = 0$ for all cities			border cities' $b = 1$; foreign cities' $B_{ai} = 1$		
	(1)	(2)	(3)	(4)	(5)	(6)
log(*MA*)	0.258***	0.291***	0.125***	0.269***	0.355***	0.200***
	(0.0145)	(0.0170)	(0.0182)	(0.0102)	(0.0143)	(0.00924)
Constant	6.938***	6.569***	8.537***	6.506***	5.492***	7.626***
	(0.144)	(0.169)	(0.188)	(0.113)	(0.160)	(0.108)
Year Effects	yes	yes	yes	yes	yes	yes
Country Effects	yes	yes	yes	yes	yes	yes
Sample	All sample cities	Non-border cities	Border cities	All sample cities	Non-borders cities	Border cities
Observations	1,272	828	444	1,272	828	444
R-squared	0.600	0.572	0.778	0.684	0.685	0.887

Robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1; the *MA* is calculated a head of the regression using parameter values and actual data as described in section 2.4; and same value of epsilon (ε) is used throughout all columns (see table 2A.7).

We repeat the same for the non-border cities and compare columns (2) and (5). Border penalty reduces the market access of the non-border cities as well, but by a smaller percentage. Compared to the 0.291 percent increase in wage rate (see column 2) for every extra percent in the market access, the 0.355 percent increase (see column 5) for each percent increase in the market access (with border penalty) would require (0.355/0.291) = 1.22 percent increase in the market under the assumption of zero border barriers. That is, the market access is lower by [(0.355/0.291) − 1 = 0.22] due to the border barriers. The difference of (0.6 − 0.22 = 0.38) is the effect of the border barriers on the border cities relative to the non-border cities. Otherwise stated, the abolition of the border barriers increases the market access of the border cities by 0.38 higher than that of non-border cities. We also estimate the model for the various scenarios including changing the parameter values of the border and foreignness. This proportion of the changes in the market access versus without border barriers generally remains consistent with these results (see Table 2A.4 in the Appendix).The absolute gain in the market access has also been higher for the border cities during our sample period. See the Appendix for the descriptive analysis.

Next we account for language similarities/differences and the distance to the borders. In this aspect, we answer the question of whether or not the above results imply that the border cities have a lower wage rate. In doing so, we included the distance of the cities from the borders. The result for the border cities indicates that the longer the distance is from the national border, the higher the distance coefficient (see Appendices, Table 2A.2, column 2). Thus, the wage rate is proportionally lower for the cities that are closer to the national borders. In this estimation, we also

included the language dummy that takes the value of one if the language spoken across the border is the same (for example, in Netherlands-Belgium border where the same language, Dutch, is spoken) and zero in other instances. However, the results show no significant relationship between the language similarity and the wage rate across the borders. However, by defining two border dummy variables, one for the Netherlands-Belgium border and another for the Netherlands-Germany border, we discover that the two borders are different, consistent with the asymmetric border effects discussed by Feenstra (2002) and also Anderson and van Wincoop (2001). The negative border effect is stronger and more consistent along the Netherlands-Germany border than it is across the Netherlands-Belgium border (see Table 2A.3 in the Appendices). This may imply that there is improved labor mobility across the Netherlands-Belgium border due to the similarity in language, longer common history and the earlier implementation of the relatively free trade agreement across this border.

We further differentiate between national market access and the foreign market access. Because of geographical proximity (lower transportation cost) and improved connection to national cities, the greater proportion of market access comes from the national market. Thus, it can be expected that the national market access is more important for the centrally located (non-border) cities. Similarly, compared to non-border cities, border cities are relatively close to and better connected to foreign cities. Thus, the implied gain in the market access following the abolition of national border restrictions is likely to be higher for the border cities compared to the non-border cities. Thus, we expect the foreign market access to be more significant for the border cities. Therefore, to investigate the importance of the foreign market access, we divide the total market access, right hand side of (2.2 and/or 2.4) above, into national market access and foreign market access: $\sum_{i=1}^{N}(.) = \sum_{i=1}^{n}(.) + \sum_{i=n+1}^{N}(.)$; where $(.) = \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]}\right)$; n is number of national sample cities and $N - n$ is number of foreign sample cities.[3] The results (Table 2.3) exhibit that the percentage change in wage rate has a positive and significant relationship with the percentage change in the foreign market access for only the border cities (see columns 3 and 6). This demonstrates the importance of geographical proximity of the border cities to the foreign markets under economic integration[4]. Our result is in agreement with the argument that foreignness itself does not affect purchases of imported goods but location does (Evans, 2001). The wage rate in the border cities has a positive and significant relationship with market access to the neighboring countries because of their location proximity to the foreign markets. This is consistent with Hanson (2001) who discerns a positive and strong correlation between growth in the manufacturing of export goods in Mexico cities along the US border and employment growth in

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[3] In the expression $(.) = \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]}\right)$, $B_{ai} = 0$ for all the national market access, i.e., the first term on the right hand side, $\sum_{i=1}^{n}(.)$.

[4] In Chapter Six, we simulate the opening of Dutch borders to Belgium and Germany using much more detailed data; and the results show that, in the long run, the municipalities in the border locations gain relatively more than the non-border municipalities following the opening up (better connection) to the neighboring markets.

U.S. cities along the Mexico border, signifying the importance of the foreign market for the bordering areas.

Table 2.3: The wage rate, and the national and foreign market access

VARIABLES	$b = B_{ai} = 0$ for all cities			border cities' $b = 1$; foreign cities' $B_{ai} = 1$		
	(1)	(2)	(3)	(4)	(5)	(6)
log(national *MA*)	0.275***	0.373***	0.168***	0.244***	0.348***	0.185***
	(0.0107)	(0.0138)	(0.00949)	(0.00963)	(0.0155)	(0.00813)
log(foreign *MA*)	− 0.00867***	− 0.0177***	0.0151***	0.000871	− 0.00273***	0.0129**
	(0.00178)	(0.00175)	(0.00391)	(0.000876)	(0.000918)	(0.00177)
Constant	6.729***	5.862***	7.485***	7.062***	5.813***	7.713***
	(0.122)	(0.155)	(0.0977)	(0.111)	(0.171)	(0.0947)
Year Effects	yes	yes	yes	yes	yes	yes
Country Effects	yes	yes	yes	yes	yes	yes
Sample	All sample cities	Non-border cities	Border cities	All sample cities	Non-borders cities	Border cities
Observations	1,272	828	444	1,272	828	444
R-squared	0.682	0.695	0.875	0.663	0.676	0.887

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; the *MA* is calculated a head of the regression using parameter values and actual data as described in section 2.4; and same value of epsilon (ε) is used throughout all columns (see table 2A.7).

We also checked for various scenarios and robustness. We have seen that the relationship between the wage rate and the total, as well as the national, market access is stronger for non-border cities than it is for the border cities (an advantage of being a non-border city). However, the relationship with the foreign market access is stronger for the cities bordering an economic integration member country (the advantage of being a border city). We estimate the wage model using different options in order to determine whether or not these results are consistent. First, we estimate the model for the various scenarios. This includes changing the parameter values of the border and foreignness. We also account for the country and time fixed effects. The proportion of the changes in the market access of with versus without border barriers under the different scenarios generally remains consistent with our basic results in Table 2.2 (see Table 2A.4 in the appendix). Second, we estimate for a different border range of 85 kilometers actual road distance instead of 75 kilometers. The coefficients over the new border range still remain smaller for the border cities. This result also holds at an annual level throughout the sample period for both the 75 and 85 kilometer border ranges (see Figure 2A.1 and 2A.2 in the Appendix for annual coefficients plotted on a graph). Since we ascertain lower coefficients for the border cities, we also expect the coefficients to become smaller for the non-borders as we include more and more cities that are closer to the borders. Consistent with this, Figure 2A.3 illustrated that, the closer to the border we

move (from 85 to 75 kilometers), the smaller the coefficients become which indicates that border effects remain throughout the sample period consistent with the literature showing persisting border effects (examples are Nitsch, 2000; Anderson and van Wincoop, 2003; and Chen, 2004). The results of the alternative scenarios are also consistent with these results (see Figure 2A.2). Moreover, the results from the alternative scenarios (different border and foreignness parameters and different types of distances) show that the foreign market access is more important for the border cities than it is for the non-border cities (also see Table 2A.5 in the Appendix). From the results, we can also ascertain that the lower the distance penalty, the more important both the national market access and the foreign market access are. For instance, when we use a logarithm of distance, the foreign market access is positive and significant for both border cities and non-border cities, but still greater for the border cities.

Theoretically, free labor mobility leads to wage rate equalization. Additionally, economic integration facilitates free labor mobility. With free labor mobility following the integration, we expect a strong tendency for workers to migrate to the cities with higher wage rates or greater market access. If this is the case, it is very likely that the migration of the workers leads to increased labor supply in those cities which drives the wage rate down. This eventually results in wage equalization across the cities and across the borders. However, we do not find evidence for this. Thus, what we understand from this is that the effects of border barriers exist even after several years of economic integration across our sample borders.

2.6. Conclusions

In this chapter, we demonstrate the significance of market access to neighboring countries across national borders. We calculate the market access employing the actual road distance, the national borders and foreignness as barriers to trade and/or labor mobility and identify it in such a way that they simultaneously affect the market access. We exploit annual data of 107 cities in Belgium, Germany and the Netherlands encompassing the periods from 1995 to 2006. We use actual geographical (road) distance between the sample cities. We identify the cities that are within a 75 kilometer range of the national borders to be border cities and the remainder as non-border cities. We subsequently estimate the wage equation. Our results indicate that, following the simulated opening of the border barriers, the border cities gain market access more than centrally located cities. This implies the importance of borders. Our estimation results also demonstrate that foreign market access is more important for wages of the border cities (geographical proximity matters) than it is for the non-border cities. The results also indicate that there has been negative border effect throughout the sample period, persisting border effects or irreversibility of spatial economic development as specified by Fujita and Mori (1996). These results remain stable and consistent across different samples of different distance ranges from the borders and throughout the sample period. Our results also show that the negative border effect is stronger across the Netherlands-Germany border than it is across the Netherlands-Belgium border. This may imply that there is better labor mobility across the latter due to the similarity in language and the relatively earlier

implementation of a free trade agreement. This is consistent with the concept that border barriers have asymmetric effects on countries of different size (Feenstra, 2004).

This chapter basically serves as an introduction to the subsequent chapters. The border effect is captured in the present chapter by a border (barrier) dummy in the market access term in the wage equation (recall equation (2.2)). This is a beneficial but also a rather simple way of attempting to measure a border effect. For the entire sample period, the border dummy basically shows the wage depressing effect of being a border city due to the relatively increased limited market access compared to non-border cities. The effect of economic integration is approximated by assuming that borders do not exist at all. On the positive side, the equation has a well-defined micro-foundation. However, if the key interest is to truly measure the effect of an economic integration shock and to separate this effect from the border location effect as such, that is, from the effect that border cities remain border cities even when economic integration is established, it would be beneficial to measure the wage or income effects of economic integration over time, specifically before and after the integration shock. In accordance with Redding and Sturm (2008) and Brakman et al. (2004a), this is precisely what the subsequent chapters intend to do based on a Difference-in-Differences estimation strategy. This strategy separates the border effect from integration effects; however, the price is that the empirical specification is more loosely connected to the micro-foundations in other chapters than what is done is this chapter. The estimation results in section 2.5 serving as an interesting benchmark and, foreshadowing the upcoming analysis, we will ascertain that the more refined estimation strategy in Chapters Three to Five will confirm some of the basic findings of this Chapter, notably, see Table 2.2, that economic integration is a boost for border cities but, even then, they are still at a disadvantage compared to non-border cities.

2.7. Appendices

(I) Tables

Table 2A.1: The cities in the samples

Belgium	Germany	The Netherlands
Aalst, Antwerp, Arlon, Brugge, Brusselse, Charleroi, Gent, Hasselt, Ieper, Kortrijk, Liege, Mons, Mouscron, Namur, Oostende, Roeselare, Turnhout, Tournai, Mechelen, Luxemburg,	Berlin, Bielefeld, Bremen, Dusseldorf, Erfurt, Essen, Frankfurt, Freiburg, Hamburg, Hannover, Ingolstadt, Kassel, Kiel, Koln, Leipzig, Magdeburg, Mannheim, Munich, Nuremberg, Oldenburg, Rostock, Stuttgart, Trier, Ulm, Wurzburg, Aachen, Augsburg, Bonn, Dortmund, Dresden, Göttingen, Heilbronn, Kaiserslautern, Koblenz, Lübeck, Münster, Osnabrück, Paderborn, Wuppertal, Wolfsburg.	Alkmaar, Almelo, Almere, Amsterdam, Apeldoorn, Arnhem, Assen, Bergen op Zoom, Breda, Delft, Delfzijl, Den Haag, Den Helder, Doetinchem, Eindhoven, Emmen, Enschede, Groningen, Haarlem, Haarlemmermeer, Heerenveen, Heerlen, Hilversum, Hoorn, Kerkrade, Leeuwarden, Leiden, Lelystad, Maastricht, Middelburg, Nijmegen, Oss, Roermond, Rotterdam, 's Hertogenbosch, Sittard-Geleen, Smallingerland, Sneek, Steenwijkerland, Terneuzen, Tiel, Tilburg, Utrecht, Velsen, Venlo, Weert, Zwolle,

Table 2A.2: The relationship between wage, the *MA,* distance to the borders and the language similarity

variables	(1)	(2)
log(*MA*)	0.290*** (0.0175)	0.128*** (0.0195)
Same language	---	− 0.00451 (0.00661)
Distance from common border (kilometers)	− 0.0327*** (0.00450)	0.0446** (0.0216)
Constant	7.007*** (0.182)	8.539*** (0.190)
Year Effects	yes	yes
Country Effects	yes	yes
Sample	non-border cities	border cities
Observations	792	480
R-squared	0.602	0.813

The dependent variable is wage. MA = the market Access; Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The results show that the further away from the borders the significantly higher the wage rate is.

Table 2A.3: The wage rate and different national borders

VARIABLES	(1)	(2)	(3)	(4)
log(total MA)	0.0346***	0.0973	0.0590***	0.0701***
	(0.00915)	(0.114)	(0.00953)	(0.00921)
Netherlands-Belgium border	$-$ 0.0177**	$-$ 0.00380	$-$ 0.0143*	$-$ 0.00672
	(0.00809)	(0.00798)	(0.00779)	(0.00780)
Netherlands-Germany border	$-$ 0.0555***	$-$ 0.0466***	$-$ 0.0543***	$-$ 0.0508***
	(0.00915)	(0.00959)	(0.00908)	(0.00908)
Constant	9.461***	8.330***	9.185***	8.738***
	(0.111)	(1.584)	(0.114)	(0.105)
Epslon (ε)	3	3	3	3
b for border cities	0	0	0.5	1
B_{rs} for foreign cities	0	0	0.5	1
Distance	(D_{ai}/10)	log(D_{ai})	(D_{ai}/10)	(D_{ai}/10)
Year Effects	yes	yes	yes	yes
Observations	1,272	1,272	1,272	1,272
R-squared	0.386	0.376	0.397	0.405

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Although the magnitude is different, the age rate consistently significantly and negatively correlated with the national borders.

Table 2A.4: The wage rate, and the total market access (various scenarios)

VARIABLES	$b = B_{ai} = 0$ for all cities; $\varepsilon = 3$; 10kms =1 unit D_{ai}			border cities' $b = 0.5$; foreign cities' $B_{rs} = 0.5$; $\varepsilon = 3$; 10kms =1 unit D_{ai}		
	(1)	(2)	(3)	(4)	(5)	(6)
log(MA)	0.202***	0.262***	0.153***	0.283***	0.348***	0.201***
	(0.00940)	(0.0136)	(0.00775)	(0.0105)	(0.0143)	(0.00915)
Constant	7.425***	6.708***	8.052***	6.563***	6.030***	7.574***
	(0.114)	(0.151)	(0.0949)	(0.123)	(0.162)	(0.108)
Year Effects	yes	yes	yes	yes	yes	yes
Country Effects	yes	yes	yes	yes	yes	yes
Sample	All sample cities	Non-border cities	Border cities	All	Non-border cities	Borders cities
Observations	1,272	828	444	1,272	828	444
R-squared	0.634	0.627	0.852	0.697	0.686	0.884

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2A.5: The wage rate and the foreign market access (various scenarios)

VARIABLES	$b = B_{ai} = 0$ for all cities; $\varepsilon = 3$; distance $= log(D_{ai})$			border cities' $b = 0.5$; foreign cities' $B_{ai}= 0.5$; $\varepsilon = 3$; $10kms = 1$ unit D_{ai}		
	(1)	(2)	(3)	(4)	(5)	(6)
log(national *MA*)	1.076***	1.204***	1.070***	0.263***	0.362***	0.180***
	(0.0628)	(0.0820)	(0.0518)	(0.0102)	(0.0144)	(0.00891)
log(foreign *MA*)	0.255***	0.319***	0.495***	– 0.000815	– 0.00561***	0.0142***
	(0.0668)	(0.0912)	(0.0735)	(0.00110)	(0.00120)	(0.00241)
Constant	– 6.973***	–9.469***	–10.20***	6.573***	5.662***	7.710***
	(1.381)	(1.818)	(1.208)	(0.114)	(0.159)	(0.103)
Year Effects	yes	yes	yes	yes	yes	yes
Country Effects	yes	yes	yes	yes	yes	yes
Sample	All sample cities	Non-border cities	Border cities	All sample cities	Non-border cities	Border cities
Observations	1,272	828	444	1,272	828	444
R-squared	0.569	0.502	0.872	0.676	0.688	0.883

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; foreign market access are consistently positive and significant for the border cities.

Table 2A.5: Ctd.	border cities' $b = 1$; foreign cities' $B_{ai} = 1$; $\varepsilon = 3$; distance $= log(D_{ai})$			border cities' $b = 1$; foreign cities' $B_{ai} = 1$; $\varepsilon = 5$; distance $= log(D_{ai})$		
VARIABLES	(7)	(8)	(9)	(10)	(11)	(12)
log(national *MA*)	1.007***	1.136***	0.914***	0.648***	0.882***	0.610***
	(0.0525)	(0.0719)	(0.0447)	(0.0285)	(0.0445)	(0.0248)
log(foreign *MA*)	0.0909***	0.116**	0.219***	0.0836***	0.0477**	0.128***
	(0.0336)	(0.0472)	(0.0401)	(0.0175)	(0.0241)	(0.0181)
Constant	–3.477***	–5.335***	–3.921***	1.734***	– 0.600	1.684***
	(0.809)	(1.092)	(0.665)	(0.416)	(0.551)	(0.316)
Year Effects	yes	yes	yes	yes	yes	yes
Country Effects	yes	yes	yes	yes	yes	yes
Sample	All sample cities	Non-border cities	Border cities	All sample cities	Non-border cities	Border cities
Observations	1,272	828	444	1,272	828	444
R-squared	0.577	0.508	0.879	0.603	0.567	0.896

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

(II) Figures

Figure 2A.1: The annual results: border versus non-border cities 75 kilometers
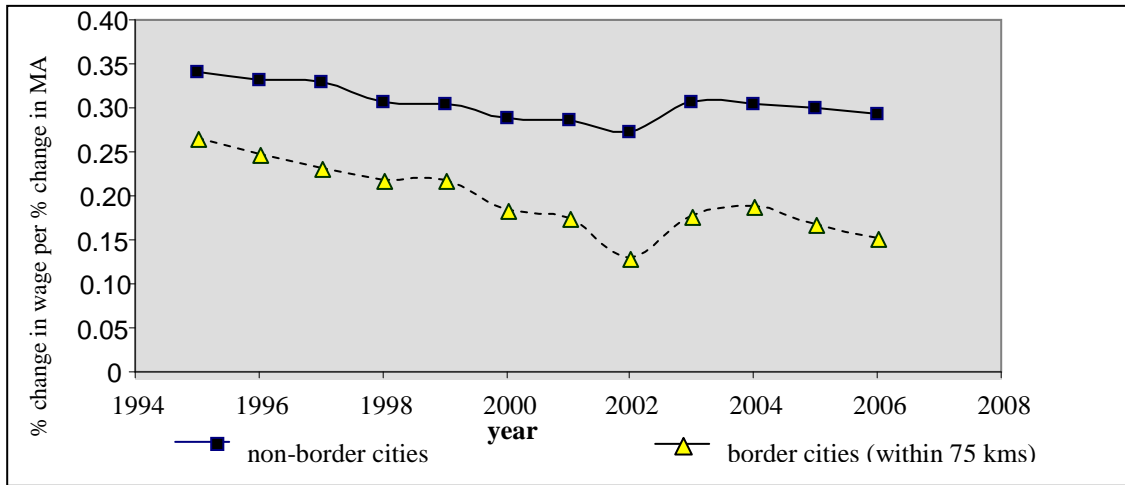
Figure 2A.2: The annual results: border versus non-border cities 85 kilometers
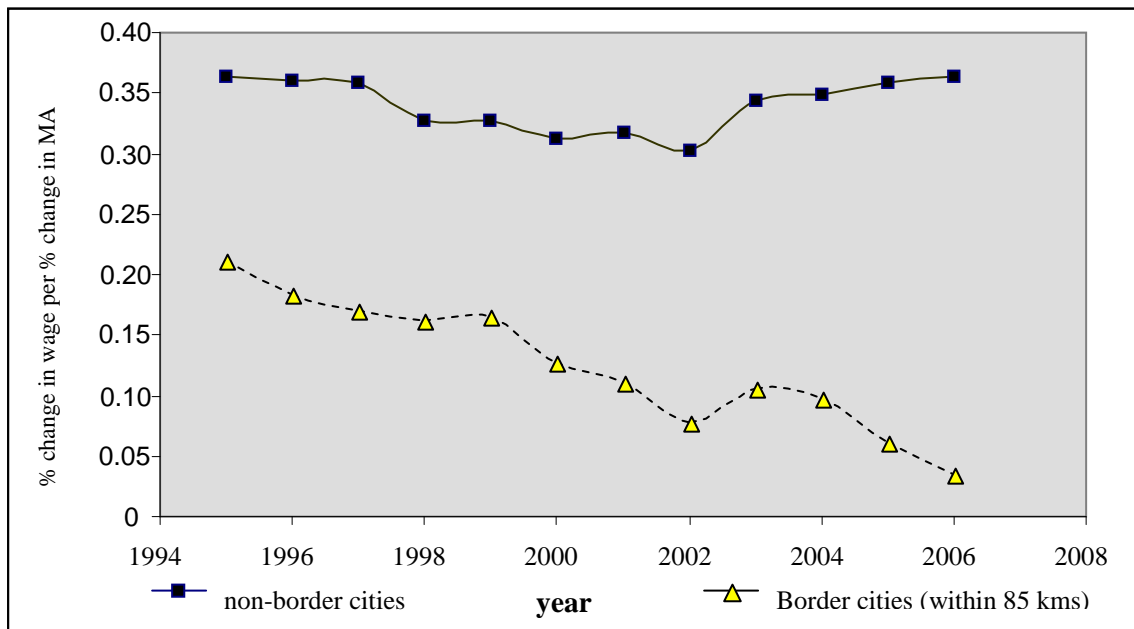
Note: Figure 2A.1 and 2A.2 show that percentage change in wage rate per percentage in the market access is lower for the border cities throughout the sample period.

Figure 2A.3: The annual results: non-border samples 75 kilometers and 85 kilometers
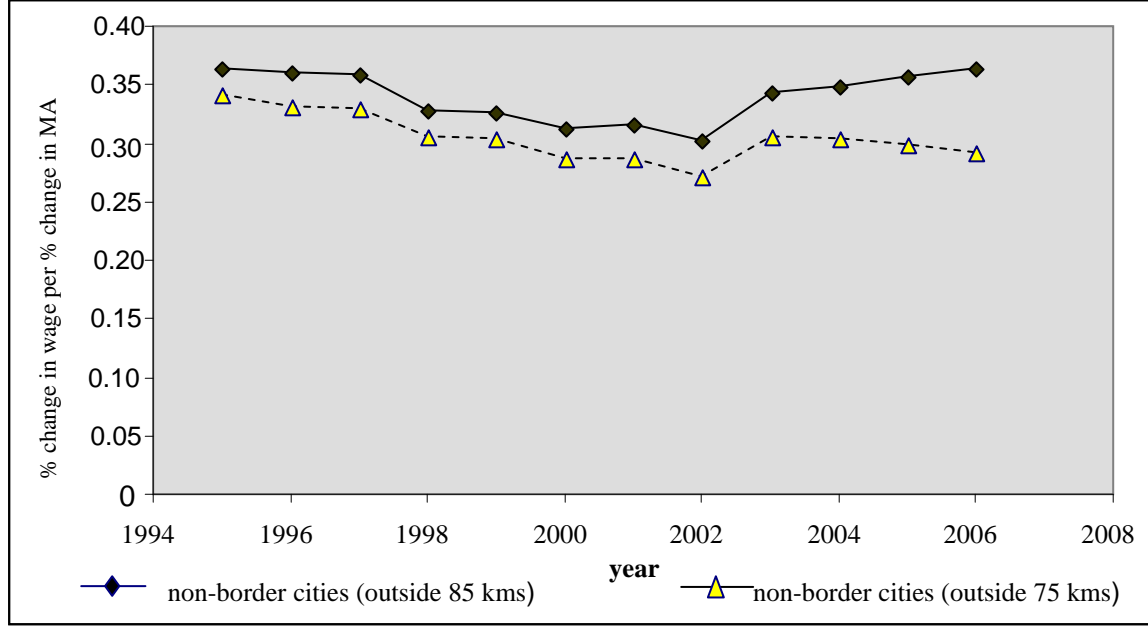
Note: Figure 2A.3 also shows that percentage change in wage rate per percentage in the market access is lower as we go toward the borders even within non-border cities throughout the sample period.

(III) Descriptive analysis: Gains in the market access

Here, we first demonstrate the relatively larger gain in market access of border cities following the loosening of national border restrictions. At least in absolute terms, all regions of the economically integrated countries' cities gain higher market access after the abolition of the border restrictions. However, given that other things are constant, the gains by the old (abolished) common border cities are higher than that of non-border cities. See equations (2A.1 through 2A.3) below for the calculation. All the parameters and variables are as defined in section 2.3. D_{ai} is the road distance between city a and city i in kilometers. N demonstrates the summation over the entire sample, indicating access to the national as well as the foreign markets after abolition of the border; n indicates summation over national sample indicating the access to the national market alone given the existence of border barriers; and T is the length of the sample period 1995 to 2006. The gain is higher for the border cities, implying the relatively more importance of foreign market access of locating on borders with other nations under economic union:

$$\Delta MA_a = \left(\frac{\left(\left(\sum_{i=1, i\neq a}^{N} \sum_{t=1}^{T} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b+B_{ai})]} \right) \right)^{1/\varepsilon} - \left(\sum_{i=1, i\neq a}^{n} \sum_{t=1}^{T} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b+B_{ai})]} \right) \right)^{1/\varepsilon} \right)}{\left(\sum_{i=1, i\neq a}^{n} \sum_{t=1}^{T} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}[(1-\varepsilon)(1+b+B_{ai})]} \right) \right)^{1/\varepsilon}} \right) \times 100 \quad (2A.1)$$

These market potential gains measure the gain in excess of the entire national market potential including the home market of the city itself. Although the absolute level of gains in the

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market access are different, the relative gains by cities of different locations remain the same whether we use $b = 0$ and $B_{ai} = 0$ or $b > 0$ and $B_{ai} > 0$. In both cases, the cities with the greatest gain are cities such as Kerkrade, Sittard-Geleen, Heerlen, Maastricht and Eindhoven of the Netherlands, Aachen of Germany and other cities that are close to the abolished borders; whereas, those cities further away from these borders gain less. However, this result is based on the assumption of no access to the foreign market before economic integration and full access to the foreign market after economic integration. Due to the nature of the assumption, this calculation derives the same result whether the economic integration actually occurs or not. Because of this reason, next, we drop this assumption and compare the actual gains in the market access of the two groups of cities during the sample period. Therefore, we assume that there was access to the foreign market even before the abolition of the national borders or the sample period. It would be more advantageous if we could aggregate data from before and after the abolition of the borders, but we don't have the data from before. However, it is still very useful and informative to compare the gains during the sample period that we currently have for the two groups of cities, border and non-border cities. Thus, the gain is now calculated as follows.

Non-border cities: ΔMA_{nb}:

$$= \frac{1}{N_{nb}} \sum_{1}^{N_{nb}} \left(\frac{\left(\sum_{i=1}^{N} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]} \right) \right)_{2006}^{1/\varepsilon} - \left(\sum_{i=1}^{N} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]} \right) \right)_{1995}^{1/\varepsilon}}{\left(\sum_{i=1}^{N} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]} \right) \right)_{1995}^{1/\varepsilon}} \right) \times 100 \quad \text{(2A.2)}$$

Border cities: ΔMA_{b}:

$$= \frac{1}{N_{b}} \sum_{1}^{N_{b}} \left(\frac{\left(\sum_{i=1}^{N} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]} \right) \right)_{2006}^{1/\varepsilon} - \left(\sum_{i=1}^{N} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]} \right) \right)_{1995}^{1/\varepsilon}}{\left(\sum_{i=1}^{N} \left(Y_i I_i^{\varepsilon-1} T^{D_{ai}\left[(1-\varepsilon)(1+b+B_{ai})\right]} \right) \right)_{1995}^{1/\varepsilon}} \right) \times 100 \quad \text{(2A.3)}$$

where N_{nb} = number of non-border cities; N_b = number of border cities; and $N = N_{nb} + N_b$. Note that both of the summations at the beginning of the sample (1995) and at the end of the sample (2006) in (2A.2) and (2A.3) encapsulate the entire sample, *N*, not only over the national market, *n*, as in the second part of the numerator and the denominator in equations (2A.1) above. This indicates that cities have access to foreign markets during the entire sample period. We used seven alternative scenarios of this market gain using different measures of the distance and the border (*b*) as well as foreignness (B_{ai}) parameters. These scenarios are depicted in Table 2A.6.

Table 2A.6: Various market access scenarios

Scenarios	ε	b for a border city	B_{rs} if s is a foreign city	distance	Remark
Scenario_1	3.0	0.0	0.0	D_{ai}	no borders
Scenario_2	3.0	0.0	0.0	$(D_{ai}/10)$	no borders
Scenario_3	3.0	0.0	0.0	$\log(D_{ai})$	no borders
Scenario_4	3.0	1.0	1.0	$(D_{ai}/10)$	with borders
Scenario_5	3.0	0.5	0.5	$(D_{ai}/10)$	with borders
Scenario_6	3.0	1.0	1.0	$\log(D_{ai})$	with borders
Scenario_7	5.0	1.0	1.0	$\log(D_{ai})$	with borders

Scenario_1 assumes that being a border city or being a foreign city is of no significance. The same is true for Scenario_2 and Scenario_3 except the use of a smoother distance penalty by taking 10 kilometers as a unit of distance and logarithm of distance, respectively. Under Scenario_4 and scenario_5, being in a border and/or foreignness matters, however, the difference is smaller in the latter. Scenario_6 and scenario_7 also allow for a border and foreignness penalty except that the latter employs a different value of ε. The changes in the market access under the various scenarios are depicted in the figure below. Under Scenario_3, much smoother distance; i.e., log(distance), combined with absence of border penalty and foreignness leads to smaller differences between gains in the border and non-border cities. In all the other different scenarios, the border cities gained more Market Access than the non-border cities over the sample period (see Figure 2A.4). This implies that, although the border cities are disadvantaged due to remote location in the national market, they benefit relatively more than the non-border cities under economic integration.

Figure 2A.4: Change in market access under different scenarios
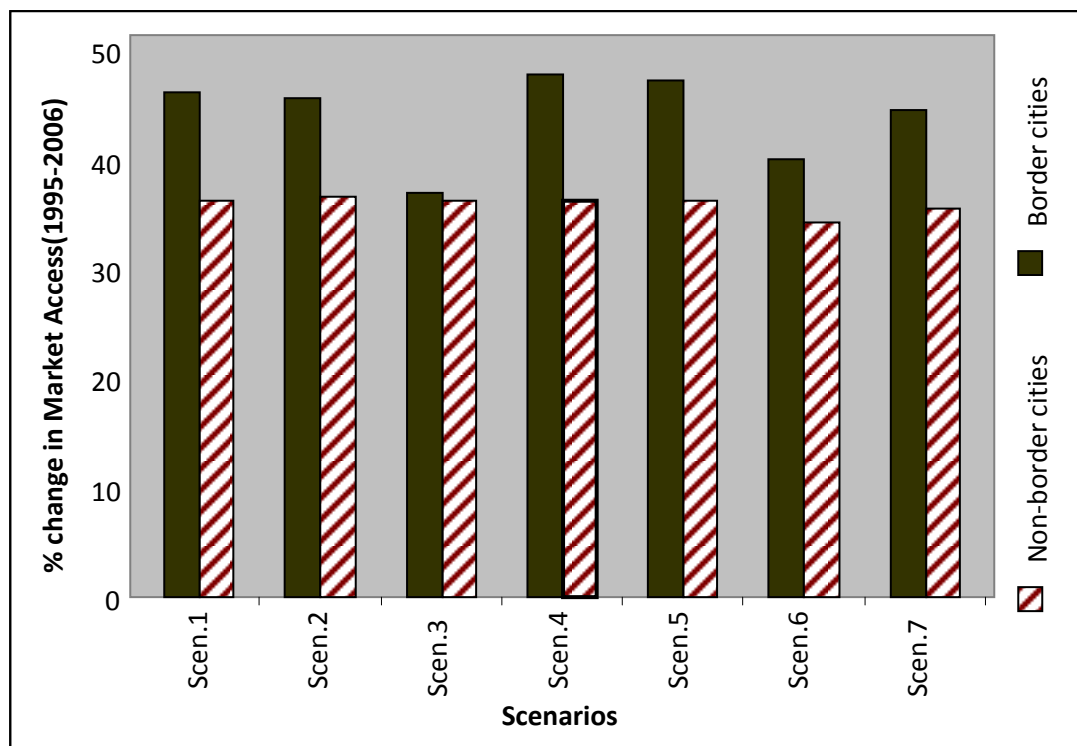
The elasticity of substitution ($\varepsilon = 3$) or ($\varepsilon = 5$) is used in the analysis. To identify a proper value of the epsilon (ε), we use iteration method. We use different values of the epsilon (ε) for the calculation of the market access in the parenthesis on the right hand side of equation (2.4); and then we estimate the regression equation itself to estimate the coefficient $(1/\varepsilon)$. We repeat this process until the value of the plugged in epsilon (ε) and the estimated slope coefficient ($1/\varepsilon$) in the equation converges. Thus, in the iteration process, we use the whole panel to come up with a single epsilon (ε) value. Some of the plugged in value of the epsilon (ε), suggested $(1/\varepsilon)$, estimated $(1/\varepsilon)$ and the absolute value of the difference between the latter two are reported in table 2A.7. From the table we see that the suggested and the estimated values of epsilon converge at $(\varepsilon = 3)$. For epsilon values less than or greater than 3, the differences between the estimated and suggested $(1/\varepsilon)$ are larger. When we impose the constants to be zero, then the convergence occurs at $(\varepsilon = 5)$. Thus, we used this value too to check whether the results change or not.

Table 2A.7: Example of selection of the epsilon (ε)

Plugged in ε	Suggested $1/\varepsilon$	Estimated $1/\varepsilon$	$\left\|suggested\ 1/\varepsilon - estimated\ 1/\varepsilon\right\|$	with constant
2.00	0.500	0.349***	0.151	yes
3.00	0.333	0.331***	0.002	yes
4.00	0.250	0.305***	0.055	yes
5.00	0.200	0.277***	0.077	yes
2.00	0.500	0.257***	0.243	no
3.00	0.333	0.257***	0.076	no
4.00	0.250	0.233***	0.017	no
5.00	0.200	0.203***	0.003	no

***, **, * significant at 0.01, 0.05, 0.1 level

Chapter Three

The Border Population Effects of EU Integration[5]

3.1.   Introduction

Systems of cities change slowly over time and appear to be stable over long time periods. This stability has often been observed by urban historians.[6] However, subsets of cities do evolve over time, following changes in the economy, institutional changes or technological developments (Desmet and Rossi-Hansberg, 2009, 2010). These evolutions can take decades or even centuries to complete (Bairoch, 1988). The time dimension creates practical difficulties in analyzing the ultimate causes of changes in city systems as consistent data for many countries and a sufficiently large number of cities over a long time period are not readily available, see Bosker et al. (2008) for an exception.

Only relatively recently have discretionary policy changes or (quasi-) natural experiments been used to shed light on what drives changes in the development of (systems of) cities and to investigate stability of the system after a shock. Davis and Weinstein (2002), for instance, analyze the consequences of the allied bombing of Japanese cities during World War II (WWII). A similar exercise was performed by Brakman et al. (2004a) for the bombing of German cities by allied forces during the same period. These studies show that the development of cities follows indeed a relatively stable path in the sense that cities tend to return to their pre-shock path following the shock. At the same time, it is possible that the development of cities leap-frogs to another development path, see Bosker et al. (2007a). Some less dramatic experiments or shocks, like changes in the degree of economic integration, illustrate that the effects for border cities in particular, can be substantial. According to Hanson (2001, 2005) the integration process between Mexico and the USA accounts for a sizeable portion of employment growth in U.S. border cities over the sample period. The opposite of integration is segregation. Redding and Sturm (2008) analyze the effects on border cities along the new border following the post WWII division of Germany into East and West Germany in 1949. They, like Hanson (2001), find that the effects on (west) German cities along the newly created intra-German border are substantial; traditionally centrally located cities suddenly found themselves in the periphery of Germany, resulting in a sharp decline of the population (more so for small than for large border cities). At an even more disaggregated scale, Ahfeldt et al. (2010) show for the case of the Berlin Wall and the city of

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[5] This chapter is based on a published paper in the Journal of Regional Science as Brakman et al., (2012), co-authored with Steven Brakman, Harry Garretsen and Charles van Marrewijk.

[6] Hohenberg (2004, p. 3051) notes that, taking both the resistance and the resilience of cities together, it is perhaps not surprising that the European system should rest so heavily on places many centuries old, despite the enormous increase in the urban population and the transformation in urban economies'.

Berlin, that also within a city a division (and subsequent reunification) can lead to remarkable changes with respect to the economic structure of a city, especially along its borders.

Border cities are of special interest in the wake of these integration shocks, because they experience more drastic changes in their so-called market access (see below) than more central cities (Hanson, 2005).[7] The novelty of this chapter is that, as far as we are aware of, the spatial effects of multiple stage EU integration process on cities along national borders has not been analyzed before, in contrast to studies that highlight the importance of the border effect on trade in general (see Feenstra, 2004, for a survey). The enlargement of the European Union (EU) and the introduction of the euro can be looked upon as two policy-induced shocks, that can shed light on the consequences of changes in market access. Central to our analysis in this chapter is the notion that cities or regions that are close to the border are most affected by these changes in EU integration, as they are especially confronted with changes in market access, whereas the effects for cities or regions further away from the border are more subdued. Note that changes in market access are not necessarily positive or negative (see section 3.3 for a discussion). Also note that with barriers to mobility in Europe, integration "shocks" likely affect nominal wages more than population due to relocation of firms among other reasons. Since we do not have sufficiently detailed nominal wage data our analysis concentrates on the impact of the distribution of population and as such understates the total integration response. Similarly, a problem that haunts quasi-natural experiments is the anticipation effect. In our case, integration is a process spread over a long time period while we focus on the impact of entry into the EU itself. Since agents will begin to respond to changes before they are implemented, these long-term anticipation effects imply that we understate the integration effects. For these two reasons our findings will understate the true integration response.

The rest of this chapter is structured as follows. In section 3.2 we summarize the two EU integration experiments (EU enlargement and the introduction of the euro) that we analyze in the remainder of the chapter, where our emphasis will be on EU enlargement. Based on Redding and Sturm (2008), section 3.3 provides the theoretical background. Section 3.4 describes the data and section 3.5 introduces the central empirical specification. The characteristics of our approach are that (i) we focus on the consequences of economic integration for cities and regions, (ii) our results are most likely not affected by other aspects such as changes in natural resources or climatic changes, and (iii) we have a sufficiently large number of observations to analyze various effects (timing, distance decay, border asymmetry and size asymmetry). Section 3.6 discusses the estimation results. As far as we are aware, we provide the first analysis to find, both at the urban and at the regional level, a positive impact of the EU enlargement process as measured by the growth in population share along the integration borders, leading to an extra growth rate of about 0.15 percentage points per annum. This integration effect declines with distance, is about the same for new and old members, and is more important for large cities and regions. Despite this EU integration effect associated with EU enlargements, being located along a border remains a burden

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[7] In general, in studies like these demand linkages between cities or regions are strong, but the geographical reach is limited, which motivates why especially border cities might experience fundamental changes in market access, rather than an economy wide sample of cities (Bosker and Garretsen, 2010).

in view of the (larger) general negative border integration effect. We do not find similar border-integration effects as a result of the introduction of the euro. Section 3.7 concludes.

3.2. EU enlargement and the introduction of the Euro

European integration has many faces, but two developments in recent years stand out: EU enlargement with new member states and the introduction of the Euro (see Baldwin and Wyplosz, 2009, or van Marrewijk, 2007, for details). The European economic integration process started after WWII with the European Coal and Steel Community (ECSC), established in 1951 by the Treaty of Paris. As the name indicates, the ECSC was an agreement related to specific sectors and established free trade among the member countries for the (at that time very important) coal and steel sectors only. Although the strengthening of the economic integration process was initially aimed to reduce the probability of future wars, one of the most important consequences of the development of the EU is to increase economic integration. Many important enlargement steps were taken to this end as summarized in Table 3.1.

Table 3.1: Overview of European Union enlargement process

1951	ECSC	European Coal and Steel Community
	Membership	Belgium, France, Luxembourg, the Netherlands, Italy, and W. Germany
1957	EURATOM	European Atomic Energy Community
1957	EEC	European Economic Community
1967	EC	European Communities; combining ECSC, EEC, and EURATOM
1973	Membership	+ United Kingdom, Ireland, and Denmark
1981	Membership	+ Greece
1986	Membership	+ Spain and Portugal
1990	Membership	+ East Germany (reunification of West and East Germany)
1993	EU	European Union
1995	Membership	+ Finland, Austria, and Sweden
1999	EMU	Economic and Monetary Union
2002	Euro	Introduction of the euro
2004	Membership	+ Cyprus, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia.
2007	Membership	+ Bulgaria and Romania.

Source: own compilation from various sources, mainly, https://europa.eu

Figure 3.1 describes the changes in the size of the EU in terms of the population involved. The vertical axis measures the total size of the population of the member states. The jumps in the line indicate that each EU enlargement increases the total affected population abruptly. Associated with this process is the simultaneous abolishment of a border in an economic sense, resulting in a sudden drop of transaction costs across borders. In this respect, especially the first enlargement in 1973 (with Denmark, Ireland and the UK), the third enlargement in 1986 (with Spain and Portugal), and the Eastern enlargement in 2004 (with ten new members along the eastern border of the EU) stand out. The total population of the EU is now close to 500 million people, making it one of the largest integrated markets in the world. For our analysis it is important to note that enlargements substantially increase the (potential) market access for the EU members.

Figure 3.1: Historical expansion of the European Union, 1951-2010
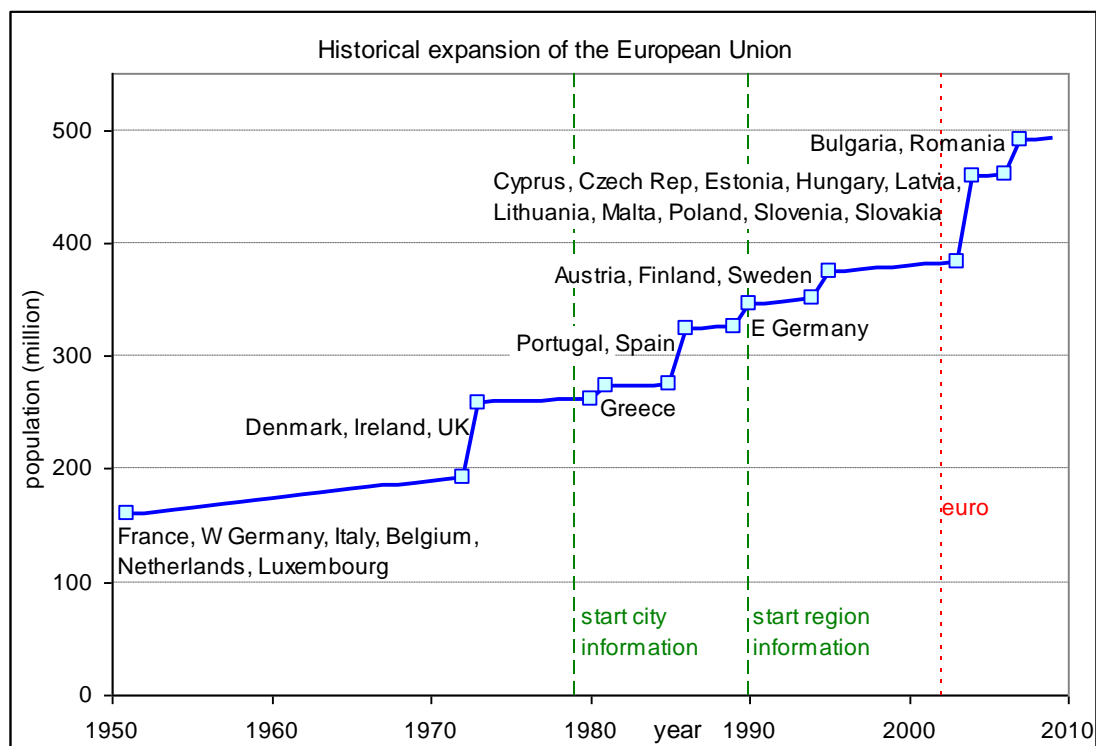
The second experiment that we will, more briefly, look at is the introduction of the Euro. This was the culmination of a process – after the collapse of the Bretton-Woods system in 1972 – via fixed exchange rates to a single currency in Europe. The history was a succession of successes and failures within the European Monetary System, but finally governments agreed on the introduction of the Euro, and as of January 1st, 2002 Euro coins and notes were introduced.[8] The Maastricht treaty stipulates that certain macro-economic criteria have to be met, related to government debt, inflation, etc., before countries can introduce the Euro. In practice this implies

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[8] Formally the Monetary Union started in 1999.

that a sub-set of countries that are a member of the EU also belong the Euro-area.[9] Furthermore, the introduction of the Euro can be viewed upon as an integration experiment reducing barriers to trade such that the potential market access of those involved increases. A priori, the effects of this experiment are expected to be smaller than for economic integration because ever since the fall of the Bretton-Woods system, European policy makers aimed (with mixed success) at more or less fixed exchange rates, and in practice border cities were often accustomed to 'dual' exchange rates for day-to-day payments (that is, foreign currencies often circulated in border cities). In addition, the introduction of the Euro took place in 2002 (or, technically, in 1999) as the Euro-members already experienced a high degree of economic integration. This might have affect commuting and shopping patterns across national borders. Note, that neither of these policy experiments was aimed at border cities in particular; possible border integration effects are, from a policy perspective, unintended side effects.

As in Hanson (2001) and Redding and Sturm (2008) we expect that especially cities and regions along the border benefit disproportionally from the increased (export) market access. However, as also stressed by Overman and Winters (2006), increased (export) market access is not the only force experienced by border cities or regions. Increased (import) competition could work in the opposite direction. In the New Economic Geography (NEG) models this effect is the so called price-competition effect. The net effect has to be determined empirically. The integration experiments we analyze are less spectacular than the German division studied by Redding and Sturm (2008) and the variation in the data following an integration shock is likely to be smaller than for the German division in 1949. Redding and Sturm (2008) argue that economic integration might be endogenous. However, it is not clear how especially border cities or regions could induce these international policy changes. Border cities as such are not the main target of economic integration. Since we use a much larger sample of cities and regions in substantially more countries than Redding and Sturm (2008) the smaller size of the shocks we study is compensated by a larger number of observations.

Finally, the question arises how long the border integration effects last. Based on the estimates of Redding and Sturm (2008) for border cities in Germany, we initially take this duration to last about 40 years.[10] With respect to the EU enlargements it took more than 20 years, after the creation of the ECSC in 1951, before the first EU enlargement occurred in 1973 (see Table 3.1). This implies that the first enlargement in 1973 and all subsequent enlargements fall within the 40 years duration period. Since our city sample starts in 1979 and the first *change* (needed for the empirical specification, see below) is only observed in 1989, the duration period of 40 years has effectively only elapsed for the founders of the EU. Consequently, no border integration effects are active between France, West Germany, Italy, Belgium, Luxembourg and the Netherlands for the period of observation (these countries were the initial members in 1951). All

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[9] In 2011 the Euro-area consists of Belgium, Germany, Ireland, Greece, Spain, France, Italy, Cyprus, Luxembourg, Malta, The Netherlands, Austria, Portugal, Slovenia, Slovakia, Finland, and Estonia.

[10] We also include some sensitivity analyses with respect to the duration of the integration effect.

other border integration changes, including that of the introduction of the Euro, are active for the entire sample period of observation once they occurred.

3.3.   Theoretical framework

The theoretical framework is based on a multi-region version of Helpman's (1998) geographical economics model, as used in Redding and Sturm (2008). As usual in these models (see Brakman et al. 2009 Ch. 3-4), the combination of increasing returns to scale and transport costs leads to *agglomeration forces* as firms want to locate production near large markets (home market effect) and consumers want to live in large markets (consumer love of variety and transport costs result in a low cost of living effect). At the same time, the model exhibits *spreading forces* as a plethora of competitors in a large market make less-crowded locations more attractive (competition effect) and (in this specific model) a large market raises the costs of (non-traded) local services, thus leading to higher costs of living near large markets (congestion effect). The tug of war between the agglomeration and spreading forces in the model determines the distribution of population among the available locations.

The economy consists of a number of locations or areas $a \in \{1,..,A\}$, where the areas can be either cities or regions. Each area has an exogenous stock H_a of non-tradable services, referred to as housing in Helpman (1998). The number of consumers or laborers L is mobile across locations and each supplies one unit of labor inelastically, spends a share $\mu \in (0,1)$ of income on horizontally differentiated varieties and the remaining share $1-\mu$ on the non-tradable services. The production of varieties takes place under increasing returns to scale (with fixed cost and constant marginal cost in terms of labor) and is based on monopolistic competition with a constant elasticity of substitution between varieties of $\varepsilon > 1$ (Dixit and Stiglitz, 1977).[11] There are iceberg transport costs for varieties, such that $T_{ai} > 1$ units must be shipped from location a to make sure one unit arrives in location i.

The population of areas is endogenously determined by migration decisions of workers between locations to ensure that the same real wage holds in all populated areas in the long-run equilibrium. If we let w_a, L_a, P_a^M, n_a, and p_a be the (nominal) wage rate, the number of laborers, the Dixit-Stiglitz price index for varieties, the number of varieties produced, and the local (free on board) price of such a variety (all at location a), respectively, then it can be shown (see Redding and Sturm, 2008) that the equilibrium real wage (which holds for all areas) can be reformulated as an equilibrium population L_a of area a:[12]

$$L_a = \Omega \underbrace{\left(\sum_i (w_i L_i)(P_i^M / T_{ai})^{\varepsilon-1}\right)}_{FMA_a}^{\mu/\varepsilon(1-\mu)} \underbrace{\left(\sum_j n_j (p_j T_{ja})^{1-\varepsilon}\right)}_{CMA_a}^{\mu/[(1-\mu)(\varepsilon-1)]} H_a, \qquad (3.1)$$

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[11] In principle, it is straightforward to include more increasing returns industries, each with a different elasticity of substitution. Thus, large cities or regions can host more industries than smaller cities.

[12] Niebuhr and Stiller (2004) provide a survey of the relevant literature.

where Ω is a function of parameters and the common real wage. The terms FMA_a and CMA_a denote firm market access and consumer market access, respectively. Firm market access FMA_a measures the proximity of firms located in *a* to the demand from all markets, including the market of its own location (depending on labor income in a location, the associated price index, and the transport costs of getting goods from *a* to all markets). It determines the wage rate that firms can afford to pay in zero profit equilibrium and combines both the home market effect and the competition effect mentioned above (if surrounding areas are characterized by relative low price indices, the current location faces more competition and is less attractive especially for high elasticities of substitution and low transportation costs). Consumer market access CMA_a measures consumer's ease of access to tradable varieties (depending on the number of varieties produced in a location, the locally charged price, and the costs of getting goods from there to *a*). It captures the cost of living effect mentioned above. Finally, the term H_a (stock of non-tradable services) is associated with the congestion effect. Note that the model assumes labor mobility (resulting in real wage equalization for all areas, *a*).[13] It is well-known that labor mobility in the EU is relatively limited. This implies that if integration, or for that matter any shock, has some impact on L_a this is additional evidence of the strength of the integration effects.

Equation (3.1) shows that locations in the vicinity of country borders, which pose significant obstacles to trade flows (leading to high trade costs T_{ai}) and thus tend to have lower firm and consumer market access, have lower population levels in long-run equilibrium. Redding and Sturm (2008) take the division between East and West Germany after WWII until the reunification in 1990 as an example of a shock that creates an integration effect. They calibrate the above model and show that (i) cities close to the border decline in population through changes in T_{ai} and T_{aj} in equation (3.1) (an effect that diminishes as the border distance increases), and (ii) the border integration effect is weaker for large cities as these – initially home to a larger set of sectors – are able to specialize and access export markets more easily than small cities. Their empirical estimates find strong support for (i) and (ii).

Note that, theoretically, creating obstacles or removing them have similar but opposite effects on the long-run equilibrium of the city size distribution, which is based on the market access of each city. This does *not* mean that creating and removing obstacles is space-neutral because the market-access measures are location-dependent. Suppose that we first create a big (artificial) border as an obstacle to trade- and interaction flows (as happened in Germany after WW II), subsequently remove that obstacle 45 years later, and then wait another 45 years for the final equilibrium to settle down. Will this final equilibrium be the same as the equilibrium that would have settled after 90 years in the absence of creating and removing the obstacle? The answer is: no. Path-dependence or hysteresis plays a prominent role in geographical economics models. The initial creation of the obstacle affects in particular the market access of cities in the vicinity of the obstacle, resulting in a reduction of their (economic) size. The concomitant

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[13] See Redding and Sturm (2008, p. 1772), equation (3.1). See Brakman, Garretsen, Van Marrewijk (2009, ch. 3) for an in depth discussion of the forces that drive equation (3.1).

redistribution of market access for each city is at least partially locked-in, both for firm market access and for consumer market access as given in equation (3.1). The subsequent removal of the obstacle only partially restores the initial situation (quite apart from the myriad of other changes that occur in the meantime). In all likelihood, therefore, the cities in the vicinity of the obstacle will suffer permanent consequences from its creation even after its subsequent removal.

Our emphasis in this chapter is on a *reverse* policy shock, instead of division we will thus look at integration. The European integration process strives to reduce international obstacles between countries (leading to lower trade costs T_{ai}). On the one hand, the process of European integration is arguably more gradual and its impact on border locations not as strong, abrupt and severe as the German division after WWII. One would thus expect the impact on border population size to be smaller and harder to find for the EU integration process. On the other hand, the number of countries, regions, and cities involved in the EU integration process is considerably larger than for the case of the German division (see the next section), such that if there *is* an economically meaningful impact we should be able to find it. Following Redding and Sturm (2008) our main hypothesis is as follows:

I.   Cities or regions that are close to an abolished border as a result of EU integration shock experience a relative population increase.

Based on the discussion above, we can formulate sub-hypotheses IIa-c:

II.   a) The border integration effect is different for large and small border areas.
        b) The border integration effect is stronger for EU enlargement compared to the introduction of the euro.
        c) The border integration effect declines as the distance to the border rises.

As discussed above whether the border integration effect is indeed positive is an empirical question (see the discussion of equation (3.1) above). Redding and Sturm (2008) stipulate that the market access effect will be dominant, but the competition effect counter-acts the home market effect. Brakman et al. (2009, Chapter 11) provide an illustration of the forces at work in a related simulation experiment. They show that 'building a bridge' between two locations in a multi-location NEG setting affects all locations, but those near the 'bridge' (or in the present case, near a disappearing border) are affected the most. The simulations indicate that the competition effect for standard parameter values does not dominate the other forces and that integration benefits the border areas, which is the main reason why we *a priori* expect the border integration effect to be positive.

3.4. The data

We collected two basic, non-balanced panel data sets: one for European cities, using data from Brinkhoff (http://www.citypopulation.de) and another for European regions, using data from Eurostat.[14] For the analysis in this chapter we included information from 34 European countries, leading to a total number of 1,457 regions and 2,410 cities, see Table 3.2 for a list of countries and the number of regions and cities for each country.

Table 3.2: Included countries with # of regions and # of cities

Country	# regions	# cities	Country	# regions	# cities
Austria	35	75	Luxembourg	1	28
Belgium	44	113	Macedonia	8	34
Bosnia & Herzegovina	n.a.	24	Malta	2	30
Bulgaria	28	43	Montenegro	n.a.	25
Croatia	21	28	Netherlands	40	121
Czech Republic	14	56	Norway	19	52
Denmark	11	72	Poland	66	177
Estonia	5	30	Portugal	30	94
Finland	20	59	Romania	42	42
France	100	39	Serbia	n.a.	62
Germany	429	155	Slovakia	8	42
Greece	51	54	Slovenia	12	43
Hungary	20	67	Spain	59	75
Ireland	8	54	Sweden	21	125
Italy	107	128	Switzerland	26	102
Latvia	6	32	Turkey	81	133
Lithuania	10	50	UK	133	146
Total				**1,457**	**2,410**

Note that the numbers in Table 3.2 are neither proportional to a country's total population nor to its size. France, for example, has only a limited number of cities included in the data set, while Germany has a large number of regions compared to other countries. Consequently, in our sample Germany and France have more regions than cities, which is in contrast to the other countries under consideration that have more cities than regions in the sample. Seven countries in Table 3.2 are not current EU member countries (although some are candidate countries, see Figure 3.2 below), these are Bosnia and Herzegovina, Croatia[15], Macedonia, Montenegro, Norway, Serbia, and Switzerland (in the estimations we differentiate between EU countries only, and all countries). Note that Bosnia and Herzegovina, Montenegro, and Serbia are only included in the city analysis, while Macedonia is only included in the region analysis. The other 30 countries are included both in the city as well as in the region analysis.

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[14] See the data appendix for a detailed description of the data.

[15] Croatia became EU member in 2013, about a year after publication of the this chapter article.

Figure 3.2: (a) The European Union in 2010 (b) The Euro area ⬛ by 2004 ☐ + by 2013

Source: http://europa.eu
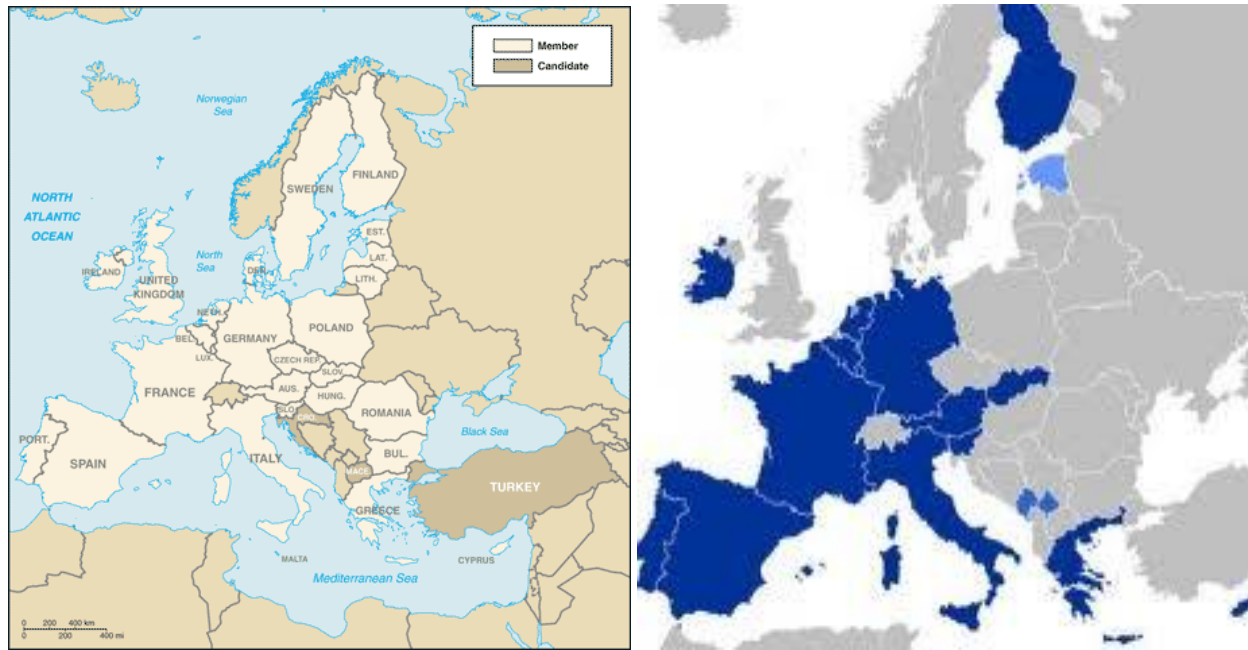
Figure 3.2 depicts the various EU countries and candidate EU countries in 2010. The analysis focuses on *classic border* integration effects, meaning that we focus on land connections. Furthermore, borders areas (cities or regions) are only defined as border areas if at some point in the history of our sample they are affected by an integration shock. An example is Germany. Border areas along the Dutch-German border are excluded as they experience no integration shock with respect to integration since the entry of The Netherlands and Germany into (the forerunner of) the EU already took place in 1951. However, border areas along the German-Polish border are included in the definition of border areas as they are affected by integration (in 2004). For the case of the Euro shock we follow the same procedure (implying that for the Euro shock border areas along the Dutch German borders are included in the border definition).

Table 3.3: Overview of affected continental land borders in sample period

Enlargement year	Affected border of enlargement between	
	Country 1	Country 2
1973	Denmark	West Germany
1981	n.a.	n.a.
1986	Spain	France
	Spain	Portugal
1990	West Germany	East Germany
1995	Sweden	Finland
	Austria	Germany (west)
	Austria	Italy
2004	Estonia	Latvia
	Latvia	Lithuania
	Lithuania	Poland
	Poland	Germany (east)
	Poland	Czech Republic
	Poland	Slovakia
	Czech Republic	Germany
	Czech Republic	Austria
	Czech Republic	Slovakia
	Hungary	Slovakia
	Hungary	Austria
	Hungary	Slovenia
	Slovenia	Austria
	Slovenia	Italy
2007	Romania	Hungary
	Romania	Bulgaria
	Bulgaria	Greece

As is clear from Figure 3.2 and Table 3.3, most EU enlargements were related to land borders. However, there are enlargements related to crossing sea borders, such as UK – France or Denmark – Sweden.[16] Focusing on land borders, we still have to determine when a region or city classifies as a border region or city that is affected by EU integration. For regions this is simple: if two regions in different countries are contiguous at a land border that is affected in the EU integration process, they classify as a border region. For cities we have to specify some cut-off distance and a way of measuring it in order to classify as a border city. In the baseline setting, we include all cities with a maximum road distance of 70 kms (fairly close to the 75 kms cutting point

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[16] A sensitivity test with respect to non-land borders is available upon request; this does not affect the results mentioned in the main text.

in Chapter 2 and still different from an 'as the crow flies' distance) to the affected border as border cities.[17] Other road distances (50 km and 85 km) are part of our sensitivity analysis.

Combining the information in Figure 3.2 with the timing and EU enlargement schedule in Table 3.1, and the sample period shown in Figure 3.1, we have a complete overview of all affected EU enlargement borders and their starting year over the entire sample period.[18] As noted above, the effect remains operative until the end of the observation period once it starts. The table shows that there was/were: 1 affected border in the 1973 enlargement, no affected borders in 1981, 2 affected borders in 1986, 1 affected border in 1990, 3 affected borders in 1995, 14 affected borders in 2004, and 3 affected borders in 2007. The majority of EU integration activity thus concentrates towards the end of the period, although some cities and regions are affected throughout the entire period.

Figure 3.3: Average annual compounded population growth rates*
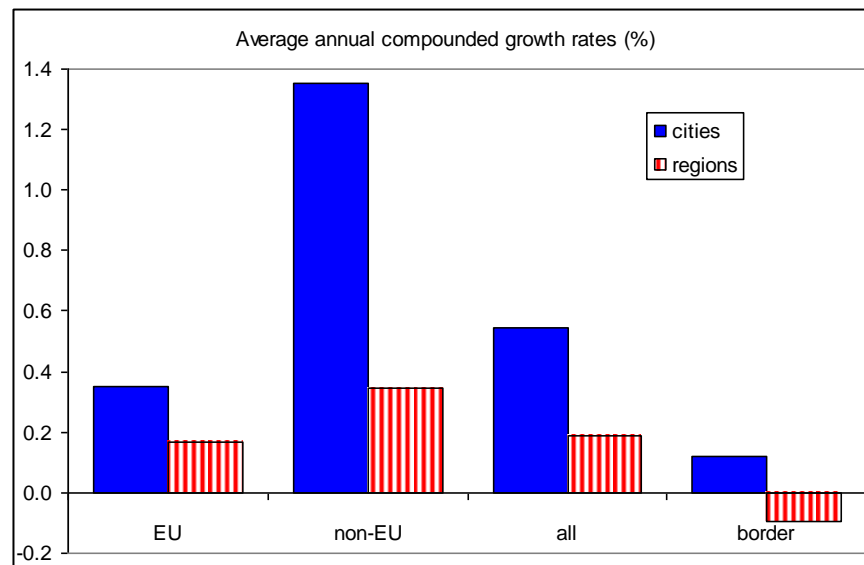
* border refers to the EU integration cities and regions, not the euro cities and regions

Table 3A.1 in the appendix provides some basic information on the different types of cities and regions identified in the EU integration process. The average city size in the EU (110,000) is both larger than the non-EU cities (82,000) and larger than the size of the cities along the EU integration border (93,000). The same holds for the median city size, which is 51,000 for EU

[17] The road distance was measured manually for all cities using Google Maps; data available on request. Furthermore, as a robustness check we also defined border cities as the group of cities that is part of a border region. This definition is problematic that the size of administrative regions of some countries are much larger than for other countries, implying that a country bias might be introduced. In general, however, the results are grosso modo comparable.

[18] Note that we exclude the only non-continental land border between Ireland and the UK affected by EU enlargement. Including it does not affect our results.

cities, 26,000 for non-EU cities, and 33,000 along the integration border. When calculating the average annual compounded growth rates (in percent), we observe (see Figure 3.3) that the smaller non-EU cities grow faster than the larger EU cities, namely 1.35 percent compared to 0.35 percent. More interesting for this study, however, is the fact that the cities along the EU integration border grow even slower (0.12 percent), which makes it a priori unlikely to find positive EU integration effects. The analysis below, however, distinguishes between the general border integration effect (which is expected to be negative) and the EU integration border integration effect (which is thus expected to be positive). Since the negative general border integration effect typically turns out to be stronger than the (temporary) positive EU integration border integration effect, the net border integration effect is negative (as illustrated in Figure 3.3). Similar observations hold for the regional data, since (i) the average population size of EU regions (374,000) is larger than along the integration borders (296,000), (ii) the median size of EU regions (251,000) is larger than along the integration borders (181,000), and (iii) the average growth rate of EU regions (0.17 percent) is larger than along the integration borders (-0.09 percent). The non-EU regions again grow more rapidly (0.35 percent) than the EU regions (see Figure 3.3).[19] In all cases, the growth rate of regions is smaller than the growth rate of the concomitant cities, indicative of a general process of urbanization.

3.5. Empirical strategy

To investigate the hypotheses discussed in section 3.3, we use a difference-in-differences methodology by comparing the growth performance of European areas close to a border abolished during the EU integration process (treatment group) to the growth performance of other European areas (control group). Consequently, we focus on the distribution of population over the regional or urban system within each country. Let pop_{at} be the population of area a in time t, $share_{at} = pop_{at} / \sum_{a \in C} pop_{at}$ (where C is the country index) be the share of the population in the regional or urban system and the population share growth is given as:

$sharegrowth_{a,t-1,t} = \left(\left(share_{a,t} - share_{a,t-1} \right) / share_{a,t-1} \right)$. Our baseline empirical specification is as follows:[20]

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[19] The size of non-EU regions is larger than the size of EU regions (in contrast to the size of cities), namely an average of 624k and a median of 314k.

[20] The link between equations (3.1) and (3.2) can be seen by log-differentiating (3.1). The border×integration dummy captures the combined effect of changes in FMA and CMA caused by changes in transport costs. The implicit assumption is that the integration dummy captures the effects on population growth through: the price index, market size (wages*initial population), and the number of varieties (firms). The main concern when considering econometric biases in estimates like these are omitted variables. To some extent the dummy variables (fixed effects) deal with this. Below we deal separately with the FMA term in the sense that smaller cities might experience an integration shock differently than large cities (that might already be home to important export industries).

$$sharegrowth_{a,t-s,t} = \beta \, border_a + \gamma(border_a \times integration_{at}) + d_t + D_C + \varepsilon_{at} \, , \tag{3.2}$$

where $sharegrowth_{a,t-s,t}$ is the annualized rate of growth (percent) in the population share of area a from time period $t-s$ to t; $border_a$ is a dummy equal to one when an area is a member of the border group as a whole and zero otherwise[21]; let $B \equiv \{a \in A \mid border_a = 1\}$, then $integration_{at}$ is a dummy equal to one at time t if $a \in B$ and an EU integration border within its reach was abolished at most 40 years ago. A similar reasoning applies to the case of the introduction of the euro. In this way we can distinguish within the border group as a whole, whether the selected group of border regions or cities that experience European integration (or the introduction of the Euro) perform differently from those not affected by European integration (or the introduction of the Euro). Furthermore, d_t is a full set of time dummies; D_C is a full set of country dummies; and ε_{at} is the error term. Note that the term $integration_{at}$ does not only depend on time but also on location as opposed to Redding and Sturm (2008). This is caused by the fact that during the EU history several borders were abolished at different locations and different time periods, see Table 3.3 for an overview. This dummy is therefore, for example, equal to zero for cities along the Austria-Italy border (either in Austria or in Italy) until 1994 and equal to one from 1995 onwards.[22]

Equation (3.2) allows for unobserved fixed effects in area population levels which are differenced out by computing growth rates. The time dummies control for common macroeconomic shocks affecting the population growth throughout Europe and trends in population growth rates. The country fixed effects take care of unobserved heterogeneity between countries, as our areas are part of different national (urban) systems with different policies (for example regarding the extent to which they stimulate activity in border areas). The coefficient β captures any systematic difference in population growth rates of border areas versus other areas. The key coefficient is γ, on the interaction between border areas and EU integration and the relative performance of population growth for treatment and control areas. The prediction is that this coefficient is positive.

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[21] See section 3.4 on the definition of affected cities or regions.

[22] Similarly, for an Austrian city such as Linz (close to both the German and Czech Republic border), this dummy is equal to zero up to 1994 and equal to one from 1995 onward (as part of Austria-Germany border region) and equal to one from 2004 onward (as part of the Czech Republic-Austria border region), that is the dummy is one until 2043 (for a period longer than 40 years). For our period of observation, this time extension beyond 40 years is never an issue.

3.6. Estimation results

3.6.1. EU enlargement

The baseline estimation results for both urban- and regional population share growth rates are given in Table 3.4. Columns (1) and (3) provide the results when information from all countries with available data are included, while columns (2) and (4) restrict attention to data from EU countries only (thus slightly narrowing the size of the control group). The results are virtually the same in all cases. The first line indicates that border areas are indeed poor performers relative to more central locations. The population share growth rate is –0.21 percentage points per year for border cities and –0.31 percentage points for border regions. Our key coefficient of interest on the interaction between border areas and EU integration ($border_a \times integration_{at}$), is given in the second row of the table. The effect is positive and highly significant. As a result of the integration process, the population share growth rate for border areas rises by about 0.15 percentage points, both for cities and regions. On the one hand, this is an indication of the success of the EU integration process. On the other hand, we observe that it is not sufficient to reverse the relative decline of border areas, neither for cities nor for regions.

Table 3.4: Urban and regional population share growth rates; baseline estimates

	Urban population		Regional population	
	(1)	(2)	(3)	(4)
$border_a$	– 0.210***	– 0.227***	– 0.312***	– 0.314***
	(0.0549)	(0.0568)	(0.0415)	(0.0418)
$border_a \times integration_{at}$	0.147***	0.180***	0.145***	0.148***
	(0.0499)	(0.0516)	(0.0542)	(0.0561)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample cities / regions	all cities	all cities	all regions	all regions
Sample countries	all countries	EU countries	all countries	EU countries
Observations	6,286	5,239	23,096	20,670
R^2	0.050	0.064	0.043	0.032

Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Our definition of affected border cities is, as discussed, based on an across-the-road travel distance to the border of 70 km. This is, of course, to some extent an arbitrary measure and specific to the context of our dataset, although it is in line with the extent of distance effect found by Redding and Sturm (2008) for the German division process. Table 3.5 provides the baseline estimates for urban population share growth for two alternative distance measures, namely 50 km

and 85 km across-the-road travel distance to the border. [23] The results are in line with our previous findings, with $border_a \times integration_{at}$ effects positive and highly statistically significant, in the range of 0.11 to 0.17 percentage points rise per year. Again, this is not sufficient to offset the relative decline of border cities. Recall, from Chapter Two, that we show neighboring countries market to be more important for the bordering cities than it is for the non-border cities. And after more than 50 years from the implementation of the first free trade agreements, the cities that are closer to the Belgium–Netherlands and Germany–the Netherlands borders still have proportionally lower wage rates compared to non-borders.

Table 3.5: Urban population share growth rates; variations in distance

	50 km border		85 km border	
	(1)	(2)	(3)	(4)
$border_a$	− 0.176***	− 0.191***	− 0.145***	− 0.168***
	(0.0550)	(0.0561)	(0.0548)	(0.0537)
$border_a \times integration_{at}$	0.111*	0.142**	0.131*	0.174**
	(0.0613)	(0.0623)	(0.0706)	(0.0689)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample cities	all cities	all cities	all cities	all cities
Sample countries	all	EU	all	EU
Observations	6,286	5,239	6,286	5,239
R^2	0.050	0.062	0.049	0.062

Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Naturally, this raises the question on the spatial reach of the $border_a \times integration_{at}$ interaction effect, recall hypothesis IIc. The results in Table 3.6 are presented to answer this, where we subdivide the border cities into cities (i) within the range of 50 km from the border, (ii) within the range 50 to 70 km from the border, and (iii) within the range of 70 to 85 km from the border. For the first two types of cities, the $border_a \times integration_{at}$ effect is positive and significant. For the third type of cities (within the range 70 to 85 km from the border), the $border_a \times integration_{at}$ is positive, but not statistically significant. This leads us to conclude that we can safely restrict attention to cities within the 70 km range, which is in line with the findings of Redding and Sturm (2008). Note that this implies that our regional estimates include a collection of border cities (within the 70 km range) as well as non-border cities (outside the 70 km

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[23] The table reports the results for urban population share of columns (1) and (2) in Table 3.4 for the alternative specification of a 50 km and 85 km border distance. We also looked at all borders in the sample, i.e. not only the border areas that are affected by a shock. Also those border cities are adversely effected by the border location, but less so (by a factor two) than the border cities at the affected borders. Border regions along the borders of these core EU members show a small positive effect..

range). The positive effect is the largest for the EU countries in the second group of distance range (see 3rd row, column (2)). This implies that the most affected cities are found within a moderate distance of the borders, neither too close nor too far. In addition, we constructed an artificial border to see if the estimates are statistical artifacts. To this end we selected, at random, 416 cities and 306 regions and defined these as border areas (the same numbers as in the sample). Next, we repeated the estimates for this random border sample for integration shocks. The treatment group and timing was also constructed at random. The results (see appendix II) indicate that this exercise resulted in non-significant outcomes, both for border areas in general as well as for the treatment group.

Table 3.6: Urban population share growth rates; extent of distance effect[24]

	(1)	(2)
$border_a$	-0.200^{***}	-0.219^{***}
	(0.0584)	(0.0605)
$border_a \times integration_{at}\big|_{50km}$	0.124^{**}	0.163^{***}
	(0.0552)	(0.0575)
$border_a \times integration_{at}\big|_{50-70km}$	0.194^{***}	0.242^{***}
	(0.0702)	(0.0719)
$border_a \times integration_{at}\big|_{70-85km}$	0.115	0.138
	(0.125)	(0.125)
Year effects	yes	yes
Country effects	yes	yes
Sample cities	all cities	all cities
Sample countries	all countries	EU countries
Observations	6286	5239
R^2	0.051	0.064

Robust standard errors in parentheses; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

The next effect we analyze is the duration of the $border_a \times integration_{at}$ effect, which is taken to be 40 years in the baseline scenario. To do that, we created four separate dummy variables, each covering a period of 10 years after the abolishment of an EU border. The dummy variable $border_a \times integration_{at}\big|_{10-20years}$, for example, equals one if an EU border was abolished for the respective border area between 10 and 20 years ago (and zero for the other time dummies). As Table 3.3 shows, the border between Spain and France was abolished in 1986. This implies that for the cities and regions along the Spain – France border the variable $border_a \times integration_{at}\big|_{10-20years}$ is equal to one in the period 1996 – 2005. Table 3.7 shows that for border cities the $border_a \times integration_{at}$ effect is operative (positive and significant) for a period of about 20 years. This is significantly shorter than the (opposite) effect on the duration of the

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[24] The table reports the results for individually exclusive distances for the baseline 70 km specification.

German division found by Redding and Sturm (2008), which lasts for 40 years. We think that the impact of the much more dramatic shock experienced in Germany is responsible for this longer duration, but the limited number of observations we have for the EU integration effect for time periods of more than 20 years also plays a role.[25] The results in Table 3.7 on the duration of the EU integration effect are a bit less straightforward for the regional data, which indicates that this effect is positive and significant for the 0 – 10 years and 20 – 30 years periods and not significant for the other periods. The inclusion of both border and non-border cities in the border region data may partially explain this finding. This categorization also sometimes leads to specific group of countries to be in a group. For instance, the countries in their 30 – 40 years since the integration can only be the oldest EU members, namely, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg and UK.

Table 3.7: Urban and regional population share growth rates; timing effect estimates

	Urban population		Regional population	
	(1)	(2)	(3)	(4)
$border_a$	− 0.200***	− 0.219***	− 0.288***	− 0.290***
	(0.0561)	(0.0583)	(0.0411)	(0.0414)
$border_a \times integration_{at}\big|_{0-10\,years}$	0.128**	0.161***	0.206***	0.213***
	(0.0528)	(0.0544)	(0.0542)	(0.0558)
$border_a \times integration_{at}\big|_{10-20\,years}$	0.154**	0.204***	− 0.0911	− 0.0961
	(0.0699)	(0.0721)	(0.0613)	(0.0623)
$border_a \times integration_{at}\big|_{20-30\,years}$	− 0.0149	− 0.00675	0.604***	0.604***
	(0.154)	(0.154)	(0.185)	(0.189)
$border_a \times integration_{at}\big|_{30-40\,years}$	− 0.0189	− 0.00752	0.209	0.202
	(0.261)	(0.261)	(0.172)	(0.170)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample cities / regions	all cities	all cities	all regions	all regions
Sample countries	all	EU	all	EU
Observations	6,286	5,239	23,096	20,670
R^2	0.050	0.064	0.044	0.033

Robust standard errors in parentheses; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table 3.8 analyzes the difference in economic impact of EU integration for cities and regions of different size, see hypothesis IIa. We divide the cities, for instance, into two groups: large and small. We define a city to be large if its earliest observation exceeds the median of all earliest observations and to be small otherwise. A similar procedure for regions would lump

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[25] As Table 3.3 shows, only the German-Danish border generates observations within the 30-40 years of duration, leading for both cities and regions to a limited number of observations in this range.

together large geographical areas or regions with many small cities or with one big city as 'large' regions. Instead, we opted for a more coherent definition, in which a region is large if it includes a city whose population size exceeds the median of cities. Table 3.8 shows that the overall positive EU integration effect for border areas is driven by the results for large cities/regions. For small cities/regions the integration effect is usually not even statistically significant, and the same hold for the border dummy as such. This differs from the findings of Redding and Sturm (2008, table 3.7, p.1794) for the reunification of Germany, which is arguably a smaller shock than the German division. They find some evidence that the reunification had positive effects, but differentiating between large and small cities results in [p.1793]: 'coefficients substantially smaller in magnitude than for the division and are not statistically significant at conventional levels.' Be as it may, for our sample we find that larger cities and regions are the ones that receive a positive integration thereby confirming hypothesis IIa.[26]

Table 3.8: Urban and regional population share growth rates; small and large areas

a. Urban population share growth rates	All countries		EU countries	
	(1)	(2)	(3)	(4)
$border_a$	-0.350^{***}	-0.120	-0.352^{***}	-0.145
	(0.0641)	(0.0898)	(0.0646)	(0.0953)
$border_a \times integration_{at}$	0.304^{***}	0.0929	0.308^{***}	0.148^{*}
	(0.0720)	(0.0715)	(0.0728)	(0.0779)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample cities[a]	large cities	small cities	large cities	small cities
Sample countries	all countries	all countries	EU countries	EU countries
Observations	3,248	3,036	2,908	2,331
R^2	0.065	0.112	0.085	0.109
b. Regional population share growth rates	All countries		EU countries	
	(1)	(2)	(3)	(4)
$border_a$	-0.403^{***}	-0.101	-0.406^{***}	-0.103
	(0.0479)	(0.0842)	(0.0486)	(0.0821)
$border_a \times integration_{at}$	0.209^{***}	0.0448	0.214^{***}	0.0471
	(0.0629)	(0.0968)	(0.0655)	(0.0934)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample regions[b]	large regions	small regions	large regions	small regions
Sample countries	all countries	all countries	EU countries	EU countries
Observations	16,314	6,782	15,060	5,610
R^2	0.033	0.112	0.034	0.048

Robust standard errors in parentheses; $^{***} p < 0.01$; $^{**} p < 0.05$; $^{*} p < 0.1$

[a] Large is bigger (and small is less) than median of earliest observations, where earliest observation is the earliest year population data are available for the city

[b] A region is large if it includes a city whose population size exceeds the median of cities.

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[26] Estimates for the complete sample but introducing a dummy for large cities or regions gives similar results.

Table 3.9: Urban and regional population share growth rates; asymmetry: old and new members since 2004

	Urban population		Regional population	
	(1)	(2)	(3)	(4)
$border_a$	-0.212^{***}	-0.229^{***}	-0.298^{***}	-0.300^{***}
	(0.0536)	(0.0557)	(0.0406)	(0.0409)
$border_a \times integration_{at,old}$	0.162^{***}	0.193^{***}	0.0930^{*}	0.0945^{*}
	(0.0611)	(0.0611)	(0.0512)	(0.0521)
$border_a \times integration_{at,new}$	0.131^{**}	0.166^{***}	0.368^{***}	0.381^{***}
	(0.0622)	(0.0645)	(0.103)	(0.109)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample cities / regions	all cities	all cities	all regions	all regions
Sample countries	all countries	EU countries	all countries	EU countries
Observations	6,286	5,239	23,096	20,670
R^2	0.050	0.064	0.043	0.032

Robust standard errors in parentheses; $^{***}\, p < 0.01$; $^{**}\, p < 0.05$; $^{*}\, p < 0.1$; $border_{art}$ refers to an artificially created border, see the main text for details.

Finally, Table 3.9 analyzes asymmetric border integration effects, where we disentangle the border integration effects for the existing EU members and the new entrants, specifically for the substantial enlargements in 2004 and 2007. Note again that for instance German cities along the Polish border are included as *border* cities of the existing EU member Germany and German cities along the Dutch or French border are included as non-border cities. As the table indicates, our main results are not affected. More specifically: (i) there is a significant and negative general border integration effect and (ii) there is a significant and border integration effect, both for the border cities of the old and new EU members, like for instance German cities along the Polish border and vice versa respectively. The table also shows that the border integration effect is about the same at the city level for old and new members, while it is higher for the new members than for the old members at the regional level.[27] We attribute this difference again to the more coherent unit of observation at the urban level than at the regional level.

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[27] At the city level an F-test for equality of the border-integration coefficients for old and new members cannot be rejected at any standard significance level. In contrast, this equality hypothesis is rejected at the 5 percent level for the regional estimates. We also estimated old and new border integration effects for the whole period and found similar results.

3.6.2. The introduction of the Euro

The second integration experiment described in section 3.2 is that of European monetary integration, ultimately resulting in the introduction of the euro for 12 countries in 2002 (enlarged in the period 2007-2011 to 17 countries).[28] As already discussed above, the additional effects of the introduction of the euro on the market access variables of border cities or regions compared to non-border cities or regions (which ultimately determines location decisions) are expected to be smaller than the additional effects of the EU integration process as measured by accession, see hypothesis IIb. Not only is the euro related to a smaller part of the economic forces, but also (and more importantly) monetary unification was a much more gradual process with many decades of experimentation with fixed or managed exchange rates and a long period of adhering to strict rules before the actual introduction of Euro coins and bills in 2002 took place. Our results are summarized in Table 3.10, which shows that (i) the population share growth rates are significantly smaller along the borders of the euro area (about 0.13 percent for cities and 0.20 percent for region) and (ii) there is no discernible positive effect on these growth rates that can be attributed to the introduction of the euro.[29] Border cities and regions have no benefits in terms of their population growth share growth from introducing the euro.

Table 3.10: Urban and regional population share growth rates; introduction of the Euro

	Urban population		Regional population	
	(1)	(2)	(3)	(4)
$border_{euro}$	-0.132^{***}	-0.138^{***}	-0.208^{***}	-0.204^{***}
	(0.0450)	(0.0459)	(0.0286)	(0.0283)
$border_{euro} \times euro_{at}$	-0.0105	0.0132	-0.0470	-0.0623
	(0.0577)	(0.0580)	(0.0451)	(0.0456)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample cities / regions	all cities	all cities	all regions	all regions
Sample countries	all countries	EU countries	all countries	EU countries
Observations	6,286	5,239	23,096	20,670
R^2	0.050	0.062	0.043	0.032

Robust standard errors in parentheses; $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

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[28] Or 20 countries if one includes San Marino, Monaco, and the Vatican.

[29] Note that the selection of border cities and regions for the introduction of the euro is quite different from that of the EU integration (accession) process, and in particular includes cities and regions along the borders of the countries that started the process: France, Germany, Italy, Netherlands, Belgium, and Luxembourg. Taking 1999 instead of 2002 as the starting year for the early 11 countries involved does not change our results.

3.7. Conclusions

Urban historians have shown that the evolution of cities follows a relatively stable path (Bairoch, 1988). At the same time, long time series on city population also reveal that (sub-sets of) cities can switch to new development paths. Relatively recently, discretionary policy changes or natural experiments have been used to shed light on what drives these changes in the development of (sub-sets of) cities and to investigate whether they are, indeed, stable after a shock or policy change. Redding and Sturm (2008) analyze the effects of the post WWII division of Germany into East and West Germany in 1949 on border cities along the new border within Germany. They find that the effects of the German division on the cities along the intra-German border were substantial, resulting in a sharp decline of the population along the new border (more so for small than for large cities).

We apply the methodology developed by Redding and Sturm (2008) to the case of the EU enlargements that took place from 1973 onwards, which we expect to affect especially border cities as these cities experience larger changes in market access than cities further away from the border. We also analyze regional data and look at the effects of the introduction of the Euro on border locations. Both at the urban and regional level, we find a positive effect of the EU integration process as measured by the growth in population share along the integration borders, leading to an additional growth of about 0.15 percentage points per annum. The positive integration effect associated with EU enlargements holds on both sides of the integration border, is active for a limited distance (up to 70km) and time period (up to 30 years), and is driven by the larger cities and regions. Despite this positive EU integration effect, being located along a border remains a burden in view of the (larger) general negative border integration effect. We do not find similar border integration effects as a result of the introduction of the euro. In short, we find support for our hypotheses that, following the economic integration, border cities/regions grow relatively faster. The border integration effect is stronger than just monetary union. Small and large cities/regions are affected differently and the integration effects decay over distance from the borders.

3.8. Appendices

3.8.1. Data description

The data consist of two non-balanced panel data sets on location and population, one for European cities and one for European regions. The data for European cities were collected from Brinkhoff (http://www.citypopulation.de/), whereas the data on the European regions were obtained from Eurostat (http://epp.eurostat.ec.europa.eu/). The urban population data covers the period from 1979 to 2010, with irregular intervals. The regional data cover the period from 1990 to 2008, with only a few missing observations. Border regions are defined as regions that have a common border with a neighboring EU country. The location of cities was collected from Google maps (http://www.maps.google.com/). Border cities are cities within a road distance of 70 kilometers from the nearest national border(s). We also experimented with border cities within 50 kilometers and 85 kilometers road distance from a national border. The total number of cities is 2410, namely 1950 EU cities and 460 non-EU cities (Table 3A.1, a). Out of the 1950 EU cities 416 (21 percent) are border cities (using the 70 kilometers border distance). The regional data set consists of 1457 regions, namely 1302 EU regions and 155 non-EU regions. Out of the 1302 EU regions 306 (24 percent) are border regions (see Table 3A.1, b).

Table 3A.1: Basic urban and regional information (EU integration)

| a. Urban data | # cities | Population | | growth[*] |
		mean	median	rate (%)
EU Cities	1,950	110,484	50,984	0.351
Non-EU cities	460	82,483	26,066	1.355
All Sample Cities	2,410	105,631	44,956	0.542
EU integration border cities (70 km)	416	93,054	32,891	0.119
b. Region data	# regions	mean	median	rate (%)
EU Regions	1,302	373,760	251,000	0.168
Non-EU regions	155	624,317	314,200	0.346
All Sample regions (total)	1,457	398,679	256,000	0.187
EU integration borders	306	296,173	180,900	-0.094

[*] Since we don't have annual data, the average annual compounded growth rate (%) is calculated based on beginning and end value

3.8.2. Random border

Table 3A.2 reports the effects of an artificially created border from a random selection of 416 non-border cities and 306 non-border regions (equal to the number of border cities or regions). The start of the integration period for each city or region was chosen randomly from one of the periods relevant for this country30 and active henceforth. As the table shows, creating this artificial border integration effect within the EU does not lead to any significant border integration effects.

Table 3A.2: Urban and regional population share growth rates; artificial border

	Urban population		Regional population	
	(1)	(2)	(3)	(4)
$border_{art}$	0.0529	0.121	0.0293	0.0494
	(0.0781)	(0.0928)	(0.0347)	(0.0391)
$border_{art} \times integration_{art,t}$	0.0308	− 0.0285	0.0241	0.00897
	(0.0920)	(0.106)	(0.0509)	(0.0543)
Year effects	yes	yes	yes	yes
Country effects	yes	yes	yes	yes
Sample cities / regions	all cities	all cities	all regions	all regions
Sample countries	all countries	EU countries	all countries	EU countries
Observations	6,286	5,239	23,096	20,670
R^2	0.049	0.062	0.041	0.030

Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; $border_{art}$ refers to an artificially created border, see the main text for details.

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[30] For countries not actively affected by integration in the whole period, such as Belgium, the nearest border effect was chosen, in this case 1995. The list is available on www.charlesvanmarrewijk.nl

Chapter Four

Asymmetric Border Effects of EU Integration: Evidences from Dutch, Belgian and German Municipalities[31]

4.1. Introduction

The analysis of the consequences of the allied bombing during World War II on Japanese cities by Davis and Weinstein (2002) and a similar study of the consequences of the allied bombing during World War II on German cities by Brakman et al. (2004a) suggests that cities (partially) return back to their long-run growth path following a systemic shock. A more common but less drastic shock is creation or abolition of border barriers. In their seminal paper Redding and Sturm (2008) analyze, in a New Economic Geography framework, the effects on border cities along the new border following the post-WWII division of Germany into East and West Germany in 1949. Building on the analysis by Redding and Sturm (2008), in Chapter Three, we investigate the EU integration effects on cities and regions bordering other EU member countries. Both Redding and Sturm (2008) and the results in Chapter Three show that the cities and regions near the borders experience stronger negative effects of borders as well as more positive effects of integration than centrally located cities or regions following the abolition of border barriers.

Chapter Three, in particular, analyzes the effects of EU integration on population distribution of the cities and regions of the EU member countries across the national border and central locations. The results show that negative border effects are compensated for by higher population growth following EU integration shocks. In the analysis it is inter alia assumed that a country is affected only once at the time when the country joined EU and/or when a neighbor country joins EU. It is also assumed that the integration effects are *symmetric* across all the borders and all member countries. Furthermore, the integration remains active for a limited period (max. 40 years). In this chapter we relax these assumptions. We thereby extend the analysis of the previous chapter in two ways: allow for asymmetric effects, and allow for indirect integration effects. We use the difference-in-difference estimation approach as employed by Redding and Sturm (2008). Our results show that borders are affected differently, hence conforming the idea of asymmetric border integration effects. The results also show that the border integration effects are limited in time for Belgium and the Netherlands. However, the results also show that the integration effects on the German border municipalities last longer. This is so likely due to Germany's geographical proximity to most of the East Europe new EU members who joined EU at later stages in time. Also indirect integration effects are present.

The remainder of this chapter is arranged as follows. Section 4.2 contains a brief discussion of the EU enlargement process and possible (in-)direct links to our current sample

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[31] This chapter is based on a joint work with Steven Brakman and Harry Garetsen

borders. Section 4.3 discusses the model introduced by Redding and Sturm (2008). Section 4.4 is about the data set. The data cover three of the oldest EU member countries (Belgium, Germany and the Netherlands), as in Chapter Two. We expect that the effects in population here are consistent with the effects in wage in Chapter Two. The availability of long time series and detailed cross-sections for these countries make them suitable for our research questions. We assess the possible variation in the (in-)direct integration effects on border locations over time as EU expands to countries that do not involve the sample borders. In addition to using population share growth, this allows us to use population growth since there are integration shocks which can be the sources of the growth as opposed to the case in Chapter Three where all the shocks are within the sample locations. Section 4.5 describes the estimation strategy, and section 4.6 the estimation results. Finally, section 4.7 discusses the major findings compared to related research. Finally, section 4.8 summarizes and concludes.

4.2. EU Enlargement, border regions and research motivation

Most forms of economic integration involve reduction or elimination of barriers on cross-border mobility of commodities and factors of production. The ongoing process of EU integration is a good example. It started with the 1951 European Coal and Steel Community (ECSC) formed by five members namely Belgium, France, Luxembourg, the Netherlands, Italy, and (West-) Germany and over time various enlargements took place (see table 4.1). The table demonstrates where and when the population related integration shocks took place which in addition change the total EU population. In addition, 17 of the 27 current member countries use the euro. Free trade and mobility of workers increase the market access of member nations.

Table 4.1: EU enlargement process and integration shocks

Time line	Integration	New members	EU population by then in millions
1951	European Coal and Steel Community (ECSC)	Belgium, France, Luxembourg, the Netherlands, Italy, and the then West Germany	160
1957	European Atomic Energy Community (EURATOM)	No	----
1957	European Economic Community (EEC)	No	----
1967	EC European Communities (combining ECSC, EEC, and EURATOM)	No	----
1973	New Membership	United Kingdom, Ireland, and Denmark	260
1981	New Membership	Greece	270
1986	New Membership	Spain and Portugal	330
1990	New Membership	East Germany (reunification of West and East Germany)	345
1993	EU European Union	No	----
1995	New Membership and Schengen visa	Finland, Austria, and Sweden	370
1999	Economic and Monetary Union(EMU)	No	----
2002	Euro Introduction of the EURO	No	----
2004	New Membership	Cyprus, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia	470
2007	New Membership	Bulgaria and Romania	497

Source: adapted and modified from Chapter Three table 3.1.

Within a NEG framework the location decisions of firms and workers depend on the combination of agglomeration forces, and spreading forces (see Redding and Sturm, 2008). With the reduction of border barriers between two countries, market access of border areas increase more than that of central locations. As a result firms and workers may relocate to border areas as these become more attractive. We focus on the municipalities of the oldest members of the EU, namely Belgium, Germany and the Netherlands, that have been part of the EU from the start.

4.3. Theoretical background

The theoretical framework is the same as in Chapter Three and is based on Redding and Sturm (2008) which we recap in this section with slight change to account for indirect market access. It is based on a multi-region version of the geographical economics model by Helpman (1998). In general, in models of geographical economics, the combination of increasing returns to scale, size of the market, and transport costs makes that firms want to locate in or near large markets and large markets offer consumers a variety of consumer goods and low transport costs (for details see Brakman et al. 2009). Moreover, and this is specific to the Helpman (1998) model, large markets raise the costs of (non-traded) local services, thus leading to higher costs of living (congestion effect). The optimal location of a workers and firms is determined by the balance of these opposing forces. The model demonstrates how both firms' market access (FMA) and consumers' market access (CMA) determines equilibrium on the labor market. This can be summarized by the following equilibrium equation:

$$L_a = \Omega \left(FMA_a\right)^{\mu/\varepsilon(1-\mu)} \left(CMA_a\right)^{\mu/[(1-\mu)(\varepsilon-1)]} H_a \tag{4.1}$$

$FMA_a = \sum_i \left(w_i(w_k)L_i\right)\left(P_i^M (P_k^M)/T_{ai}\right)^{\varepsilon-1}$ is market access of firms located in location a to all the markets of all locations including their own location; $CMA_a = \sum_j n_j(n_k)\left(p_j(p_k)T_{ja}\right)^{1-\varepsilon}$ is consumers' market access to consumer goods in location a. Ω is a function of parameters and the common real wage; and w_i, L_i, P_i^M, n_i and p_i are respectively, the nominal wage rate, the number of workers, the CES price index for varieties, the number of varieties produced, and the local (free on board) price of a variety, all at location i. The economy consists of a number of locations $a \in \{1, . . . , M\}$, where the locations can be either cities, municipalities (as it is in this chapter) or regions. Each location has an exogenous stock H_a of non-tradable services, referred to as housing (Helpman, 1998). FMA_a shows how easily firms operate in location a. It depends on labor income in location i, the associated price index, and the transport costs of getting goods from location a to all markets. It includes the home market effect in which large markets or those near large markets attract labour inflows. It determines the equilibrium wage rate that firms can afford to pay in equilibrium, depending on the home market advantage and the competition from other (surrounding location) markets. Here we assume that location a has access to location i as in Chapter Three. The difference with Chapter Three is that there are markets k adjacent to location i but not to location a. The market access of location k by both locations a and i is limited by

national borders. Once k and i are integrated, k affects *MA* at location i directly and *MA* at location a through location i, indirectly. Thus, FMA_a is indirectly affected by wage, w_k, labour supply, L_k, and price index , P_k^M at location k. CMA_a reflects the cost of living in location a. It depends on the number of varieties produced in the location, the locally charged price, p_j at location j, and transportation costs, T_{ja}.

The difference here with the model in Chapter Three is that we assume the consumer market access of location a is affected not only by the same or a neighboring country market j, but also indirectly by the market k of a country neighboring j although not neighbor of a itself. Here n_j affects CMA_a directly and n_j itself is a function of number of varieties n_k produced at location k as the number of varieties produced at each location changes following the opening of trade between location j and k. This is important since we analyze integration where countries join the EU at different points in time and some have no common borders. For instance, when the Netherlands and Germany opens for trade the total number of consumer varieties n_j produced in both countries together increase, but varieties produced in each country decreases due to specialization. Later, when Poland joins EU the total number of varieties available in the market increases due to n_k from the new market, but number of varieties produced in each country decreases once again due to specialization. Thus, n_j is a negative function of n_k. One can see this in a different way. One way is that if we assume that the sum of all varieties produced and traded with the union members is 100% = 1, i.e., $\sum_j n_j = 1$; and when a third country joins the union the sum of all varieties still 100%, i.e., $\sum_{j+k}(n_j + n_k)=1$, implying the proportion of varieties produced in each member country is smaller[32]. This holds even in case integration enhances technological advancement or diffusion which expands variety of products available as Grossman and Helpman (1991, Ch.3). Another way is that we assume the total number of varieties produced after integration remains the same as before. This is also consistent with a second type of model (see Grossman and Helpman, 1991, Ch.4) where any technological advancement, that may arise from integration in our context, leads to increasing specialization. Then, $\sum_j (n_j/N)=1$ before and $\sum_{j+k}((n_j + n_k)/N)=1$ after the integration implying each member produce fewer varieties when new member joins the union, no matter whether they have common borders or not. Similarly price p_j at location j is affected by price p_k at location k. When a country with low (high) production cost and low (high) commodity prices joins the union, the wages and prices in the old members markets also gets lower (higher); i.e., given other things constant, $w_i(w_k) = \zeta + \varphi w_k^\ell$ and $p_j(p_k) = \xi + \lambda p_k^\partial$; where $\varphi > 0$; $\lambda > 0$; $\ell > 0$; $\partial > 0$; and ζ and ξ are positive constants[33]. The

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[32] Note that, in absolute terms, the sum of the varieties are smaller after integration: $(n_j + n_k)_t > (n_j + n_k)_{t+1}$; or in other words $(n_j)_t > (n_j)_{t+1}$ and $(n_k)_t > (n_k)_{t+1}$ where $t + 1$ is the time after the third country joins the union.

[33] For $\ell = 1$ and $\partial = 1$ the relationships are linear, and else non-linear.

number of workers L is mobile across locations: each supplies one unit of labor in-elastically, spends a share $(0 \leq \mu \leq 1)$ of income on horizontally differentiated consumers varieties and the remaining share $[0 \leq (1 - \mu) \leq 1]$ on the non-tradable services. Supply of cheaper labour from the new member also derives the wage rate down in the old member markets. Production of varieties takes place under increasing returns to scale (with fixed cost and constant marginal cost in terms of labor) with a constant elasticity of substitution $(\varepsilon > 1)$ between varieties. Transport costs for varieties are of the ice-berg type, such that $(T_{ai} > 1)$ units must be shipped from location a to make sure one unit arrives in location i. Thus, the proportion $(T_{ai} - 1)$ measures the trade cost. Trade costs, $(T_{ai} - 1)$, is a function of the distance between the two locations. This implies that the strength of competition from other regions decreases as distance increases. Anything that changes the transportation cost and the market access leads to new equilibrium through labor mobility. The relative wage rate may increase or decrease in the short run due to two opposing effects. (i) *Home market effect*: other things equal, the wage rate will tend to be higher in the larger market. (ii) *The extent of competition*: workers in the region with the smaller manufacturing labor force will face less competition for the local workers market than those in the more populous locations. Furthermore, real wages are higher in the larger market due to a lower price for manufactured goods (see Krugman, 1991a). The population size in the various locations a is endogenously determined by migration decisions of workers such that real wages are equalized between locations in the long-run equilibrium.

The long-run equilibrium population of location r in this model is based on the assumption of free mobility of the workers. In the context of EU integration process labor mobility, especially between the member countries, is largely limited to national markets before joining the EU. After a country joins the EU, the integration process triggers new dynamics by reducing the transportation cost T_{ai} especially of bordering locations across the national borders into the newly accessed neighboring markets. Redding and Sturm (2008) take division between East and West Germany after WWII until the reunification in 1990 as an example of a negative (obstacle) shock to the labor mobility and so higher T_{ai}. They provide evidence for lower population growth in West Germany near the artificially created borders between the East and West Germany. Similarly, in Chapter Three we take the opposite (removal border barriers by EU integration process) and show evidence of an increase in population (share) of the border cities and regions. The focus of this chapter is on the extension of the analysis of the EU integration process (the removal of the obstacles) for 3 EU member countries, Belgium, Germany and the Netherlands. As we stated in the introduction of this chapter, and in contrast to Redding and Sturm (2008) or Chapter Three of this thesis, and by using population growth[34] as our central variable we want to test whether:

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[34] Note that growth is appropriate variable in this chapter as opposed to the earlier since the sample here areas are sub-set of the areas affected by the integration, having external sources for growth or the opposite.

i) the EU integration process goes along with asymmetric effects on border and non-border regions in the 3 countries under consideration

ii) the EU integration process possibly not only has direct effects on common border areas but also indirect effects, that is to say an impact on non-bordering areas across our 3 countries.

4.4. The data

We use municipality level data with a relatively long time dimension and detailed spatial units for three of the oldest EU member states: Belgium, Germany and the Netherlands. The sources of our basic data are http://statbel.fgov.be/ for the Belgium municipalities, http://www.destatis.de/ for the Germany municipalities and http://www.cbs.nl/ for the Netherlands municipalities[35]. The Belgian data cover a relative short period, 1990-2010. However, the spatial units are very detailed with 589 municipalities. The data for the Netherlands cover 418 municipalities for a longer period, 1960 to 2009. The German data also cover a relative long period of time, 1976-2007 for 440 German municipalities. Initially we take a 10 kilometers border range to define a border. The data summary is given in table 4.2.

Table 4.2: Sample data

Countries	number of municipalities	years covered	border municipalities (10 kms)	non-border municipalities	total observations
Belgium	589	1990 – 2010	200	389	5890
Germany	440	1976 – 2007	91	349	11844
Netherlands	418	1960 – 2009	139	279	21700

We define six different groups of border municipalities, two for each sample country. These borders are: (i) The Dutch municipalities bordering Germany, (ii) The Netherlands municipalities bordering Belgium, (ii) German regions bordering the Netherlands, (iv) German regions bordering France, (v) Belgian regions bordering the Netherlands, and (vi) Belgian regions bordering France. Belgian municipalities bordering Germany as well as German municipalities bordering Belgium are too small in number so we could not include them in our analysis.

The data of the Netherlands and Germany provide us with active[36] integration for 30 to 40 years. The data for the two countries start in 1960 and 1976, respectively. The integration of 1951 between the sample countries along the borders of these countries is expected to be possible 'active' for 30-40 years (see Redding and Sturm, 2008; and Chapter Three). Different integration shocks occurred throughout our sample period (see table 4.3 below). We assume that the later

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[35] The Germany and the Netherlands data were secured free of charge whereas Belgium municipalities' administrative unit data were purchased from the corresponding statistics offices.

[36] Integration status is assumed to be active for 30 to 40 years after the adoption of a particular integration policy (see Redding and Sturm, 2008; and the previous chapter).

integration shocks as new members join EU might have indirect effects on population of the municipalities of the sample countries (older members). Thus, we explicitly include indirect as well as direct integration effects. We expect the EU entry of the new members (United Kingdom, Ireland, and Denmark in 1973; Greece in 1981; Spain and Portugal in 1986; East Germany: reunification of West and East Germany in 1990; Finland, Austria, and Sweden in 1995; Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia in 2004 and Bulgaria and Romania in 2007) to have indirect effects on the municipalities in our sample.

Table 4.3: EU integration shocks' status and expected effects on the sample countries

Integration shock year	Integration	New members	Integration active till[37]	Expected effects[38]
1951 (ECSC1951)	European Coal and Steel Community (ECSC)	Belgium, France, Luxembourg, the Netherlands, Italy, and West Germany	early 1990s	direct
1957 (EURATOM1957)	European Atomic Energy Community (EURATOM)	No	late 1990s	direct
1957 (EEC1957)	European Economic Community (EEC)	No	late 1990s	direct
1967 (EC1967)	EC European Communities (combining ECSC, EEC, and EURATOM)	No	late 2000s	direct
1973 (EC1973)	New Membership	United Kingdom, Ireland, and Denmark	through end	indirect
1981(EC1981)	New Membership	Greece	through end	indirect
1986(EC1986)	New Membership	Spain and Portugal	through end	indirect
1990 (EC1990)	New Membership	East Germany (reunification of West and East Germany)	through end	direct & indirect[39]
1993(EU1993)	EU European Union	No	through end	direct
1995 (EU1995)	New Membership + Schengen Visa	Finland, Austria, and Sweden	through end	direct & indirect
1999(EMU1999)	Economic & Monetary Union(EMU)	No	through end	direct
2002(EURO2002)	Euro Introduction of the EURO	No	through end	direct
2004 (EU2004)	New Membership	Cyprus, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia	through end	indirect
2007(EU2007)	New Membership	Bulgaria and Romania	through end	indirect

Note: active through end = active through the end of the sample period

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[37] See footnote 36.

[38] The integration effect is expected to be 'direct' if the particular integration shock involves the sample countries or a bordering country; else the effect is expected to be 'indirect'.

[39] Since Germany is part of this particular integration shock, it has direct effects on the German borders whereas the effects on the German municipalities bordering Belgium, France, Luxembourg, France, and the Netherlands as well as on the other sample countries (Belgium and the Netherlands) are indirect.

In our estimations, we distinguish between the 'direct' and the 'indirect' integration shocks (see table 4.3). The direct shocks used in the estimation are the EC1967, EU1993, EMU1999 (or EURO2002 as an alternative) since they affect the sample countries simultaneously and the borders between them. The indirect shocks do not affect the sample borders of the sample countries; and we used the EC1973, EC1986, EU1995 and EU2004 for the estimation. The ECSC1951, EURATOM1957 and EEC1957 are excluded since our data do not cover the periods when these shocks happened; whereas the EC1981, EC1990 and EU2007 are excluded due to either limited spatial coverage or limited time dimension. Another integration shock during 1995 was the Schengen Agreement which led to the creation of Europe's borderless Schengen Area in 1995. The treaty was initially signed on 14 June 1985 between five of the then ten member states of the European Economic Community near the town of Schengen in Luxembourg. It proposed the gradual abolition of border checks at the signatories' common borders which became effective in 1995. It allows people crossing borders at any convenient points and abolishes stops at border controls within the member countries.

4.5. Estimation strategy

In this chapter we use the same empirical strategy of difference-in-differences (DID) methodology as also employed by Redding and Sturm (2008) or the previous chapter. Here we recap the discussion of the estimation strategy with respect to the new data and the new variables. The DID method allows for time-invariant unobserved differences between the control and treatment groups. In particular it removes differences in unobserved characteristics that are constant over time and that affect individual variable (for instance a municipality population in this chapter) in a constant way. Time dummies control for other common shocks which affect population of the whole sample countries. There are two major differences worth mentioning about the data used in Chapter Three and the ones used in this chapter, since they somehow affects our calculations and the variables we use in equation (4.2). First, the sample data in this chapter are more detailed spatial level as well as annual data as opposed to the whole EU data in the previous chapter. These allow us to use annual growth as well as separate between different borders. Second, in Chapter Three the sample covers the whole integration area, and thus the population effects come from redistribution of population only from within the sample locations, EU. Thus, it is more appropriate to look at population share growth than absolute growth. However, in this chapter the sample area is smaller than integration area. Thus, integration shocks outside the sample area can affect absolute population growth. Thus, use of both the absolute population growth and population share growth are appropriate. Thus, we compare the population (share) growth performances of border municipalities of the sample countries with the population (share) growth performance of their centrally located non-border municipalities following an EU integration policy implementation. We define population growth as,

$$popgrowth_{a,t-1,t} = \left(\left(population_{a,t} - population_{a,t-1}\right)/population_{a,t-1}\right).$$

The baseline empirical model is specified as follows:

$$popgrowth_{a,t-1,t} = \beta\, border_a + \gamma(border_a \times integratio\, n_{a,t+s}) + D_t + \varepsilon_{at} \qquad (4.2)$$

The border dummy, $border_a$ takes value of one if municipality r is within a given range of an integration border and zero otherwise; an integration dummy, $integratio\, n_{a,t+s}$ takes value of 1 from time t when an integration effect starts and on ward. D_t is full set of time dummies; and ε_{at} is a stochastic error term. The time dummies control for common shocks affecting the population growth throughout the sample countries and trends in population growth rates. The coefficient β captures any systematic difference in population growth rates of border municipalities versus non-border municipalities. The focus of our analysis here is on the interaction coefficient γ, which captures the relative performance of population growth for treatment groups, the bordering municipalities, compared to the controls, the non-border municipalities. Border municipalities are expected to gain relatively more in population (share) growth following the integration.

The size of the administrative units in Germany is much larger than that of the municipalities size in Belgium and the Netherlands. However, the DID approach is best used for comparable control groups (for instance see Bertrand et al., 2004; and Cameron and Trivedi, 2005). We take care of this issue as follows. First, we apply our baseline estimations at national level where our control group of the border municipalities are very much comparable. Second, we extend our analysis by differentiating between large and small municipalities to make the control as well as the treatment group even more comparable. Another concern with this approach is the assumption of homoscedastic error term and the correctness of default error term estimated using OLS techniques. Here we estimate robust standard errors to avoid this problem. Moreover, this problem is less likely since our data have a relatively long time dimension. The error term will be homoscedastic under at least two circumstances (Donald and Lang, 2007): (i) if the number of observations per group is large, or (ii) if there are no within-group varying characteristics, and the number of observations is the same for all groups. As further checks of the correctness of the standard errors we clustered the errors by municipality as this would avoid possible inflated t-values.

We assume that there might be an *in*direct integration effect even when a country joining EU at time t has no common border with any of the 3 sample countries. We use the same specification to estimate for the direct and the indirect integration effects separately (see again Table 4.3 for the list of the direct and indirect integration shocks). Moreover, we define $share_{at} = population_{at} / \sum_{a}^{C} population_{at} =$ share of a municipality a population in the national population at time t; where C is number of municipalities (or cities or regions in general sense) in a country. Using the share we calculate $sharegrowth_{a,t-1,t} = \left((share_{a,t} - share_{a,t-1}) / share_{a,t-1} \right)$; and we estimate the model by substituting $popgrowth_{a,t-1,t}$ by $sharegrowth_{a,t-1,t}$ in the above specifications to check if there are differences in the share growth and the actual population growth. As opposed to Redding and Sturm (2008) and Chapter Three, our two main hypotheses are thus that: (i) There are direct integration effects from the country itself or from bordering country as well as indirect

integration effects from a third non-bordering EU member country; (ii) The integration effects can be asymmetric. That means, for instance, the Netherlands side and the Germany side of the Netherlands-Germany border can be affected differently by the same integration shock due to differences in relative strength of home market effect and competition. From Chapter Two, we can remember that neighboring countries market is more important for the bordering cities than it is for the non-border cities; and this is different across different national borders.

4.6. Estimation results

4.6.1. Baseline estimates

The baseline estimations refer to the direct and the indirect integration effects on six sample border groupings: Belgium bordering the Netherlands, Belgium bordering France, the Netherlands bordering Belgium, the Netherlands bordering Germany, Germany bordering the Netherlands and Germany bordering France. As the sample covers different time spans for different countries comparisons over time are not appropriate. Thus comparisons are at national level; i.e., the Netherlands border municipalities are compared with centrally located Netherlands municipalities. An advantage is that it improves the reliability of the results from differences-in-differences (DID) approach. For common integration effects we refer to Chapter Three.

The baseline estimation results for the direct integration effects are given in Table 4.4. Columns (1) and (2) show the estimation results for two Belgian borders (1) bordering France and (2) bordering the Netherlands. The results show that the municipalities bordering France have significantly lower growth compared to the centrally located municipalities as opposed to the municipalities bordering the Netherlands. However, the reverse happened after the European monitory Union (EMU) of 1999 [as an alternative we also look at 2002 when the actual euro notes and coins were introduced]; i. e., the municipalities bordering the Netherlands grew significantly lower than centrally located municipalities after the adoption of the monitory union or the EURO currency. Since the adoption of the monetary union (EMU1999) and the introduction of the common currency (EURO2002) were so close we present these as alternatives. The results are also very similar for these two integration shocks. Columns (2) and (3) compare either sides of the border between Belgium and the Netherlands. The border coefficient during the EMU1990 and EURO2002, the period for which the data were available on both sides of the border, the municipalities on both sides of the border have non-negative growth. However, after the EMU [or the EURO] the Belgian side municipalities have had significantly lower growth compared to the central locations whereas the Netherlands side municipalities have also grown slower but insignificantly.

Columns (3) and (4) compare the two borders of the Netherlands, one bordering Belgium and another bordering Germany. The municipalities bordering Germany had significantly higher growth rate following the early integration shock EC1967 whereas the municipalities bordering Belgium also had higher but insignificant growth. Moreover, the Netherlands municipalities

bordering Belgium have non-negative growth earlier and for relatively longer period than the municipalities bordering Germany. This result is very much in line with the finding in Chapter Two, where the wage rate has stronger connection with the market access at around this border than around the Netherlands– Germany border. Both groups of the Netherlands border municipalities have had lower growth rate following the latest direct integration shocks of EMU1999 (or EURO2002). Column (5) and (6) provide the estimation results for the two sides of the border between Germany and the Netherlands. The results show that the Germany side municipalities have non-negative growth relative to the centrally located municipalities during the sample periods. The results also show that, these municipalities have had significantly higher growth rate following the EU1993, EMU1999 and the EURO2002 integration shocks. Columns (5) and (6) present the results for the two Germany borders, one bordering the Netherlands and the other bordering France. The negative border coefficients in column (6) show that the Germany municipalities bordering France have lower growth rates than the municipalities bordering the Netherlands which have significantly higher growth rate even without the late integration shocks. However, both groups of the municipalities have significantly higher growth following the EU1993, EMU1999 and the EURO2002 integration shocks.

Table 4.4: Direct integration effects on population growth; baseline estimates

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) Bordering Netherlands	(6) Bordering France
EC1967	$border_a$	na	na	-0.389 (0.344)	-0.477 (0.316)	na	na
	$border_a \times integration_{at}$	na	na	0.749 (0.518)	0.660* (0.372)	na	na
EU1993	$border_a$	na	na	0.170 (0.441)	-0.0826 (0.177)	0.0541 (0.0715)	-0.0792 (0.0915)
	$border_a \times integration_{at}$	na	na	0.243 (0.614)	0.513 (0.431)	0.370*** (0.0808)	0.216** (0.103)
EMU1999	$border_a$	-0.389*** (0.0700)	0.0631 (0.0771)	0.363 (0.403)	-0.00136 (0.171)	0.160*** (0.0561)	-0.0383 (0.0695)
	$border_a \times integration_{at}$	0.0541 (0.0760)	-0.167** (0.0807)	-0.643 (0.468)	0.424 (0.569)	0.267*** (0.0686)	0.222** (0.0896)
EURO2002	$border_a$	-0.396*** (0.0467)	0.0267 (0.0484)	0.295 (0.378)	0.0928 (0.179)	0.191*** (0.0507)	-0.0261 (0.0621)
	$border_a \times integration_{at}$	0.0706 (0.0570)	-0.143*** (0.0547)	-0.396 (0.472)	-0.0846 (0.618)	0.244*** (0.0618)	0.272*** (0.0921)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	Observations	4,023	3,995	14,132	16,493	8,336	7,930
	R-Squared[40]	0.455	0.499	0.036	0.040	0.076	0.075

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = the data are not available (or not sufficient) to estimate for this shock.

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[40] Observations, and R-squared are comparable over the different regression results using different integration shocks.

Table 4.5 gives the estimates of the indirect EU integration effects. The indirect integration effects are positive and more significant for the sample border municipalities that are geographically closer to the countries joining EU following a specific integration shock. We defined the EC1973, EC1986, EU1995 and EU2004 as indirect integration shocks since they did not directly involve the sample borders. Columns (1) and (2) give the results for the two Belgian borders. The municipalities bordering France have significantly lower growth rate for longer duration than the municipalities bordering the Netherlands. Following the indirect integration shock of EU2004 the municipalities bordering France have had non-negative growth relative to centrally located municipalities whereas the municipalities bordering the Netherlands have significantly lower growth rates than more central locations.

Columns (2) and (3) provide the estimates for the two sides of the Netherlands-Belgium border. The results show that, compared to municipalities on the Belgium side, the municipalities on the Netherlands side have mostly non-negative growth rates. Columns (3) and (4) compare the two border groups of the Netherlands municipalities. The municipalities bordering Germany have in general lower growth rates for longer duration of the sample period and benefit more from the all the indirect integration shocks EC1973, EC1986, EU1995, EU2004 compared to the municipalities bordering Belgium. This may be because the Netherlands-Belgium border municipalities have been more integrated due to language similarities. Columns (4) and (5) show the estimates for the two sides of the Netherlands-Germany border. The Netherlands side municipalities gain more following the EC1986, whereas the German municipalities gain significantly higher growth rate following the later integration shocks of EU1995 and EU2004. Germany is geographically closer to these countries than The Netherlands. Columns (5) and (6) give the results for the two Germany sample borders. The municipalities bordering France have relatively lower growth rates throughout the sample period and gain significantly following all the integration shocks and gain more than the municipalities bordering the Netherlands following EC1986.

Table 4.5: Indirect integration effects on population growth; baseline estimates

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) bordering Netherlands	(6) bordering France
EC1973	$border_r$	na	na	0.958 (1.105)	− 0.414* (0.233)	na	na
	$border_a \times integration_{at}$	na	na	− 0.952 (1.131)	0.661** (0.319)	na	na
EC1986	$border_a$	na	na	0.0464 (0.533)	− 0.322* (0.169)	0.106 (0.109)	− 0.254* (0.139)
	$border_a \times integration_{at}$	na	na	0.427 (0.646)	0.857** (0.359)	0.183 (0.116)	0.388*** (0.147)
EU1995	$border_a$	− 0.341*** (0.0275)	− 0.0850*** (0.0227)	0.151 (0.415)	− 0.0823 (0.168)	0.0844 (0.0646)	− 0.0441 (0.0829)
	$border_a \times integration_{at}$	---	---	0.352 (0.646)	0.589 (0.480)	0.357*** (0.0759)	0.167* (0.0964)
EU2004	$border_a$	− 0.396*** (0.0467)	0.0267 (0.0484)	0.304 (0.365)	0.0587 (0.172)	0.215*** (0.0472)	− 0.00292 (0.0581)
	$border_a \times integration_{at}$	0.0706 (0.0570)	− 0.143*** (0.0547)	− 0.639 (0.426)	0.239 (0.846)	0.191*** (0.0633)	0.233** (0.104)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	Observations	4,023	3,995	14,132	16,493	8,336	7,930
	R-Squared	0.455	0.499	0.036	0.040	0.076	0.075

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = the data are not available (or not sufficient) to estimate for this shock. --- the interaction term between the border and the integrations shock of EU1995 drops due to multicollinearity.

4.6.2. Densely populated and less populated municipalities

Next we differentiate between small and large municipalities based on population density to make the comparison among more similar and comparable groups of municipalities for two major reasons. First, different size municipalities may be affected by the integration shocks differently (see Chapter Three). Second, the difference-in-difference approach is more efficient when applied to more comparable control and treatment groups of units. In Chapter Three, we found that larger border cities benefit from the positive integration effects more than small cities. Note, that we use municipalities instead of cities. Municipality includes rural areas and may consist of more than one cities or towns.

We distinguish small from large municipalities in two ways. First using total population size as in Chapter Three. Small municipalities are the ones with total population of less than median national population and large municipalities are the municipalities with population larger than median population. In addition, we distinguish large from small municipalities based on

population *density*. Low density municipalities have a population density less than national median and high density municipalities have a density that is higher than national median density.

Table 4.6: Direct integration effects on population growth; low density municipalities

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) Bordering Netherlands	(6) Bordering France
EC1967	$border_a$	na	na	− 0.428 (0.987)	− 0.496 (0.888)	na	na
	$border_a \times integration_{at}$	na	na	0.499 (1.128)	0.590 (0.936)	na	na
EU1993	$border_a$	na	na	0.148 (0.656)	− 0.101 (0.322)	0.00327 (0.107)	0.106 (0.149)
	$border_a \times integration_{at}$	na	na	− 0.470 (0.886)	0.390 (0.637)	0.510*** (0.121)	0.0635 (0.167)
EMU1999	$border_a$	− 0.505*** (0.0906)	− 0.00198 (0.126)	0.0548 (0.590)	− 0.0149 (0.310)	0.102 (0.0831)	0.0714 (0.112)
	$border_a \times integration_{at}$	0.0899 (0.0989)	− 0.163 (0.132)	− 0.276 (0.724)	0.193 (0.724)	0.532*** (0.0980)	0.223 (0.149)
EURO2002	$border_a$	− 0.488*** (0.0599)	− 0.0600 (0.0785)	− 0.0350 (0.556)	0.0880 (0.318)	0.146** (0.0742)	0.0675 (0.100)
	$border_a \times integration_{at}$	0.0802 (0.0743)	− 0.112 (0.0890)	0.351 (0.692)	− 0.520 (0.449)	0.590*** (0.0891)	0.355** (0.152)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	sample municipalities	low density	low density	low density	low density	low density	low density
	Observations	2,070	1,710	6,117	7,488	3,558	3,390
	R-Squared	0.483	0.529	0.034	0.034	0.129	0.127

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = data not available (or not sufficient) to estimate for this shock.

   A problem with the population size criterion is that a municipality can consist of two or more small cities. Also, a small municipality can consist of only one large city. Therefore, we prefer the second criterion. Tables 4.6 and 4.7 give the results of the direct integration effects for the low density and high density municipalities, respectively. These results are in general consistent with the findings in Chapter Three. The high density Belgian municipalities bordering France gain more than low density municipalities following the EMU1999 [or EURO2002] (see column (1) in both tables (4.6) and (4.7)). This loss in growth is higher and more significant for high density municipalities than less dense municipalities. The highly dense Netherlands municipalities bordering Belgium gain more following the EC1967 and EU1993 and experience significantly lower growth following the EMU1999 [or EURO2002] compared to less dense municipalities (see column (3)). Comparing column (1) of tables (4.6) and (4.7), the high density municipalities of the Netherlands bordering Germany gain higher growth than less dense

municipalities following all the direct integration shocks. The results for the Germany municipalities are the opposite. Less dense municipalities of both sample borders generally gain significantly higher following the latest three direct integration as opposed to the high density municipalities who gained growth significantly only from the EU1993 integration shock (see columns (5) and (6)). This shows that both criteria of dividing between the municipalities do not change the results.

The effects of the indirect integration shocks are basically the same with the direct integration shocks for all the sample borders except the result of the EC1986 integration shock for Germany municipalities bordering France (see tables (4.8) and (4.9)). Column (6) shows that on the contrary to the direct integration shocks, the high dense municipalities gain significantly higher compared to the less dense municipalities in this border location following this indirect integration shock.

Table 4.7: Direct integration effects on population growth; high density municipalities

Integration shock	Belgium		The Netherlands		Germany	
	(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) Bordering Netherlands	(6) Bordering France
EC1967 $border_a$	na	na	-0.865^{***} (0.207)	-0.594^{***} (0.195)	na	na
$border_a \times integration_{at}$	na	na	1.205^{***} (0.418)	0.609^{*} (0.320)	na	na
EU1993 $border_a$	na	na	-0.304^{***} (0.117)	-0.275^{*} (0.153)	0.0978 (0.115)	-0.0992 (0.121)
$border_a \times integration_{at}$	na	na	1.504 (0.934)	0.652 (0.622)	0.294^{**} (0.125)	0.271^{**} (0.133)
EMU1999 $border_a$	-0.444^{***} (0.0953)	0.126 (0.0918)	0.375 (0.404)	-0.236^{*} (0.135)	0.222^{**} (0.0876)	0.00314 (0.0909)
$border_a \times integration_{at}$	0.0951 (0.105)	-0.178^{*} (0.0964)	-0.827^{*} (0.451)	0.848 (0.960)	0.0717 (0.103)	0.110 (0.112)
EURO2002 $border_a$	-0.491^{***} (0.0629)	0.102^{*} (0.0581)	0.327 (0.377)	-0.188 (0.135)	0.251^{***} (0.0786)	0.0256 (0.0809)
$border_a \times integration_{at}$	0.169^{**} (0.0797)	-0.173^{***} (0.0661)	-0.826^{*} (0.458)	0.875 (1.324)	-0.0387 (0.0904)	0.0522 (0.114)
Year effects	yes	yes	yes	yes	yes	yes
Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
Sample municipalities	high density	high density	high density	high density	high density	high density
Observations	1,953	2,285	8,015	9,005	4,778	4,540
R-Squared	0.462	0.497	0.133	0.112	0.067	0.067

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = data not available (or not sufficient) to estimate for this shock.

The abolition of border barriers triggers relocation of people and firms to the locations that have higher market access following the integration shocks, in this case the border municipalities. In the case of Redding and Sturm (2008) and in Chapter Three, the samples cover all the areas

that are affected by the integration shock (and not only the sample countries in this chapter). To check for this we estimated the baseline model using *population share growth*; and the results generally remain the same with the results from the actual population growth.

We also carried out a number of additional robustness checks:

(i) we checked whether the positive border effects, exist in all peripheral municipalities or only those who have land borders with another country benefits from the abolition of the borders. We test for the existence of positive effects in any peripheral municipalities by looking at coastal municipalities. The coastal municipalities border with the sea and have no immediate market access on the other side of the border. We re-estimated the baseline model by substituting *'border'* by *'coast'*. The estimated coefficient for the interaction between the *'coast'* and *'integration'* is always negative for both Belgium and the Netherlands. It is negative and significant for Belgium throughout the sample period, and negative and statistically significant for the Netherlands during 1990s and generally negative, but insignificant, throughout the rest of the sample period. These municipalities have been growing slower than the rest of the municipalities and compared to their own earlier growth. This implies the normal land borders with other countries are more attractive to people than the coastal municipalities following the integration. The border coefficient shows that the Germany coastal municipalities have significantly lower growth throughout the sample period compared to the rest of Germany. However, although they are growing slower than the rest of the country, the Germany coastal municipalities have been growing significantly faster since 1990 to the end of the sample period compared to their own earlier growth. This could be due to Germany's geographical proximity to many East European countries who joined EU in 2004. See section 4.7 below for more discussion about the possible relation of this with immigration from the East European countries. Moreover, these municipalities are large and they potentially have good economic opportunities for people since they have borders with some major sea ports.

(ii) We re-estimate the regression model by using standard errors clustered by the municipalities to check whether the results change. The results generally remain the same. We also estimated a fixed effect model and tested for the validity of the pooled OLS model. Again, the results from the fixed effect model are generally the same; and the tests do not support the hypothesis that the fixed effect model is better than the pooled OLS model. We also looked at the standard errors to check for existence of patterns over time and between groups. The error terms of a valid estimation model should not have pattern over time and between the control and the treatment groups. The distribution of the errors terms from both heteroscedasticity robust error terms and the error terms clustered by municipality are fairly randomly distributed between the groups and over time. The distribution is not affected due to changing the integration points as well as for changing the dependent variable between absolute population growth and the population share growth. An example of the result is given in Figure 4A.1 (see in the appendices) for the Dutch municipalities with respect to the two border treatment groups, bordering Belgium and bordering Germany.

(iii) Finally, we checked whether the length of the sample period has a significant influence on the results. The data for the Netherlands cover from 1960 to 2009; whereas the

Germany and Belgium data cover from 1976 to 2007 and from 1990 to 2010, respectively. We now take common periods only. The results for the common periods are given in tables 4A.7, 4A.8, 4A.9 and 4A.10 (see the appendices). The results of asymmetric border effects basically remain consistent.

4.7.   Extensions and evaluations

This chapter, due to data limitations does not cover all of the EU. Thus, the integration effects should not necessarily come from the sample area itself; and some locations within the sample should not necessarily grow at slower rate. To control for this we estimate for the common integration effects of both the control (non-border regions) and treatment (border regions) groups separately. This gives us information on whether non-border municipalities have experienced positive direct and/or indirect integration effects too and if so whether this is the case at early stages or later during the sample periods. In this case equation (4.2) becomes:

$$ popgrowth_{a,t-1,t} = \beta\, border_a + \eta\, integratio\ n_{a,t+s} + \gamma \big(border_a \times integratio\ n_{a,t+s}\big) + D_t + \varepsilon_{at}. \qquad (4.3) $$

One of the benefits of this specification is that although the time dummies control for the common effects of the integration shock itself (see Redding and Sturm, 2008), it helps to estimate for common direct and indirect effects especially when the integration effects on the border municipalities alone is not visible. This also helps us to know whether the positive significant gains by borders are relative to their earlier growth alone or relative to central locations or both. As opposed to the full set of time dummies which captures unspecific but general common shocks, η helps us to capture common effects to both the control and treatment groups, but of specific integration policy shocks. Since we do not have data on the origin and destination of people, the comparison between the common integration η and the interaction term γ helps to evaluate as to whether people move to the border locations or the vice versa during specific periods following an integration shock. Adding this common integration term does not affect our results presented in the previous section. The results are given in the appendix (see tables 4A.1 and 4A.2 for direct and indirect integration shocks, respectively).

Also the timing of integration effects can be an issue; some shocks might be anticipated, and for some the results might take time. We account for this by using time $t = t + s$; where $s \in (-k, k)$ and k is a positive integer and $t + s \in (t_0, t_f)$ where t_0 is the start and t_f is the end of observations in the sample.   Here we assume that a specific integration shock may have anticipated as well as lagged integration effects. We estimate equation (3) several times by changing the time of the integration effect as if it happens every year. Since the data are missing for the beginning of the earliest active integration shock during 1950s for the Netherlands data, we introduce the first possible integration shock in 1965, a few years after the start of the data and the same applies to Belgium and Germany. This is based on the assumption of anticipated or lagging integration effect and keeping the integration dummy from the start of the data (i.e., *integration*$_{at}$ =1 from the start) is, technically, not possible since (*border*$_a$) and (*borderr* $\times$ *integration*$_{at}$) are

exactly the same. The estimation results for the six groups of the border municipalities are summarized and given by figures 4.1, 4.2 and 4.3. The graphs[41] plot the estimated coefficients, β, η and γ. The dotted line in each figure represents the estimated values of the border coefficient β; the dashed line plots the estimated coefficient of the common integration term η; and the coefficient of the interaction between the border and the integration γ is represented by the solid line. The circular dots overlapping any of these curves represent statistical significance of the estimates.

The left panel of figure 4.1 shows the results for the Netherlands municipalities bordering Germany. The border coefficient remains negative for most of the sample period until the early 2000s. The difference between the growth of the border and non-border municipalities has been continuously declining. The population growth with respect to the interaction between border and integration γ remains higher until early 2000s compared to the average growth including the non-border municipalities η. The integration effect on this border municipalities remain positive significant from the earlier periods till around the end of 1980s. This result is well in line with limited duration of integration effects found by Redding and Sturm (2008) and Chapter Three of this thesis. The later integration shocks have insignificant effects and thus the population growth of the border municipalities are declining lately compared to the non-border municipalities and their own earlier growth. The positive integration effects were much quicker for the Netherlands municipalities bordering Belgium (the right panel of figure 4.1). However, the interaction coefficient shows that the decline for this group of municipalities is bigger over recent periods compared to non-border municipalities and to their own earlier growth. The common integration effect remains consistently positive and significant especially around major integration shocks of the EC1986, EU1993, and EU2004 EU expansion to the East European countries.

Figure 4.1: Dutch (border) municipalities
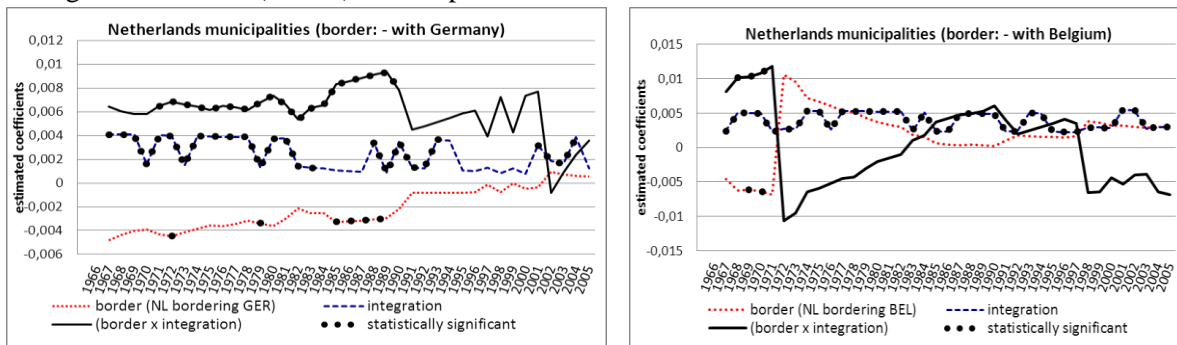
Note: #,## (Dutch style decimals) are the same as #.## (international style).

The German municipalities' data only start in 1976 and we could not look at pre-1980 integration effect. Compared to the Netherlands side of the German-Netherlands border, the German side border municipalities have non-negative growth but insignificant for most of the sample period compared to non-border municipalities (see figure 4.2). The interaction between the

[41] The graphs show several estimate coefficients by moving the integration point over time as the estimate tables are together too big to report here. The estimates tables are either given in the appendices or can be provided up on request.

border and the integration is positive and significant specially starting from mid-1980s through the end of the sample period. Since late 1990s these border municipalities have positive significant and higher growth than the non-border municipalities. In contrast to this, the German municipalities bordering France have negative growth throughout the sample period compared the non-border municipalities. However, the interaction between the border and integration shows that they have been growing significantly faster following a number of direct and indirect integration shocks compared the non-borders and their own earlier growth. The estimates of the common integration coefficient η show that centrally located German municipalities have been growing significantly slower than the municipalities bordering both the Netherlands and France. This shows that the German border municipalities seem to cease to be disadvantaged peripheries in terms of population growth, at least during the sample period (i.e., no more negative border effects).

Figure 4.2: German (border) municipalities
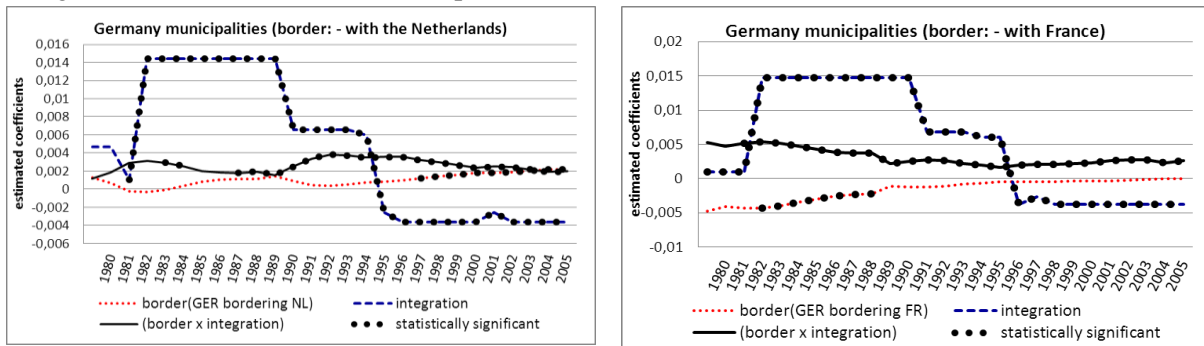
Note: #,## (Dutch style decimals) are the same as #.## (international style).

The fact that the positive significant integration effects last throughout the sample period for German border municipalities shows that these effects are lasting for more than 50 years contrary to the earlier findings of 30 to 40 years by Redding and Sturm (2008) and in Chapter Three. This can be explained by indirect effects of later integration shocks which opened the Eastern Germany borders to the East European countries. One of the reasons why the municipalities bordering with the Netherlands and France are more attractive than the non-border municipalities could be the fact that the municipalities in the western borders have big cities that are within shorter distances of one another compared to central Germany. Moreover, they are more attractive as they are geographically closer to the high income neighboring countries with high market potential on its west borders.

Belgian municipalities bordering France have significantly lower growth than non-border municipalities whereas the municipalities bordering the Netherlands have positive growth for most of the sample period, though insignificant, compared to non-border municipalities (see figure 4.3). The interaction between the border and the integration is insignificant for the municipalities bordering France whereas it is negative significant for the municipalities bordering the Netherlands showing recent years declines in population growth compared to non-border municipalities and their own earlier growth. The common integration effects are positive and

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significant throughout the sample period showing that centrally located municipalities have grown faster since late 1990s.

Figure 4.3: Belgian (border) municipalities
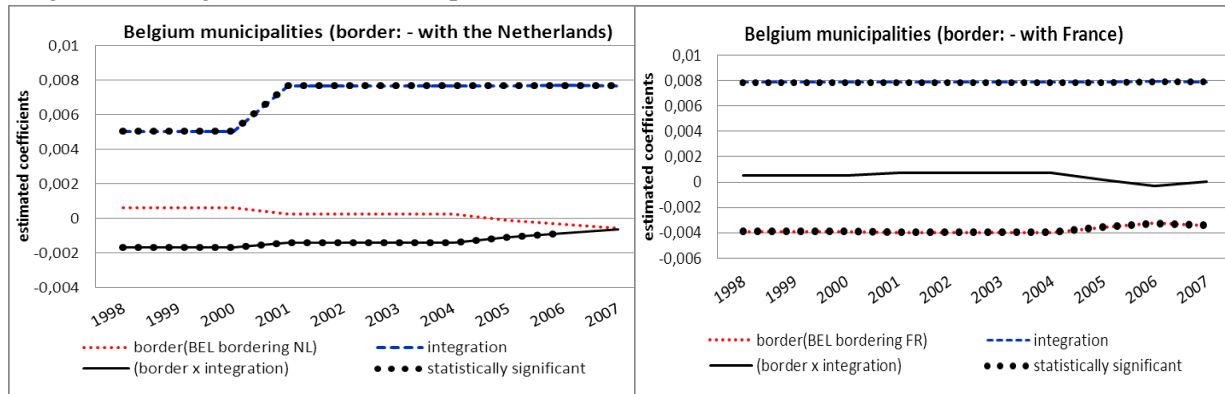
Note: #,## (Dutch style decimals) are the same as #.## (international style).

In summary, all the six different treatment groups of border municipalities have different types of growth over the time periods covered by the sample. The Netherlands border municipalities have grown significantly faster than the non-border municipalities earlier and declining recently. Centrally located municipalities of the Netherlands and Belgium have been growing faster than before and faster than border municipalities during the most recent times of the sample periods. However, it is the reverse in Germany. Germany border municipalities have been growing faster than centrally located municipalities throughout the sample periods. From this analysis we have learned that German border municipalities are affected by the integration shocks more than Belgium and the Netherlands municipalities. The use of the concept of anticipated and lagged integration effects and using integration shocks every year shows us the limitations of the difference-in-differences (DID) approach in testing for policy impacts. This is because the significant effects of the integration are not limited to the years of the actual integration shocks. Moreover, it is difficult to distinguish between the effects of different integration shocks especially when they are within only few years of each other.

The third and final extension is to test for structural breaks. We use the method suggested by Baum et al. (1999) as well as the method by Bai and Perron (1998, 2003) to locate breaks (if any). The former identifies two breaks at a time whereas the later identifies all possible breaks and suggests the optimal number of breaks. The Bai and Perron (1998, 2003) method identifies all possible breaks ($M=1$, $M=2$, ... , $M=n$); and the optimal number of breaks is the one with the smallest Bayesian information criterion (BIC) given that there is at least a break ($M \geq 1$). The results are summarized in table 4.8. The details and choices of the optimal breaks are given in the appendix (table 4A.11). In both approaches the earliest breaks of the late 1960s in the population growth of the Netherlands bordering municipalities Germany as well as Belgium are the only significant breaks. These breaks can be associated with the formation of a bigger European Communities (EC) combining ECSC, EEC, and EURATOM in 1967. The slight deviation of the

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detected break points are likely due to the lags in response of the business and consumers to the policy shock.

The data for Belgium cover only 1990 to 2010 and we do not find any break during the sample period covered by the data in either of the population growth or population share growth. It could be due to short period of time of the sample coverage that we could not detect the breaks. With the first approach we identify four major breaks in the German municipalities' population growth and all of them are statistically significant. The break points are six for both Germany borders when we use the Bai and Perron (1998, 2003). This is likely due to the fact that all data are used in identifying the break (i.e. there is not exclusion as in the first approach). There are three optimal breaks for the sample bordering the Netherlands and two optimal breaks for those bordering France. All of them are statistically significant.

Table 4.8: Structural break test in population growth

Country	bordering with	Maximum identified breaks	optimal breaks	significant breaks
(a) Baum, Barkoulas and Caglayan (1999) approach				
Belgium	the Netherlands	none	n.a.	--
	France	none	n.a.	--
Germany	the Netherlands	1986, 1995, 1998, 2002	n.a.	all
	France	1991, 1995, 1998, 2002	n.a.	all
The	Germany	1970, 1983, 1999, 2002, 2005	n.a.	1970
Netherlands	Belgium	1969, 1988, 1995, 1998, 2001, 2003	n.a.	1969
(b) Bai and Perron (1998, 2003) approach[42]				
	bordering with	Max. identified breaks	optimal breaks	significant breaks
Belgium	the Netherlands	none	---	--
	France	none	---	--
Germany	the Netherlands	1981, 1985, 1989, 1993, 1997, 2003	1989, 1993, 2003	all
	France	1980, 1985, 1989, 1993, 1997, 2003	1987, 1994	all
The	Germany	1967, 1974, 1984, 1991, 2001	1991	1967
Netherlands	Belgium	1968, 1975, 1982, 1989, 1997	1973	1968

n.a. = does not apply

The search for the break points show that the sample countries have experienced different types of effects. The breaks following the policy adoptions are significant for the Netherlands only during early stages whereas it is significant throughout for Germany municipalities bordering the Netherlands as well as those bordering France. It also reveals that the breaks either coincide with the policy shocks or within the vicinity of the year of the actual policy shocks. For instance, the formation of the European single free market in 1993 was the likely source of the 1993 break in Germany bordering with the Netherlands and 1994 (one year later) break in those bordering France. Due to anticipation effects or lagging effects people and business may relocate a year or two prior to or a year or two later than a given actual policy implementation leading to different break points than the actual year of the policy implementation (see table 4.9 for summary of the closest breaks with the specific integration shocks). For instance, the EU expansion as well as the adoption of the Schengen visa area in 1995 are the most likely causes of the breaks in the same

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[42] See table 4A.11 for the whole list of breaks and choice of the optimal breaks. Moreover table 4A.12 in the appendix gives the summary and test statistics of the optimal break points.

year or in 1997 (two years later) in both Germany borders (see table 4.8). The closest break points from the alternative approaches are used in the summary, table 4.9. Identifying the exact and specific sources of each change requires more detailed data; and we would like to address this in our future works.

Table 4.9: EU integration shocks and breaks in border population growth

| Integration shocks | Closest/associated break points | | | |
| | the Netherlands | | Germany bordering | |
	Belgium	Germany	the Netherlands	France
EC1967	1968	1967	n.d.	n.d.
EC1973	1975	1974	n.d.	n.d.
EC1986	1988	1984	1986	1987
EU1993	1995	1991	1993	1993
EU/Schengen1995	1995	---	1995	1995
EMU1999	2001	1999	1998	1998
EURO2002	2003	2002	2002	2002
EU2004	2003	2005	2003	2003

Note: n.d. = no sufficient data for the period. There are insufficient data during the 1950s and after 2007 to find breaks around these integration shocks; and no breaks identified for Belgium due to limited time dimension of the data

4.8. Conclusions

Various natural or policy induced shocks may change regional development paths either temporarily or permanently. In this chapter we analyze the population effects of EU integration using the same methodology as Redding and Sturm (2008) and in Chapter Three while using a more detailed and extensive data set for Belgian, German and Dutch municipalities to analyze the impact of EU integration on border and non-border municipalities. Compared to previous studies as well as Chapter Three, in this chapter we include asymmetric effects of the EU integration and allow for the existence of indirect integration effects. Consistent with our finding of border asymmetry in chapter two, we find that the population of the border municipalities of Belgium and the Netherlands have grown relatively faster than non-border municipalities, but only so for a limited period of time following the earliest integration shocks. However, the German border municipalities have had significantly higher growth than centrally located municipalities throughout the sample period. This means that the disproportionate growth effects on the German border municipalities have lasted for longer periods than the Belgium and the Netherlands counterparts. This might partly be due to Germany's geographical proximity to immigrants from the new EU members. By allowing for indirect integration effects we find that the integration effects last longer than predicted in previous studies on the border effects of (EU) integration. Our results also show that different countries borders and even different borders of the same country bordering different countries are affected differently, that is to say we find evidence to support the notion of asymmetric border effects. Separating the integration effects from other factors such as diminishing effects of war in the border area is a potential area for future research. Another area of extension in future research on this topic can be determining whether the cause of asymmetric effect are geographical factors such as hinterland effects or historical path differences in socio-economic factors.

4.9. Appendices

The results in the appendices provide extra information (also discussed in the main body of the chapter). For instance, we separate between integration ($integration_{at}$) in general and integration in the border ($border_a \times integration_{at}$). The results from table 4A.1, for instance, show that the integration effect was stronger in the central Germany in 1990s, but stronger in the borders later in time(see column (5) and (6).

Table 4A.1: Direct integration effects on population growth; baseline estimates with common integration

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) Bordering Netherlands	(6) Bordering France
EC1967	$border_a$	na	na	− 0.389 (0.344)	− 0.477 (0.316)	na	na
	$integration_{at}$	na	na	1.686 (1.117)	0.487 (0.320)	na	na
	$border_a \times integration_{at}$	na	na	0.749 (0.518)	0.660* (0.372)	na	na
EU1993	$border_a$	na	na	0.170 (0.441)	− 0.0826 (0.177)	0.0541 (0.0715)	− 0.0792 (0.0915)
	$integration_{at}$	na	na	0.502*** (0.147)	0.365** (0.144)	0.653*** (0.0608)	0.682*** (0.0632)
	$border_a \times integration_{at}$	na	na	0.243 (0.614)	0.513 (0.431)	0.370*** (0.0808)	0.216** (0.103)
EMU1999	$border_a$	− 0.389*** (0.0700)	0.0631 (0.0771)	0.363 (0.403)	− 0.00136 (0.171)	0.160*** (0.0561)	− 0.0383 (0.0695)
	$integration_{at}$	0.786*** (0.0391)	0.504*** (0.0255)	0.293*** (0.0565)	0.121 (0.101)	− 0.361*** (0.0341)	− 0.373*** (0.0367)
	$border_a \times integration_{at}$	0.0541 (0.0760)	− 0.167** (0.0807)	− 0.643 (0.468)	0.424 (0.569)	0.267*** (0.0686)	0.222** (0.0896)
EURO2002	$border_a$	− 0.396*** (0.0467)	0.0267 (0.0484)	0.295 (0.378)	0.0928 (0.179)	0.191*** (0.0507)	− 0.0261 (0.0621)
	$integration_{at}$	0.784*** (0.0392)	0.768*** (0.0384)	0.545*** (0.145)	0.187* (0.107)	− 0.361*** (0.0342)	− 0.267*** (0.0429)
	$border_a \times integration_{at}$	0.0706 (0.0570)	− 0.143*** (0.0547)	− 0.396 (0.472)	− 0.0846 (0.618)	0.244*** (0.0618)	0.272*** (0.0921)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	Observations	4,023	3,995	14,132	16,493	8,336	7,930
	R-Squared[43]	0.455	0.499	0.036	0.040	0.076	0.075

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = the data are not available (or not sufficient) to estimate for this shock.

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[43] Observations, and R-squared are the same over the different regression results using different integration shocks

Table 4A.2: Indirect integration effects on population growth; baseline estimates with common integration

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) bordering Netherlands	(6) bordering France
EC1973	$border_a$	na	na	0.958 (1.105)	− 0.414* (0.233)	na	na
	$integration_{at}$	na	na	0.269** (0.0563)	0.149** (0.0598)	na	na
	$border_a \times integration_{at}$	na	na	− 0.952 (1.131)	0.661** (0.319)	na	na
EC1986	$border_a$	na	na	0.0464 (0.533)	− 0.322* (0.169)	0.106 (0.109)	− 0.254* (0.139)
	$integration_{at}$	na	na	0.231** (0.0612)	0.102 (0.0717)	1.441*** (0.0950)	1.474*** (0.0994)
	$border_a \times integration_{at}$	na	na	0.427 (0.646)	0.857** (0.359)	0.183 (0.116)	0.388*** (0.147)
EU1995	$border_a$	− 0.341*** (0.0275)	− 0.0850*** (0.0227)	0.151 (0.415)	− 0.0823 (0.168)	0.0844 (0.0646)	− 0.0441 (0.0829)
	$integration_{at}$	0.787*** (0.0389)	0.762*** (0.0382)	0.228** (0.0672)	0.107 (0.0880)	− 0.258*** (0.0407)	0.607*** (0.137)
	$border_a \times integration_{at}$	---	---	0.352 (0.646)	0.589 (0.480)	0.357*** (0.0759)	0.167* (0.0964)
EU2004	$border_a$	− 0.396*** (0.0467)	0.0267 (0.0484)	0.304 (0.365)	0.0587 (0.172)	0.215*** (0.0472)	− 0.00292 (0.0581)
	$integration_{at}$	0.784*** (0.0392)	0.768*** (0.0384)	0.298** (0.0561)	0.387** (0.188)	− 0.360*** (0.0343)	− 0.375*** (0.0365)
	$border_a \times integration_{at}$	0.0706 (0.0570)	− 0.143*** (0.0547)	− 0.639 (0.426)	0.239 (0.846)	0.191*** (0.0633)	0.233** (0.104)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	Observations	4,023	3,995	14,132	16,493	8,336	7,930
	R-Squared	0.455	0.499	0.036	0.040	0.076	0.075

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = data not available (or not sufficient) to estimate for this shock. The effects of integration are more common to all municipalities in smaller countries (see Belgium and the Netherlands) than specifically to the border locations which is the case in bigger country (see Germany), especially in later integrations. This generally holds both in the previous and below tables.

Table 4A.3: Direct integration effects on population growth; low density municipalities

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) Bordering Netherlands	(6) Bordering France
EC1967	$border_a$	na	na	-0.428 (0.987)	-0.496 (0.888)	na	na
	$integration_{at}$	na	na	0.155 (0.104)	0.0949 (0.101)	na	na
	$border_a \times integration_{at}$	na	na	0.499 (1.128)	0.590 (0.936)	na	na
EU1993	$border_a$	na	na	0.148 (0.656)	-0.101 (0.322)	0.00327 (0.107)	0.106 (0.149)
	$integration_{at}$	na	na	0.208** (0.105)	0.0517 (0.145)	0.987*** (0.102)	0.972*** (0.105)
	$border_a \times integration_{at}$	na	na	-0.470 (0.886)	0.390 (0.637)	0.510*** (0.121)	0.0635 (0.167)
EMU1999	$border_a$	-0.505*** (0.0906)	-0.0020 (0.126)	0.0548 (0.590)	-0.0149 (0.310)	0.102 (0.0831)	0.0714 (0.112)
	$integration_{at}$	0.825*** (0.0609)	0.788*** (0.0664)	0.191** (0.0946)	0.0669 (0.158)	-0.583*** (0.0487)	0.272*** (0.0782)
	$border_a \times integration_{at}$	0.0899 (0.0989)	-0.163 (0.132)	-0.276 (0.724)	0.193 (0.724)	0.532*** (0.0980)	0.223 (0.149)
EURO2002	$border_a$	-0.488*** (0.0599)	-0.0600 (0.0785)	-0.0350 (0.556)	0.0880 (0.318)	0.146** (0.0742)	0.0675 (0.100)
	$integration_{at}$	0.822*** (0.0612)	0.789*** (0.0666)	0.124 (0.0946)	0.211** (0.102)	-0.586*** (0.0488)	-0.619*** (0.0492)
	$border_a \times integration_{at}$	0.0802 (0.0743)	-0.112 (0.0890)	0.351 (0.692)	-0.520 (0.449)	0.590*** (0.0891)	0.355** (0.152)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	sample municipalities	low density	low density	low density	low density	low density	low density
	Observations	2,070	1,710	6,117	7,488	3,558	3,390
	R-Squared	0.483	0.529	0.034	0.034	0.129	0.127

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = data not available (or not sufficient) to estimate for this shock.

Table 4A.4: Direct integration effects on population growth; high density municipalities

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) Bordering Netherlands	(6) Bordering France
EC1967	$border_a$	na	na	− 0.865*** (0.207)	− 0.594*** (0.195)	na	na
	$integration_{at}$	na	na	0.776*** (0.232)	0.246*** (0.0735)	na	na
	$border_a \times integration_{at}$	na	na	1.205*** (0.418)	0.609* (0.320)	na	na
EU1993	$border_a$	na	na	− 0.304*** (0.117)	− 0.275* (0.153)	0.0978 (0.115)	− 0.0992 (0.121)
	$integration_{at}$	na	na	0.272*** (0.0908)	0.622*** (0.224)	0.431*** (0.0700)	0.490*** (0.0753)
	$border_a \times integration_{at}$	na	na	1.504 (0.934)	0.652 (0.622)	0.294** (0.125)	0.271** (0.133)
EMU1999	$border_a$	− 0.444*** (0.0953)	0.126 (0.0918)	0.375 (0.404)	− 0.236* (0.135)	0.222** (0.0876)	0.00314 (0.0909)
	$integration_{at}$	0.769*** (0.0488)	0.747*** (0.0449)	0.365*** (0.0735)	0.593** (0.243)	− 0.166*** (0.0424)	− 0.0548 (0.0509)
	$border_a \times integration_{at}$	0.0951 (0.105)	− 0.178* (0.0964)	− 0.827* (0.451)	0.848 (0.960)	0.0717 (0.103)	0.110 (0.112)
EURO2002	$border_a$	− 0.491*** (0.0629)	0.102* (0.0581)	0.327 (0.377)	− 0.188 (0.135)	0.251*** (0.0786)	0.0256 (0.0809)
	$integration_{at}$	0.766*** (0.0489)	0.751*** (0.0450)	0.367*** (0.0742)	0.166 (0.173)	− 0.163*** (0.0425)	− 0.0522 (0.0511)
	$border_a \times integration_{at}$	0.169** (0.0797)	− 0.173*** (0.0661)	− 0.826* (0.458)	0.875 (1.324)	− 0.0387 (0.0904)	0.0522 (0.114)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	Observations	high density	high density	high density	high density	high density	high density
	R-Squared	1,953	2,285	8,015	9,005	4,778	4,540
		0.462	0.497	0.133	0.112	0.067	0.067

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = data not available (or not sufficient) to estimate for this shock.

Table 4A.5: Indirect integration effects on population growth; low density municipalities

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) bordering Netherlands	(6) bordering France
EC1973	$border_a$	na	na	1.884 (1.604)	-0.105 (0.502)	na	na
	$integration_{at}$	na	na	0.247*** (0.0904)	0.102 (0.106)	na	na
	$border_a \times integration_{at}$	na	na	-2.523 (1.645)	0.168 (0.603)	na	na
EC1986	$border_a$	na	na	-0.00738 (0.798)	-0.403 (0.339)	0.107 (0.148)	-0.00091 (0.181)
	$integration_{at}$	na	na	0.166* (0.0981)	-0.00467 (0.122)	1.622*** (0.0783)	1.703*** (0.0771)
	$border_a \times integration_{at}$	na	na	0.0305 (0.949)	0.907 (0.569)	0.213 (0.163)	0.193 (0.204)
EU1995	$border_a$	-0.425*** (0.0367)	-0.147*** (0.0371)	0.123 (0.618)	-0.102 (0.306)	0.0361 (0.0970)	0.0991 (0.132)
	$integration_{at}$	0.827*** (0.0606)	0.784*** (0.0662)	0.204* (0.117)	0.0380 (0.159)	1.210*** (0.286)	1.181*** (0.300)
	$border_a \times integration_{at}$	---	---	-0.451 (0.930)	0.453 (0.696)	0.515*** (0.112)	0.0894 (0.159)
EU2004	$border_a$	-0.488*** (0.0599)	-0.0600 (0.0785)	0.0146 (0.537)	0.0558 (0.305)	0.193*** (0.0703)	0.101 (0.0946)
	$integration_{at}$	0.822*** (0.0612)	0.789*** (0.0666)	0.173** (0.0865)	0.178 (0.109)	-0.586*** (0.0489)	-0.618*** (0.0492)
	$border_a \times integration_{at}$	0.0802 (0.0743)	-0.112 (0.0890)	-0.0960 (0.604)	-0.385 (0.504)	0.547*** (0.0924)	0.277 (0.170)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	sample	low density	low density	low density	low density	low density	low density
	Observations	2,070	1,710	6,117	7,488	3,558	3,390
	R-Squared	0.483	0.529	0.034	0.034	0.129	0.127

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = data not available (or not sufficient) to estimate for this shock.

Table 4A.6: Indirect integration effects on population growth; highly dense municipalities

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) bordering Netherlands	(6) bordering France
EC1973	$border_a$	na	na	-1.158^{***} (0.178)	-0.764^{***} (0.177)	na	na
	$integration_{at}$	na	na	0.305^{***} (0.0761)	0.227^{***} (0.0760)	na	na
	$border_a \times integration_{at}$	na	na	1.783^{***} (0.454)	0.940^{***} (0.342)	na	na
EC1986	$border_a$	na	na	-0.417^{***} (0.147)	-0.402^{***} (0.149)	0.136 (0.188)	-0.271 (0.195)
	$integration_{at}$	na	na	0.292^{***} (0.0815)	0.210^{**} (0.0863)	1.324^{***} (0.147)	1.324^{***} (0.154)
	$border_a \times integration_{at}$	na	na	1.274^{*} (0.660)	0.721 (0.466)	0.147 (0.195)	0.421^{**} (0.202)
EU1995	$border_a$	-0.359^{***} (0.0408)	-0.0319 (0.0279)	-0.279^{**} (0.110)	-0.279^{*} (0.145)	0.128 (0.103)	-0.0442 (0.109)
	$integration_{at}$	0.770^{***} (0.0487)	0.743^{***} (0.0448)	0.264^{***} (0.0959)	0.609^{***} (0.228)	0.172^{**} (0.0847)	0.206^{**} (0.0888)
	$border_a \times integration_{at}$	---	---	1.637 (1.066)	0.758 (0.703)	0.269^{**} (0.116)	0.185 (0.123)
EU2004	$border_a$	-0.491^{***} (0.0629)	0.102^{*} (0.0581)	0.290 (0.362)	-0.209 (0.130)	0.257^{***} (0.0729)	0.0334 (0.0753)
	$integration_{at}$	0.766^{***} (0.0489)	0.751^{***} (0.0450)	0.823^{***} (0.234)	0.520^{*} (0.311)	-0.0639 (0.0480)	-0.150^{***} (0.0474)
	$border_a \times integration_{at}$	0.169^{**} (0.0797)	-0.173^{***} (0.0661)	-0.779 (0.488)	1.421 (1.830)	-0.102 (0.0888)	0.0200 (0.127)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	sample	high density	high density	high density	high density	high density	high density
	Observations	1,953	2,285	8,015	9,005	4,778	4,540
	R-Squared	0.461	0.496	0.133	0.112	0.067	0.067

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; 'na' = data not available (or not sufficient) to estimate for this shock.

Table 4A.7: Direct integration effects; Netherlands and Germany common sample periods (1976 on ward)

Integration shock		The Netherlands		Germany	
		(1) bordering Belgium	(2) bordering Germany	(3) Bordering Netherlands	(4) Bordering France
EU1993	$border_a$	− 0.198 (0.313)	0.158 (0.262)	0.0541 (0.0715)	− 0.0792 (0.0915)
	$integration_{at}$	0.236*** (0.0638)	0.365** (0.144)	0.653*** (0.0608)	0.682*** (0.0632)
	$border_a \times integration_{at}$	0.610 (0.529)	0.272 (0.473)	0.370*** (0.0808)	0.216** (0.103)
EMU1999	$border_a$	0.211 (0.342)	0.230 (0.239)	0.160*** (0.0561)	− 0.0383 (0.0695)
	$integration_{at}$	0.560*** (0.144)	0.367** (0.157)	− 0.361*** (0.0341)	− 0.373*** (0.0367)
	$border_a \times integration_{at}$	− 0.491 (0.417)	0.192 (0.593)	0.267*** (0.0686)	0.222** (0.0896)
EURO2002	$border_a$	0.120 (0.311)	0.352 (0.248)	0.191*** (0.0507)	− 0.0261 (0.0621)
	$integration_{at}$	0.545*** (0.145)	0.434*** (0.161)	− 0.361*** (0.0342)	−0.267*** (0.0429)
	$border_a \times integration_{at}$	− 0.221 (0.421)	− 0.344 (0.641)	0.244*** (0.0618)	0.272*** (0.0921)
	Year effects	yes	yes	yes	yes
	Country	Netherlands	Netherlands	Germany	Germany
	Observations	9,790	11,387	8,336	7,930
	R-Squared	0.027	0.026	0.076	0.075

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4A.8: Indirect integration effects; Netherlands and Germany common sample periods

Integration shock		The Netherlands		Germany	
		(3) bordering Belgium	(4) bordering Germany	(5) bordering Netherlands	(6) bordering France
EC1986	$border_a$	− 0.759*** (0.222)	− 0.261 (0.244)	0.106 (0.109)	− 0.254* (0.139)
	$integration_{at}$	0.231*** (0.0612)	0.348** (0.139)	1.441*** (0.0950)	1.474*** (0.0994)
	$border_a \times integration_{at}$	1.232*** (0.427)	0.797** (0.400)	0.183 (0.116)	0.388*** (0.147)
EU1995	$border_a$	− 0.193 (0.281)	0.134 (0.238)	0.0844 (0.0646)	− 0.0441 (0.0829)
	$integration_{at}$	0.228*** (0.0672)	0.107 (0.0880)	− 0.258*** (0.0407)	0.607*** (0.137)
	$border_a \times integration_{at}$	0.696 (0.569)	0.373 (0.508)	0.357*** (0.0759)	0.167* (0.0964)
EU2004	$border_a$	0.143 (0.297)	0.283 (0.232)	0.215*** (0.0472)	− 0.00292 (0.0581)
	$integration_{at}$	0.565*** (0.145)	0.387** (0.188)	− 0.360*** (0.0343)	− 0.375*** (0.0365)
	$border_a \times integration_{at}$	− 0.478 (0.370)	0.0151 (0.860)	0.191*** (0.0633)	0.233** (0.104)
	Year effects	yes	yes	yes	yes
	Country	Netherlands	Netherlands	Germany	Germany
	Observations	9,790	11,387	8,336	7,930
	R-Squared	0.027	0.026	0.076	0.075

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4A.9: Direct integration effects; all sample countries common sample periods (1990 on ward)

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) Bordering Netherlands	(6) Bordering France
EMU1999	$border_a$	− 0.389*** (0.0700)	0.0631 (0.0771)	1.482* (0.846)	0.710 (0.532)	0.252*** (0.0654)	0.0733 (0.0671)
	$integration_{at}$	0.786*** (0.0391)	0.504*** (0.0255)	0.560*** (0.144)	0.367** (0.157)	− 0.257*** (0.0407)	− 0.264*** (0.0428)
	$border_a \times integration_{at}$	0.0541 (0.0760)	− 0.167** (0.0807)	−1.761** (0.879)	− 0.287 (0.760)	0.174** (0.0764)	0.110 (0.0876)
EURO2002	$border_a$	− 0.396*** (0.0467)	0.0267 (0.0484)	0.991 (0.663)	0.863* (0.491)	0.291*** (0.0547)	0.0698 (0.0560)
	$integration_{at}$	0.784*** (0.0392)	0.768*** (0.0384)	0.545*** (0.145)	0.187* (0.107)	− 0.361*** (0.0342)	− 0.376*** (0.0366)
	$border_a \times integration_{at}$	0.0706 (0.0570)	− 0.143*** (0.0547)	−1.091 (0.721)	− 0.855 (0.768)	0.145** (0.0652)	0.176** (0.0881)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	Observations	4,023	3,995	5,577	6,452	5,475	5,225
	R-Squared	0.455	0.499	0.026	0.024	0.214	0.210

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4A.10: Indirect integration effects; all sample countries common sample periods (1990 on ward)

Integration shock		Belgium		The Netherlands		Germany	
		(1) bordering France	(2) bordering Netherlands	(3) bordering Belgium	(4) bordering Germany	(5) bordering Netherlands	(6) bordering France
EU1995	$border_a$	− 0.341*** (0.0275)	− 0.0850*** (0.0227)	0.910 (0.964)	0.714 (0.714)	0.0721 (0.0835)	0.143 (0.0933)
	$integration_{at}$	0.787*** (0.0389)	0.762*** (0.0382)	0.494*** (0.149)	0.353** (0.149)	− 0.258*** (0.0407)	0.607*** (0.137)
	$border_a \times integration_{at}$	---	---	− 0.407 (1.084)	− 0.207 (0.843)	0.369*** (0.0925)	− 0.0204 (0.105)
EU2004	$border_a$	− 0.396*** (0.0467)	0.0267 (0.0484)	0.930 (0.590)	0.651 (0.426)	0.320*** (0.0481)	0.0995** (0.0507)
	$integration_{at}$	0.784*** (0.0392)	0.768*** (0.0384)	0.565*** (0.145)	0.387** (0.188)	− 0.360*** (0.0343)	− 0.375*** (0.0365)
	$border_a \times integration_{at}$	0.0706 (0.0570)	− 0.143*** (0.0547)	−1.265** (0.629)	− 0.353 (0.931)	0.0854 (0.0639)	0.131 (0.0999)
	Year effects	yes	yes	yes	yes	yes	yes
	Country	Belgium	Belgium	Netherlands	Netherlands	Germany	Germany
	Observations	4,023	3,995	5,577	6,452	5,475	5,225
	R-Squared	0.455	0.499	0.026	0.024	0.214	0.210

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 4A.11: Optimal break points (M +1 segments)

	Break Points	Break points (year) (a) Netherlands bordering Germany	BIC	Break points (year) (b) Netherlands bordering Belgium	BIC
Population growth	$M = 0$	---	-218.8785	--	-198.1164
	$M = 1$	1991	-214.9159	1973	-195.9676
	$M = 2$	1984, 1991	-210.2889	1968, 1975	-193.3849
	$M = 3$	1984, 1991, 2001,	-203.3084	1968, 1975, 2001	-186.9578
	$M = 4$	1974, 1984, 1991, 2001,	-196.2163	1968, 1975, 1989, 1997	-183.1390
	$M = 5$	1967, 1974, 1984, 1991, 2001,	-188.7173	1968, 1975, 1982, 1989, 1997	-175.9902
		(c) Germany bordering the Netherlands		(d) Germany bordering France	
	$M = 0$	---	-240.4691	---	-230.2624
	$M = 1$	1988	-251.7890	1987	-236.0828
	$M = 2$	1989, 1996	-269.6126	1987, 1994	-271.1989
	$M = 3$	1989, 1993,	-271.9714	1987, 1994,	-269.8490
	$M = 4$	1989, 1993, 1997, 2003	-271.3142	1985, 1989, 1993, 1997	-265.7883
	$M = 5$	1982, 1989, 1993, 1997, 2003	-267.5730	1985, 1989, 1993, 1997,	-261.8892
	$M = 6$	1981, 1985, 1989, 1993, 1997, 2003	-260.5748	1980, 1985, 1989, 1993, 1997,	-256.1860
		(e) Belgium bordering the Netherlands No break(too short data time periods)		(f) Belgium bordering France No break (too short data time periods)	
Population share growth		(a) Netherlands bordering Germany		(b) Netherlands bordering Belgium	
	$M = 0$	---	-219.5589	--	-202.0854
	$M = 1$	1991	-213.7800	1973	-197.1594
	$M = 2$	1984, 1991	-210.5929	1970, 1977	-195.8460
	$M = 3$	1970, 1984, 1991,	-203.3770	1970, 1977,	-189.1012
	$M = 4$	1970, 1984, 1991, 2001,	-196.0288	1970, 1977, 1989,	-185.3903
	$M = 5$	1970, 1977, 1984, 1991, 2001	-188.4600	1968, 1975, 1982, 1989,	-178.0354
		(c) Germany bordering the Netherlands		(d) Germany bordering France	
	$M = 0$	---	-280.4385	---	-277.7932
	$M = 1$	1990	-291.0032	1984	-281.6716
	$M = 2$	1986, 1990	-293.2276	1987, 1995	-303.0169
	$M = 3$	1986, 1990, 1999	-294.8569	1982, 1987, 1995	-303.0468
	$M = 4$	1986, 1990, 1996, 2003	-289.3797	1982, 1987, 1994, 1998	-297.0659
	$M = 5$	1980, 1986, 1990, 1996, 2003	-282.8228	1982, 1987, 1994, 1998, 2002	-290.3385
	$M = 6$	1980, 1986, 1990, 1995, 1999, 2003	-276.2249	1982, 1987, 1991, 1995, 1999,	-282.8089
		(e) Belgium bordering the Netherlands No break (too short data time periods)		(f) Belgium bordering France No break (too short data time periods)	

Note: The highlighted rows are the optimal break points (smallest *BIC* for $M \geq 1$)

Table 4A.12: Summary optimal break points (test statistics)

		Break Points	Break points (year) (a) Netherlands bordering Germany	Tests Ch2(Prob > Ch2)	Break points (year) (b) Netherlands bordering Belgium	Tests Ch2(Prob > Ch2)
Population growth		$M = 1$	1991	0.82(0.3649)	1973	1.09(0.2963)
		$M = 5$	1967	3.28 (0.0701)	1968	5.43(0.0198)
			(c) Germany bordering the Netherlands		(d) Germany bordering France	
		$M = 2$			1987	19.72(0.0000)
					1994	5.98(0.0504)
		$M = 3$	1989	27.13(0.0000)		
			1993	37.77(0.0000)		
			2003	12.34(0.0004)		
Pop. Share growth			(a) Netherlands bordering Germany		(b) Netherlands bordering Belgium	
		$M = 1$	1991	0.85(0.3574)	1973	1.10(0.2940)
		$M = 5$	1970	4.82(0.0281)	1968	5.36(0.0206)
			(c) Germany bordering the Netherlands		(d) Germany bordering France	
		$M = 3$	1986	9.93(0.0016)	1982	12.95(0.0003)
			1990	41.14(0.0000)	1987	18.59(0.0000)
			1999	33.94(0.0000)	1995	5.45(0.0196)

Note: significant breaks when p-value in the parenthesis ($p < 0.01$; [**] $p < 0.05$; [*] $p < 0.1$)

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Figure 4A.1: The robust error terms; example from the Netherlands municipalities
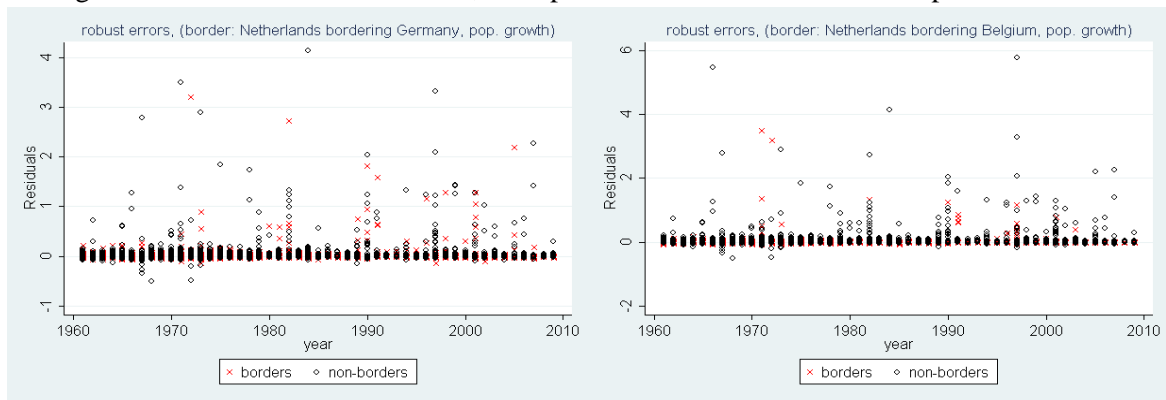
Figure 4A.2: Structural breaks in population (share) growth: all Netherlands' bordering Belgium
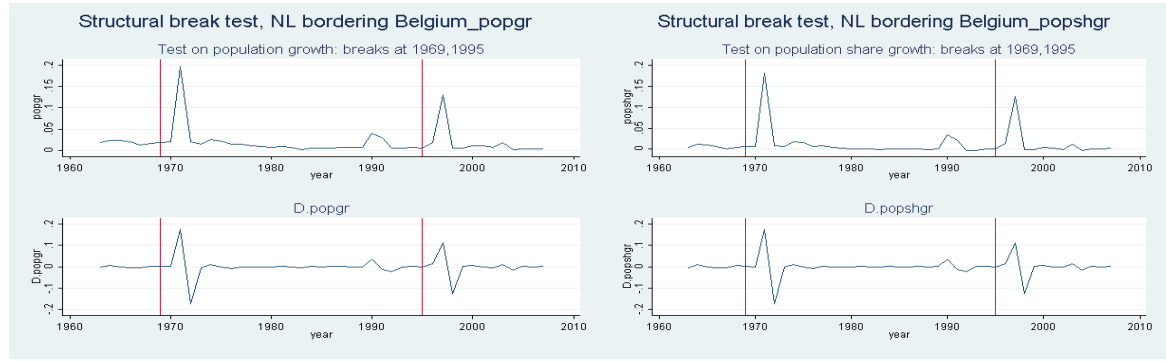
Chapter Five

Town Twinning and German City Growth[44]

5.1. Introduction

Shocks like the creation or abolition of national borders are associated with a change in market access. The fall of the Berlin wall in Germany in 1989 is an example of such a shock. This created sudden economic opportunities for cities along the former border between western and eastern Germany. After the reunification, these former "border" cities experienced higher population growth rates than more centrally located cities within Germany (Redding and Sturm, 2008, see also Ahlfeldt, et al, 2012). Other examples of shocks are the expansion of the European Community (EC), later the European Union (EU). The increased economic integration between member countries and between new members increased market access for cities along the borders of the EU. Brakman et al. (2012) show, for instance, that the involved cities and regions along borders that experienced EC/EU economic integration were positively affected by this change in market access, which compensates, to some extent, the negative effect of being a (peripheral) border location.

In this chapter we analyze so-called town twinning (hereafter, TT), which is another form of integration that might affect the international economic or market access of a city. TT involves co-operation, in the broadest sense, between towns or cities across national borders. Although TT has a long history, dating back to the 19th century, the heydays of TT began after WWII (Zelinsky, 1991, Furmankiewitcz, 2005, and Clarke, 2009). The need between countries to reacquaint themselves with their former enemies was particularly felt in the post-war period, and in particular so in Germany. As a side effect of this largely politically motivated twinning episode, transaction costs would be reduced and interaction or flow of people between cities that became part of TT, and we hypothesize that as a result population growth could be more pronounced compared to other cities that had no or fewer international TT partners. Although our data don't allow us to prove this mechanism, TT might help people and firms find their optimal cities where they are more productive.[45]

The central topic of this chapter is to analyze whether TT indeed has a positive effect on population growth in German cities. To our knowledge the only empirical attempts to measure effects of TT are de Villiers et al. (2007) and Baycan-Levent et al. (2010), both based on the survey of municipal officials that were asked whether they considered TT successful. However, a full-fledged econometric analysis is missing. In this chapter we try to fill this gap. Our argument is thus that twinning cities have advantages over other cities as they, by co-operating with each other, reduce transaction costs and increase economic proximity. At the same time, the

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[44] This chapter is based on a joint work with Steven Brakman and Harry Garetsen.

[45] More productive cities can be more attractive to people and firms from twinning partners as well as non-partner cities.

organization and maintenance of TT involves (coordination) costs; so it is not a priori clear whether TT will be beneficial for the cities concerned. The difference between this chapter and Redding and Sturm (2008) or Brakman et al. (2012) is that we do not put special emphasis on national borders, and do not analyze shocks, but focus on the evolutionary influence that TT has on city population growth. To this end we construct a complete dataset on TT for Germany. We focus on Germany because Germany, as we argue in section 5.2, is the main actor in TT in post WWII Europe.

The chapter is arranged as follows. In section 5.2 we briefly discuss the history of TT, and what it implies in practice. Section 5.3 describes the dataset. Our variables of interest are population growth and the TT in Germany with cities outside Germany. The estimation strategy is developed in section 5.4. The main estimation results are described in section 5.5. In general, and after also conducting a range of robustness checks, we do find evidence of a significant positive relationship between TT and German city growth, in particular when we take the number of TT relationships into account and focus on TT with French cities or cities in neighboring countries more generally. Finally, Section 5.6 concludes.

5.2. Town twinning: history, motives and theory

TT is a relative old phenomenon.[46] The term was used as early as the 1850s to describe the cooperative activities of building transportation and other public infrastructure between, for example, the neighboring cities of Minneapolis and St. Paul, Minnesota, USA, (see Borchert 1961). The world fairs that were initiated in the 19th century also stimulated contacts between cities (Fighiera 1984, cited in Zelinsky, 1991). Following these early attempts many others followed in order to enhance cooperation between cities. For example, the foundation of the International Union of Local Authorities (IULA) at Ghent in Belgium in 1913 was specifically aimed at stimulating international cooperation between cities (Zelinsky, 1991). Ties between cities were also stimulated by ad hoc initiatives by city councils or private enthusiasts for more co-operations between cities (Clarke, 2009).

The concept of TT is as such rather opaque. It involves all sorts of interactions that are aimed to foster mutual understanding between the inhabitants of cities that take part in the initiatives, such as: bilateral visits of officials, musical events, language courses, or exchanges of letters between schoolchildren. However, it also encompasses the sharing of technical expertise, the sharing of knowledge and advice that have more direct economic consequences (Zelinsky, 1991). All these activities can result in a form of TT. The term town twinning is adopted from the relationship that existed between the twin cities of Minneapolis and St. Paul, Minnesota, USA, but increasingly was used to describe the relationship between international partner cities, which is

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[46] We do not discuss co-operation between cities that were motivated by religious motives (missionary efforts), initiatives by freemasons, Rotarians and the like, as systematic data for these initiatives are lacking and because the initiatives are aimed at special interest groups.

how we will also use the term. As is clear from the historical overview in Zelinsky 1991, and, inter alia, Clarke (2009, 2010), TT is very much a European phenomenon. From Zelinsly (1991, Table 3, p.12), it can be deduced that the top-20 of countries in 1988 that are involved in international twinning is dominated by EU countries (15 out of the 20), and that the leading TT countries are France, the UK and Germany that together have almost 8500 twinning relations, which is comparable to the other 17 countries combined. Proximity is also important; most TTs take place with *neighborin*g countries (Zelinsky, 1991).

Data on TT show that it became very popular after WWII, especially during the 1950s (Falkenhain et al., 2012; Furmankiewicz, 2005; Jayne, 2011, 2013; Joenniemi and Sergunin, 2009; Papagaroufali, 2006; Vion 2002, Campbell, 1987; and Zelinsky, 1991). The promotion of the TT was one of the priorities of the Council of European Municipalities which explains the huge increase in the number of TTs in the 1950s. The WWII experience was a great stimulus for TT initiatives.[47] As a consequence, most of the TTs were between towns from countries that were enemies during WWII. Germany became the center of the twinning activities. By 2012, German municipalities together have over 5000 international twinning partners, mostly with European partners, especially France. The TT orientation towards France is not surprising if one realizes that France and Germany were arch-enemies in three main wars between 1870 and 1945 so post-WWII peace policy in Western Europe focused on these two countries. During the cold war an ideological dimension was added to the motives to form partnerships; TT could help to promote understanding for different ideological systems. The latter initiatives were often met by distrust of more central governments (Clarke, 2010), and it is questionable whether these ideological forms of TT reduced transaction costs in a way that could stimulate population growth. Figure 5.1 shows the recent data on town twinning in the European countries. The map shows that TT is most popular in Germany and France.

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[47] See for a history of TT in some individual countries: for the UK -Clarke, 2009; Clarke, 2010; Clarke, 2011 and Jayne, 2011, for France - Vion, 2002; and Campbell, 1987, for Greece - Papagaroufali, 2006, for northern Europe - Joenniemi and Sergunin, 2009, and for Poland - Furmankiewicz, 2005 and 2007.

Figure 5.1: The geography of town twinning in Europe

Source: own construction, based on Zelinsky (1988) and CEMR (2010); 3.000 (Dutch number style) is same
as 3,000 or 3000 (international number style).

Our brief overview of TT suggests that, in general, two motives for TT seem to stand out:

- A political motive, following WWII, TT was used as a tool in the process of reconciliation between former enemies (f.i. Falkenhain et al., 2012), Clarke, 2010, Vion, 2002).
- An economic motive, TT is aimed at economic co-operation and by doing so generates international flows of goods and people, because economic distance is reduced via the reduction in inter-city transaction costs (Grosspietsch, 2009, Jayne et al., 2011, Jayne et al., 2013).

In the literature on TT few examples exist to measure the effects of TT empirically. De Villiers et al. (2007) and Baycan-Levent et al. (2010) use opinion polls among municipal officials. The results suggest that the success of TT depends on the existence of already existing relations with partner cities and similarities in the urban problems they face. Falkenhain et al. (2012), show that geographical proximity is an important factor for twinning density. Clarke (2009, 2010, 2011) uses narratives to analyze TT. Jayne et al. (2011) emphasizes relational geography versus territorial geography where towns extend their boundaries through space and time.

This chapter adds to this literature by explicitly measuring and estimating the effects of TT on city population growth for German cities. We hypothesize that TT increases international market access of cities by specifically reducing transaction costs between cities that have international partners and also reduces direct transportation costs between partner cities (see for the micro economic foundations, Redding and Sturm, 2008, Brakman et al. 2012). We also hypothesize that these positive effects of TT can outweigh the coordination costs of being engaged in TT such that TT can indeed have an overall positive effect on cities. German cities involved in

TT are located throughout Germany, implying that we do not focus on border effects per se, but concentrate on those cities or locations that have TT relations with foreign cities. The reduction in economic distance between these locations and foreign cities, *ceteris paribus*, is thought to stimulate local economies and boost population growth. A theoretical analysis of the effects can, for instance, be found in Brakman et al. (2009, ch. 11, table 11.4). In a twelve city simulation, based on a Krugman-type new economic geography model (Krugman, 1991a), it can be shown that building 'a bridge' between pairs of cities, stimulates growth in cities on the two sides of the bridge. TT is expected to have a similar effect. Town twinning is not something which is enforced upon cities but it is a deliberate choice by 2 cities whether or not to engage in mutual town twinning. They do so when the perceived economic and non-economic benefits are thought to outweigh the set up and maintenance coordination costs. The former can be looked upon as quasi fixed in the sense that these costs are lower when a German city has already more TT relationships, particularly so when the existing TT relationships are with cities in the same foreign country and if ceteris paribus these countries (and thus twinning cities) are more nearby. This leads us to expect that the alleged positive growth effects of TT are larger for cities that have a larger number of TT relationships.

5.3. The dataset

We focus our analysis on TT related to German cities. As discussed in section 5.2, Germany is the center of twinning activities and data for Germany are systematically available (in contrast to most other countries). The data are obtained from '*Rat der Gemeinden und Regionen Euro*pas', http://www.rgre.de/, and the German section of the Council of European Municipalities and Regions (CEMR). The sample includes over 5000 twinning relationships of over 600 German towns, cities and municipalities with locations around the world. The population data are obtained from the *Statistisches Bundesamt* http://www.destatis.de/. Our data cover the period 1976 to 2007. The population data relate to the municipalities level or the county level. If possible we use data for the lowest level of aggregation. The spatial units of the population data and the TT data differ and we refer to the Appendix (Table 5A.11) as to how the population and TT data were matched so as to apply to the same spatial unit. We use *Kreise* as the smallest spatial unit of observation. Cities within Kreise that are involved in TT are aggregated. The data on spatial units are obtained from GFK GeoMarketing, http://www.gfk-geomarketing.de/.

Tables 5.1 shows some summary statistics. The data for Germany cover two forms of TT relationships: partnerships and friendship. Partnership is a form of twinning in which the partners engage in activities based on contracts, whereas friendships are less far-reaching and are based on agreements with limited formal activities or projects. We therefore expect the effects of partnership TT on population growth to be relatively stronger. Table 5.1 shows that number of twinning connections is larger than the number of twinning towns and cities; cities can and often do have more than one twinning relationships. 366 Germany towns and municipalities with

complete coverage for all years did have 1502 twinning connections by 1976. This increased to 419 German towns having 3071 twinning connections in 1990 and 610 towns having 5067 twinning connections in 2007.

Table 5.1: German town twinning 1976 – 2007, partnerships and friendships

		all twinnings (Partnership + Friendship)		Partnership		Friendship	
	year	number	%	number	%	number	%
(a)	1976	366	100%	357	98%	65	18%
Cumulative twinning towns and cities[48]	1990	419	100%	410	98%	122	29%
	2007	610	100%	579	95%	239	39%
(b)	1976	1502	100%	1426	95%	76	5%
Cumulative twinning connections[49]	1990	3071	100%	2890	94%	181	6%
	2007	5067	100%	4565	90%	502	10%

Note: The percentages under partnership and friendship don't add up to 100% because a town can have one or more partnership with town(s) as well as one or more friendship connections with other towns and/or cities. A city or town can have more than one twinning partnership and/or friendship.

Figure 2a shows the average numbers for German TT where 'all municipalities/counties' includes non-twinners as well, whereas, the group 'twinning municipalities/counties' include only those with at least one town twinning relationship. In 1976 twinning municipalities/counties had on average about 4.5 twinning partners. Including non-twinners reduces this number to about 3. By the year 2012, the figures grew to about 13 and 10 twinning connections, respectively. So for both groups a gradual increase in the average number of TT relationships is visible. Figure 2b shows the absolute number of municipalities/counties or Kreise with at least one twinning connection in the categories of partnership, friendship, or both, over time. In figure 2b, the '*partners*' and '*partners + friends*' are very similar because the same city which has partnership TT also typically has some friendship TT connections. This implies that partnership and friendship connections are not mutually exclusive.

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[48] The percentages under partnership and friendship don't add up to 100 percent because a town can have one or more partnership with town(s) as well as one or more friendship connections with other towns and/or cities.

[49] A city or town can have more than one twinning partnership and/or friendship.

Figure 5.2a: Mean number of twinning
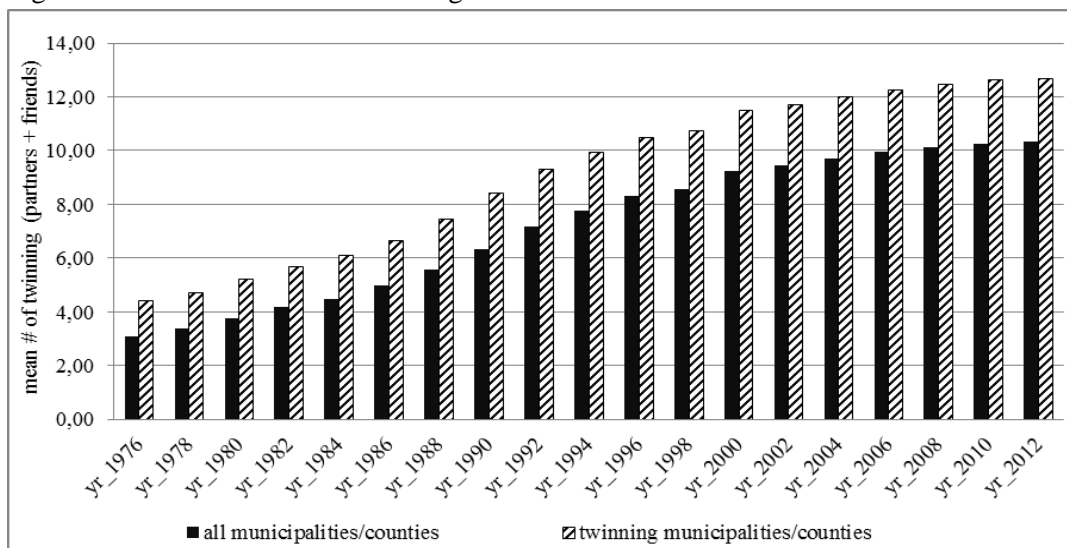
Note: #,## (Dutch style decimals) are the same as #.## (international style)

Figure 5.2b: Number of municipalities/counties with at least one twinning connection
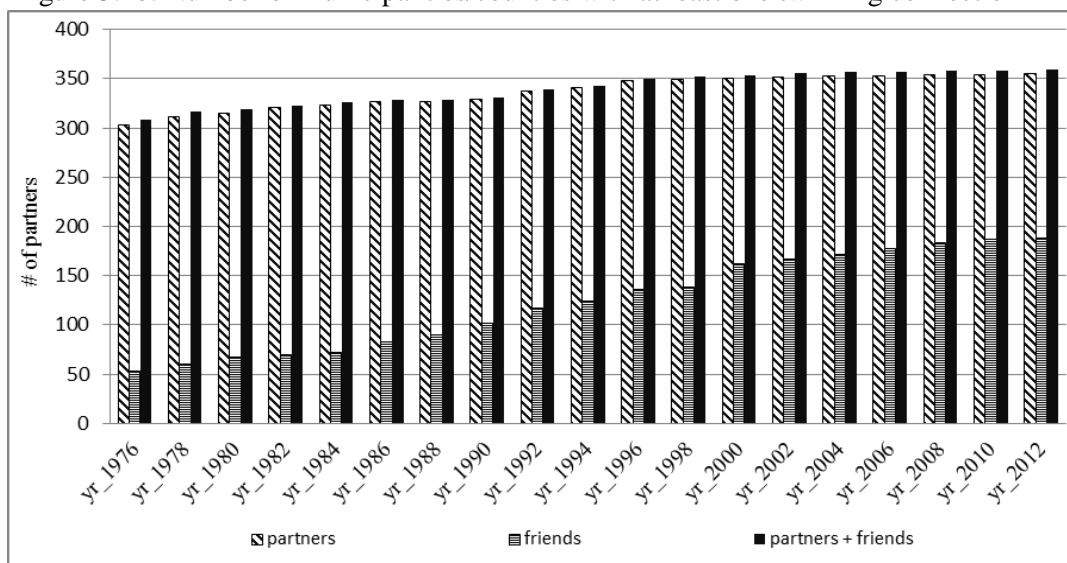
Out of over 2000 German cities and towns, 366 of them had at least one twinning connection in 1976, and 610 cities and towns had a twinning relationship in 2007 (see table 1). Even after aggregating into the municipalities/counties or Kreise a large number of German Kreise still do not have any town twinning connection at all.

In our estimations we also look at the intensity of twinning. Figure 2c gives a sense of the difference between town twinning as such and the intensity. The striped bars show whether

German towns are engaged in town twinning at all by having at least one twinning connection, and the solid bars show the intensity by displaying the number of German Kreise with more than the mean number twinning connections. Figure 2c illustrates that the growth of German town twinning in our sample period occurred until 2000 and then leveled off. The number of towns with more than the average number of TT is approximately 120.

Figure 5.2c: Municipalities/counties with at least one (or mean) twinning
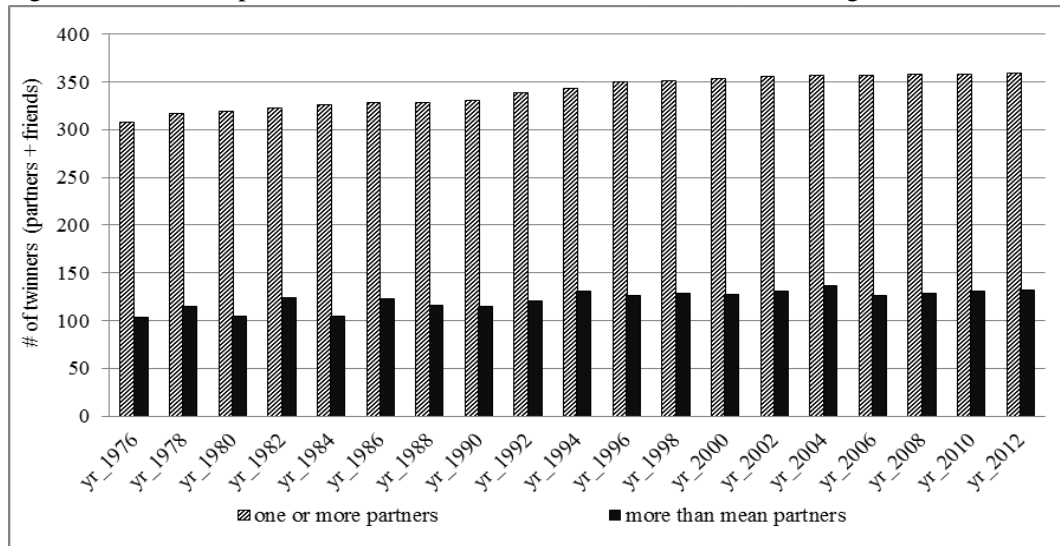
When it comes to the geography of the German TT counterparts, Table 5.2 shows that 36 % of all German TTs are with French cities; over 90 % of TTs are with European countries, including Russia. Within Germany, the twinning activities are historically concentrated in the western part of Germany, see Figure 5.3.

Table 5.2: Top 40 German twinning partners (98 %), 2012

s.n.	Partner	# of	%	Cum.	s.n.	Partner	# of	%	Cum.
1	France	2054	36.41	36.41	21	Greece	34	0.60	92.27
2	Britain	440	7.80	44.21	22	Ukraine	32	0.57	92.84
3	Poland	417	7.39	51.60	23	Nicaragua	26	0.46	93.30
4	Italy	364	6.45	58.06	24	Romania	26	0.46	93.76
5	Austria	304	5.39	63.45	25	Lithuania	24	0.43	94.19
6	Hungary	251	4.45	67.90	26	Croatia	23	0.41	94.59
7	Czech Rep.	168	2.98	70.87	27	Latvia	21	0.37	94.97
8	USA	168	2.98	73.85	28	Luxemburg	20	0.35	95.32
9	Netherlands	167	2.96	76.81	29	Portugal	18	0.32	95.64
10	Russia	121	2.15	78.96	30	Slovenia	18	0.32	95.96
11	Belgium	120	2.13	81.08	31	Slovakia	16	0.28	96.24
12	Denmark	89	1.58	82.66	32	Estonia	15	0.27	96.51
13	Israel	79	1.40	84.06	33	Belarus	13	0.23	96.74
14	Turkey	76	1.35	85.41	34	Norway	13	0.23	96.97
15	Switzerland	72	1.28	86.69	35	Ireland	12	0.21	97.18
16	China	63	1.12	87.80	36	Burkina Faso	11	0.20	97.38
17	Finland	61	1.08	88.88	37	Bosnia &Herz.	10	0.18	97.55
18	Sweden	57	1.01	89.90	38	Bulgaria	10	0.18	97.73
19	Japan	53	0.94	90.83	39	Ruanda	7	0.12	97.85
20	Spain	47	0.83	91.67	40	Serbia	7	0.12	97.98

Source: own calculation from the data

Figure 5.3: The geographical distribution of German twinning and time trend

Source: own calculation from the data

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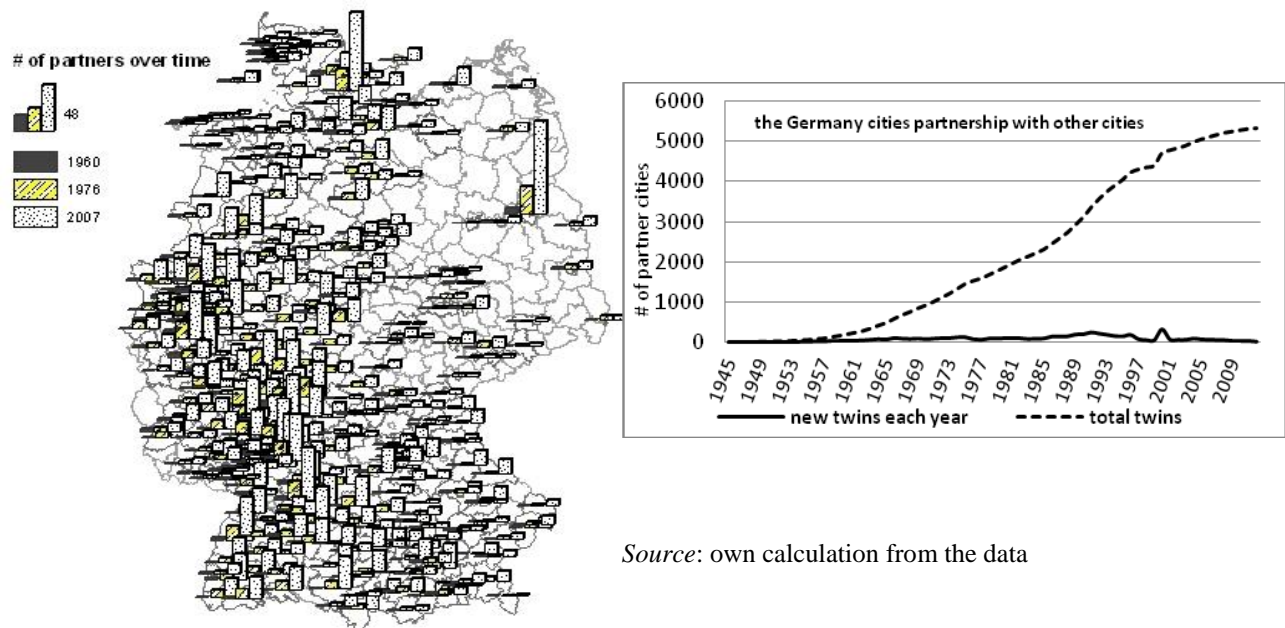
As visualization of Table 5.2, Figure 5.3 shows the geographical distribution of the major twinning partners' countries and again illustrates the fact that the neighbors of Germany are most important for German TT.

Figure 5.4: Major twinning partner countries for Germany
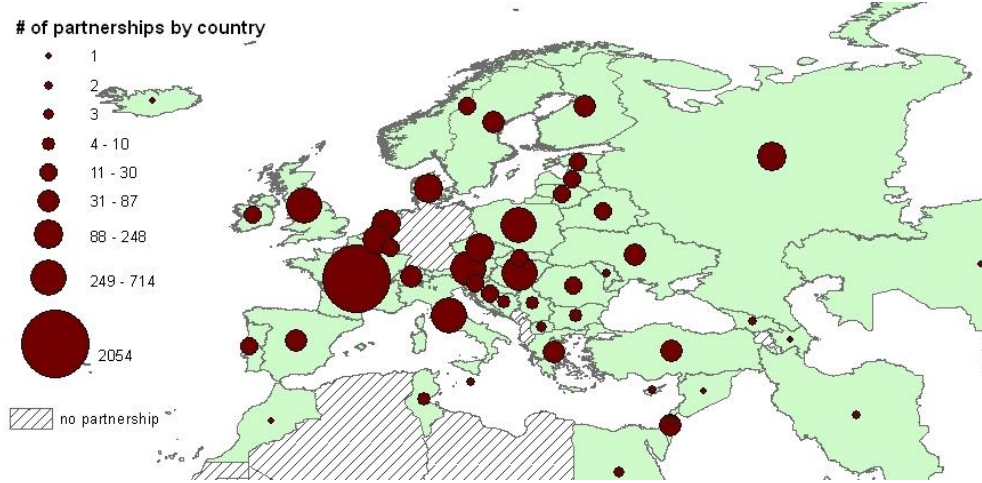
Source: own calculation from the data based on absolute number of twinning partners

5.4. Estimation strategy

We apply a difference-in-differences (DID) method. Furthermore, we use instrumental variables to deal with reverse causality. Our main argument is that German twinning cities have advantages over non-twinning cities as they enter into agreements (local policy shock) that increase economic proximity by reducing transaction costs with the non-German partner cities, and indirectly the countries involved, and as a result these German TT cities grow relatively faster. The DID approach can be used to analyze the effects of (non-)policy measures applied to sub-samples of the complete sample. The DID method allows for time-invariant unobserved differences between the control and treatment groups. In particular it removes differences in unobserved characteristics that are constant over time and that can affect the dependent variable, here population growth. The basic specification is (see also Brakman et al., 2012 for a discussion):

$$popgrowth_{m,t} = \phi\, twinning_{m,t} + D_t + D_l + \varepsilon_{m,t} \tag{5.1}$$

$$popgrowth_{m,t} = \beta\, twinning_{m,t} + \gamma\big(twinning_{m,t} \times partners_{m,t}\big) + D_t + D_l + \varepsilon_{m,t} \tag{5.2}$$

where $popgrowth_{m,t}$ is annual population growth of German municipality (or county) m at time t; $twinning_{mt}$ indicates whether a twinning relationship between a German municipality with

international partner city exists. It equals 1 if the municipality has one or more international twinning partner(s) and 0 otherwise. We also include the number of partners explicitly assuming that the larger the number of partners, the larger the reduction in transaction costs; the value of $twinning_{mt}$ than equals to *number* of international partners. The variable $partners_{m,t}$ refers to a particular country or group of countries with which TT exists, like for instance only the sub-sample of French TT partner cities. Treating $twinning_{mt}$ as a dummy variable refers to what might be called the extensive margin of TT (is there any TT at all?), whereas treating $twinning_{mt}$ as the actual number of TT partners than refers to the intensive margin (how much TT is going on, the "volume" of TT relationships so to say). Given that TT also invokes (coordination) costs on the part of the German TT city, we expect that for German cities which are more heavily involved in TT, and thus have more experience in setting up and maintaining TT relationships, the effect of TT on population growth to be stronger. In other words we expect the effect of the intensive margin of TT to be stronger as compared to what we dubbed the extensive margin of TT. We thus also expect that the nature of the TT arrangement might matter; partnership TT would then be more relevant than friendship TT.

For the variable $partners_{m,t}$ we look at the following subsamples: French TT counterparts, TT with only neighboring countries, TT with European countries, TT with the founding fathers of the EU (EU 6), or the 1980s members (EC12) and the 1990s members (EU15). D_t, D_l and ε_{mt} indicate time dummies, location dummies and a stochastic error term. The time dummies are annual, whereas location dummies are related to the 15 states of Germany (*Bundesländer)* and as such capture unobserved characteristics of various states. The time dummies control for common shocks affecting the population growth throughout the sample. The DID approach is best used for comparable control groups (see Bertrand et al., 2004; and Cameron and Trivedi, 2005). By differentiating between large and small German counties and municipalities we also control for city size affects in our results. Furthermore, we estimate by using robust standard errors (Donald and Lang, 2007). In our robustness checks, we also used clustered standard errors to control for the fact the population growth of German cities need not to be (spatially) independent.

We also address the issue of reverse causality, that is, whether TT stimulates population growth or whether stronger economic performance and hence population growth are formalized in TT activities. We use data on the WWII destruction of German cities as instruments. Specifically, the level of destruction of residential houses, number of people killed, tax revenue loss and tons of rubbles resulting from bombing of the Germany towns and cities during WWII are used as instruments. The motivation for these instruments is that especially cities that experienced WWII destruction directly or more intensively, are more motivated to strengthen ties between former enemies in order to increase mutual understanding and prevent future wars. The data for the instruments are obtained from Brakman et. al (2004a). We employ the Sargan (1958) as well as Basmann (1960) tests to check the power of the instruments. Other qualities of the instruments are also checked. For instance, the instruments should correlate with the right-hand side only.

5.5. Estimation results

5.5.1. Baseline results

Table 5.3 presents the baseline results when estimating equation (5.1) only. We thus use location fixed effects that are related to the 15 states in Germany. Each of the Kreise in our sample is part of one of the states, and because Kreise are a lower level of aggregation, states consist of more than one Kreis. The inclusion of state fixed effects captures the idea that states might have special treatments for TT (which are unobserved)[50]. The columns indicated by dum=1 or dummy=1 correspond to equation (5.1), and capture whether TT exists at all, columns with inten= n or intensity=1, capture the intensity of TT and uses 'n' the number of TT relationships explicitly. Furthermore, time dummies are used. We also differentiate between partnerships and friendships, as the ties between cities in a partnership are thought to be stronger.

Table 5.3: Twinning by German cities and population growth (full sample)

Variables	partnerships + friendships		partnerships only		friendships only	
	(dum=1) (1)	(inten=n) (2)	(dum = 1) (3)	(inten = n) (4)	(dum = 1) (5)	(inten = n) (6)
$Twinning_{mt}$	− 0.0756 (0.0566)	0.0068*** (0.00106)	− 0.0955* (0.0559)	0.00724*** (0.00118)	0.108*** (0.0218)	0.0208*** (0.00549)
Year effects	yes	yes	yes	yes	yes	yes
Location effects	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.119	0.119	0.119	0.119	0.119	0.119

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; inten = intensity = n= number of twinning partner cities; dum = dummy =1 if a municipality has one or more twinning partner(s).

The results for population growth for twinning as such are mixed (columns 1, 3, and 5). Only in the case of TT friendships, a significant and positive relation exists. When we measure TT by the number of TT contacts the population growth effect (the intensive margin of TT) is positive throughout (columns 2, 4, and 6).

As France is by far the most important twinning partner of Germany, we focus on France separately in Table 5.4; $partners_{m,t}$ stands for the TT partners between Germany and France. Separating France from TT in general shows that France dominates the positive population growth effects of TT. The twinning variable becomes ambiguous and is only significantly positive in columns (5) and (6). Having a partner in France is important for German cities; both from the

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[50] Since we use state fixed effects this also deals with the difference in TT between the former states of West and East Germany prior to German re-unification in 1990.

extensive (column 4) and in particular from the intensive (column 5) margin perspective.[51] We include location fixed effects to separate eastern from western German cities.

Table 5.4: Twinning with France

Variables	partnerships + friendships		partnerships only		friendships only	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
$Twinning_{mt}$	− 0.218*** (0.0661)	− 0.00162 (0.0020)	− 0.244*** (0.0660)	− 0.00312 (0.0024)	0.123*** (0.0228)	0.0248*** (0.0063)
$Twinning\,\mathrm{mt} \times France_{mt}$[52]	0.441*** (0.0815)	0.0170*** (0.0044)	0.443*** (0.0785)	0.0198*** (0.0048)	− 0.101** (0.0403)	− 0.0377 (0.0246)
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.121	0.120	0.122	0.120	0.119	0.119

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; inten = intensity = n= number of twinning partner cities; dum = dummy =1 if a municipality has one or more twinning partner(s).

The conclusion is that TT has a small but detectable effect on population growth when the TT with French cities is concerned. This effect is due to the more far reaching form of TT, partnerships. Twinning can stimulate population growth, but it seems relevant to focus on subgroups of TT relationships, here French cities. We also do so for other subsamples in section 5.2 The question we will, however, address first is that of reverse causality; it could be the case that (trade) relations are good between groups of countries and their respective cities (which as such boosts population growth), and that these ties are formalized in TT. To address this, we use an instrumental variable estimation. As instruments we use the level of destruction of residential houses, the number of people killed, tax revenue loss, and tons of rubble resulting from bombing of the German towns and cities during the WWII by allied forces.

The motivation to include war related instruments is that locations that were hit particularly hard by WWII could have been more motivated to get involved in TT than other cities. The perceived importance of mutual understanding in these cities is stronger than in others; see table A10 in the appendix for an analysis of the strength of the instruments. We used the instruments in three categories: 'a' = all the four instruments used together; 'b' = residential buildings loss, rubble per capita, and tax revenue loss, and 'c' = residential buildings loss, and tax revenue loss. Table 5.5 shows the results of the IV estimates when we estimate equation (5.1) with IV. It includes a full set of fixed effects. The results for the extensive margin are again ambiguous,

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[51] Other neighboring countries give, in a qualitative sense, similar results. Results are available upon request.

[52] $France_{mt} =$ Share of France towns and cities in the total international twinning partners of a Germany municipality or county

but the intensive margin stands out. In all variants that deal with the number of twinning relations the effect of twinning is positive.

Table 5.5: All twinnings, IV estimates

| Variables | partnerships + friendships | | partnerships + friendships | | partnerships + friendships | |
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
Twinning$_{mt}$	−3.762***	0.0578***	− 4.521***	0.0816***	− 6.666***	0.0851***
	(0.875)	(0.00998)	(1.052)	(0.0118)	(1.515)	(0.0122)
Instruments	a	a	b	b	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	---	0.066	---	0.021	---	0.013
Sargan score (p-value)	21.60(0.000)	20.55(0.000)	16.69(0.000)	3.48(0.176)	4.89(0.027)	1.77(0.183)
Basmann score(p-value)	21.55(0.000)	20.50(0.000)	16.64(0.000)	3.47(0.177)	4.87(0.027)	1.76(0.184)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; dum = dummy; inten = intensity

The Sargan (1958) as well as Basmann (1960) test statistics show that the instrument 'a' doesn't meet the requirement of the over-identifying restriction. However, the instruments 'b' and 'c' fulfill the test of over-identification restriction when we consider the intensity of TT (columns (4) and (6). In these cases the number of TTs has a positive and statistically significant effect on population growth.

Table 5.6 shows the IV estimates of table (5.4) with singling out France as the twinning partner. As in the other cases it includes a full set of fixed effects. In line with the estimation results in Table (5.4), the results indicate that the extensive margin as well as the intensive margin of TT with France is positive and significant. The tests for over-identifying restrictions show that the instruments meet the requirement of the over-identifying restrictions.[53] Causal relationship is confirmed as the instruments combinations are generally valid; the validities of columns (1), (3), (4) and (5) not being rejected at all, whereas columns (2) and (6) are rejected at 1 and 5 percent levels, respectively.

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[53] Separating partnership and friendship for each group of instruments does not affect the results, or the validity of the instruments also in general remain valid. For instance, see table 5A.1 in the appendix for the separate estimates using the instruments group 'b'. Causal relationship is confirmed as all the instruments combinations are valid; the validities of columns (1), (2), (3), (5) and (6) not being rejected at all whereas column (4) is rejected only at 10 percent level.

Table 5.6: Twinning with France, IV estimates

Variables	partnerships + friendships		partnerships + friendships		partnerships + friendships	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
$Twinning_{mt}$	− 0.720***	− 0.0734***	− 0.737***	− 0.153***	− 0.745***	− 0.154***
	(0.106)	(0.0163)	(0.108)	(0.0261)	(0.109)	(0.0262)
$Twinning_{mt} \times France_{mt}$	1.997***	0.163***	2.049***	0.324***	2.076***	0.326***
	(0.280)	(0.0327)	(0.287)	(0.0526)	(0.290)	(0.0529)
Instruments	a	a	b	b	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.074	0.071	0.072	---	0.072	---
Sargan score (p-value)	3.05(0.383)	23.88(0.000)	2.26(0.322)	4.23(0.121)	1.81(0.178)	4.05(0.044)
Basmann score(p-value)	3.04(0.385)	23.82(0.000)	2.26(0.324)	4.21(0.122)	1.80(0.180)	4.03(0.045)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; dum = dummy; inten = intensity; we estimate the regression equations using different spatial level fixed effects; and the results remain fairly the same. For instance, when estimating using municipality level fixed effects instead of states the coefficient of $Twinning_{mt} \times France_{mt}$ is 1.980 instead of 1.997 in column (1) and remain strongly significant.

The literature suggests that large urban locations are not only more efficient than smaller ones, but they have also an advantage in innovation, and their economies can grow faster than smaller locations, see also Ludema and Wooton (1999) who show that trade liberalization initially benefits larger agglomerations. We therefore define German municipalities that are smaller than the median population size as small, and those that are larger than the median population size as large (see Table 5A.2 and 5A.3 in the appendix). Without using instruments introduced above, TT has positive effects for large and small municipalities, particularly when we account for the intensity of twinning (for example see Table 5A.2 as well as Table 5A.9). After instrumenting, however, the significant and positive TT effects only remain valid for *large* municipalities (table 5A.3), we return to this difference between large and small cities in the next sub-section.

Timing could also be a factor. We looked at early versus late twinning (see table 5A.5). We choose 1960 and 1970 as dividing line to discriminate between early and late TT. These dates distinguish between the original but limited EU integration and the time when EU expansion started (with UK, Ireland and Denmark becoming the members in 1973 which was followed by other countries joining the EU in the 1980s, 1990s and 2000s). Table 5A.5 in the appendix presents the results using instruments 'a' and 'c'. The results for instrument 'b' are not reported for space reasons and because they are very similar with the results for instrument 'a'. Tables 5A.4 (no instruments) and 5A.5 (instruments) in general show that early TT has a stronger effect than later TT, although the effects remain positive over the whole period.

5.5.2. Additional estimations and robustness checks

As German TT with France turns out to be important for the effects of TT on German population growth, we now investigate whether EU connections more generally are important for the impact of twinning. Countries that are more involved in German TT than other countries are, for instance, the countries that are (founding) members of the EC/EU. The original six members of the pre-1973 European Communities (EC6) are: Belgium, France, Luxembourg, the Netherlands, Italy, and (West) Germany; the EC9 includes the EC6 as well as United Kingdom, Ireland, and Denmark who joined in 1973; EC12 includes the EC9 as well as Greece, Spain and Portugal who joined in the 1980s; the EU15 of includes EC12 members as well as Finland, Austria, and Sweden who joined in 1995; and EU25 includes the EU15 as well as Cyprus, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia who joined EU since 2004 (for more details see Brakman et al., 2012). Estimating separately for the '*partnership + friendship*', '*partnership only*' and '*friendship only*' gives a similar pattern of results as above; i.e., the results are stronger for partnerships than friendships. The results in Table 5.7 combine the IV estimation results of both TT partnerships and friendships; i.e., '*partnership + friendship*'. Controlling for the EC (or EU) membership shows that now only the extensive margin of TT, so the number of TT relationships, with the EC6 member countries has a significant separate effect throughout all estimations but the sign is now negative. However, in the EC6 case, the instruments are weak implying that there is no strong evidence of TT with the EC and EU members leading to higher population growth (see also Tables 5A.6 and 5A.7). This is perhaps so because of German cities limited level of twinning with these groups of countries and the twinning effect doesn't stand out in the phase other factors especially the EC/EU integration effects. The same holds when we separate between early and late twinning for the EC and EU (see table 5A.8).

Table 5.7: Twinning with the EC and EU countries, IV estimates

Variables	EC6		EC12		EU15		EU25	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)	(dum=1) (7)	(inten=n) (8)
$Twinning_{mt}$	−1.38*** (0.437)	0.289*** (0.0793)	0.793 (0.544)	0.432*** (0.099)	0.732 (0.550)	0.411*** (0.0924)	2.159*** (0.626)	0.20*** (0.047)
$Twinning_{mt} \times EC(U)_j$	1.871*** (0.622)	− 0.01*** (0.0028)	−1.224 (0.763)	− 0.01*** (0.003)	−1.134 (0.769)	− 0.011*** (0.003)	−3.14*** (0.874)	− 0.01*** (0.0011)
Instruments	a	a	a	a	a	a	a	a
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
Location effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.084	---	0.078	---	0.082	---	---	---
Sargan score (p-value)	45.30 (0.000)	17.11 (0.001)	51.39 (0.000)	5.72 (0.126)	52.05 (0.000)	7.08 (0.070)	36.29 (0.000)	26.16 (0.000)
Basmann score (p-value)	45.30 (0.000)	17.02 (0.001)	51.40 (0.000)	5.70 (0.127)	52.06 (0.000)	7.05 (0.070)	36.25 (0.000)	26.11 (0.000)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; $EC(U)_j \in (EC6, EC12, EU15, EU25)$; dum = dummy; inten = intensity

After observing the differences between the effects from twinning with France and TT with the various historical compositions of the EC and EU countries, we realize that geographical proximity or contiguity also could be a factor. Countries that are nearby in a geographical sense are also, ceteris paribus, near each other in other respects, like a common culture. It may be then relatively more easy (or less costly) to set up TT relationships with these countries (recall also that these countries, like France, were typically invaded by Germany during WWII). From Table 5.2 we can see that in addition to France, 7 neighboring countries (with additionally 1200 TT relationships) are in the top-15 of German TT partners.

Table 5.8: Twinning with neighboring countries, IV estimates

Variables	partnerships + friendships		partnerships + friendships		partnerships + friendships	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
$Twinning_{mt}$	− 0.710***	− 0.0896***	− 0.724***	− 0.123***	− 0.737***	− 0.128***
	(0.102)	(0.0160)	(0.104)	(0.0195)	(0.105)	(0.0200)
$Twinning_{mt} \times Neighbor_{mt}$	1.289***	0.147***	1.319***	0.198***	1.345***	0.206***
	(0.176)	(0.0241)	(0.180)	(0.0294)	(0.182)	(0.0302)
Instruments	a	a	b	b	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.104	0.092	0.103	0.074	0.102	0.071
Sargan score (p-value)	1.64(0.651)	12.50(0.006)	0.92(0.632)	2.62(0.269)	0.12(0.730)	1.06(0.303)
Basmann score(p-value)	1.63(0.653)	12.45(0.006)	0.91(0.633)	2.63(0.269)	0.12(0.731)	1.06(0.304)

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; dum = dummy; inten = intensity

As can be seen in Table 5.8, we find positive and significant of both extensive (columns 1, 3 and 5) and intensive margin that is the number of twin towns (columns 2 4 and 6), of TT on population growth which is not very surprising given the dominance of (neighbor) France for German TT, recall Table (5.6). Dividing the sample into large and small locations shows that the results are again only significant for the larger municipalities, see Table 5.9. This supports the argument that large urban locations are not only more efficient than smaller ones, but also have an advantage in innovation, and grow faster than smaller locations. Recall that this is true for the border integration also as we have seen in Chapter Three and Chapter Four that larger cities and benefit more from the EU integration. These results clearly show that both types of integration shocks that reduce barriers to trade and labor mobility, namely the border integration and TT benefit larger urban areas than smaller ones.

Table 5.9: Twinning with neighboring countries, IV estimates (small vs large German cities)

Variables	partnerships + friendships		partnerships + friendships		partnerships + friendships	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
Small Municipalities						
$Twinning_{mt}$	− 0.0420	− 0.0641	− 0.0418	− 0.0683	− 0.0221	− 0.0570
	(0.351)	(0.0752)	(0.351)	(0.0770)	(0.359)	(0.0789)
$Twinning_{mt} \times Neighbor_{mt}$	0.595	0.0885	0.595	0.0938	0.565	0.0797
	(0.482)	(0.0935)	(0.482)	(0.0957)	(0.495)	(0.0980)
Instruments	a	a	b	b	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,588	4,588	4,588	4,588	4,588	4,588
R-Squared	0.055	0.053	0.055	0.052	0.055	0.053
Sargan score (p-value)	0.73(0.867)	2.03(0.566)	0.73(0.694)	1.96(0.375)	0.66(0.417)	1.54(0.214)
Basmann score(p-value)	0.72(0.868)	2.02(0.569)	0.72(0.670)	1.95(0.378)	0.65(0.419)	1.53(0.216)
Large municipalities						
$Twinning_{mt}$	− 0.856***	− 0.0992***	− 0.908***	− 0.145***	− 0.911***	− 0.148***
	(0.0632)	(0.00832)	(0.0655)	(0.0112)	(0.0655)	(0.0114)
$Twinning_{mt} \times Neighbor_{mt}$	1.465***	0.167***	1.549***	0.235***	1.554***	0.240***
	(0.0804)	(0.0122)	(0.0849)	(0.0166)	(0.0851)	(0.0168)
Instruments	a	a	b	b	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,526	4,526	4,526	4,526	4,526	4,526
R-Squared	0.306	0.376	0.192	0.376	0.182	0.181
Sargan score (p-value)	18.99(0.000)	59.45(0.000)	8.46(0.015)	5.55(0.062)	7.36(0.007)	0.82(0.365)
Basmann score(p-value)	18.87(0.000)	59.62(0.000)	8.39(0.015)	5.50(0.064)	7.30(0.007)	0.81(0.367)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; dum = dummy; inten = intensity

We also provide a couple of other sensitivity checks. One of them is that we estimate the regression equations using different spatial level fixed effects; and the results remain fairly the same. For instance, when estimating using municipality level fixed effects instead of states the coefficient of $Twinning_{mt} \times France_{mt}$ is 1.980 instead of 1.997 in column (1) of Table 5.6 and remain strongly significant. In Tables 5.10 and 5.11, we provide alternative results for twinning with France and with neighboring countries in general. Instead of dividing the sample into small and large municipalities, we include a city size dummy. The dummy 'Large_1970s' is based on the initial population size (in the 1970s) and includes a city if the city size was larger than the median size. In columns (3) and (6) we use the share of the initial population size as 'Share_1970s'. Our data set starts in 1976. For both the size dummy and the initial population share variable, we used the first available year of data. For instance, if year 1976 data is missing for a municipality, we use 1977 population as initial population, and so on until the end of 1970s. In both Tables 10 and 11, we use the IV estimation using instruments 'b'. Columns (1) through (3)

use robust standard errors; whereas, Columns (4) through (6) use *clustered* robust standard errors to account for the possibility of spatial interdependence. Columns (1) and (4) show the results with the two types of standard errors. Columns (2) and (5) account for the initial size in the form of the city size dummy. In columns (3) and (6) we use the share of the initial year population.

Table 5.10: Twinning with France, additional IV estimates (partnerships + friendships)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Twinning dummy =1					
$Twinning_{mt}$	− 0.737***	− 0.727***	− 0.738***	− 0.737***	− 0.727**	− 0.738**
	(0.0766)	(0.0951)	(0.0990)	(0.2450)	(0.3296)	(0.3640)
$Twinning_{mt} \times France_{mt}$	2.049***	2.002***	2.025***	2.049***	2.002***	2.025***
	(0.1832)	(0.1743)	(0.1814)	(0.6613)	(0.6462)	(0.7295)
Instruments	b	b	b	b	b	b
Year effects	yes	yes	yes	yes	yes	yes
Location effects	yes	yes	yes	yes	yes	yes
Large_1970s		0.0085			0.0085	
		(0.0319)			(0.0494)	
Share_1970s			0.0329			0.0329
			(0.0898)			(0.1418)
St. Errors	robust	robust	robust	cluster-robust	cluster-robust	cluster-robust
Observations	11,191	9623	9623	11,191	9623	9623
R-Squared	0.072	0.047	0.046	0.072	0.047	0.046
IV OI test score (p-value)	5.601(0.061)	1.466(0.480)	1.379(0.502)	Na	Na	na
	Twinning intensity = n					
$Twinning_{mt}$	− 0.153***	− 0.228***	− 0.536***	− 0.153*	− 0.228*	− 0.536
	(0.0237)	(0.0349)	(0.1394)	(0.0834)	(0.1351)	(0.8137)
$Twinning_{mt} \times France_{mt}$	0.324***	0.428***	0.956***	0.324**	0.428*	0.956
	(0.0413)	(0.0581)	(0.2337)	(0.1619)	(0.2404)	(1.4157)
Instruments	b	b	b	b	b	b
Year effects	yes	yes	yes	yes	yes	yes
Location effects	yes	yes	yes	yes	yes	yes
Large_1970s		0.0854			0.0854	
		(0.0536)			(0.2384)	
Share_1970s			3.1214***			3.1214
			(1.0351)			(6.4731)
St. Errors	robust	robust	robust	cluster-robust	cluster-robust	cluster-robust
Observations	11,191	9623	9623	11,191	9623	9623
R-Squared	--	--	--	--	--	--
IV OI test score(p-value)	11.687(0.003)	8.023(0.018)	0.640(0.726)	Na	na	na

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; IV OI test: Instrumental Variables over-identification test. na = not available since IV OI test is not available with cluster robust errors.

Table 5.11: Twinning with Neighboring countries, additional IV estimates (partnerships + friendships)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
			Twinning dummy =1			
$Twinning_{mt}$	− 0.724***	− 0.664***	− 0.676***	− 0.724***	− 0.664**	− 0.676**
	(0.0730)	(0.0880)	(0.0906)	(0.2159)	(0.2833)	(0.2999)
$Twinning_{mt} \times Neighbor_{mt}$	1.319***	1.294***	1.311***	1.319***	1.294***	1.311***
	(0.1102)	(0.1066)	(0.1097)	(0.3069)	(0.3156)	(0.3444)
Instruments	b	b	b	b	b	b
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Large_1970s		0.0536*			0.0536*	
		(0.0294)			(0.0298)	
Share_1970s			0.0895			0.0895
			(0.0888)			(0.1141)
St. Errors	robust	robust	robust	cluster-robust	cluster-robust	cluster-robust
Observations	11191	9623	9623	11191	9623	9623
R-Squared	0.103	0.085	0.084	0.103	0.085	0.084
IV OI score (p-value)	2.610(0.271)	0.689(0.709)	0.753(0.686)	na	na	Na
			Twinning intensity = n			
$Twinning_{mt}$	− 0.123***	− 0.147***	− 0.187***	− 0.123***	− 0.147***	− 0.187*
	(0.0146)	(0.0171)	(0.0249)	(0.0442)	(0.0541)	(0.1038)
$Twinning_{mt} \times Neighbor_{mt}$	0.198***	0.221***	0.274***	0.198***	0.221***	0.274*
	(0.0201)	(0.0229)	(0.0327)	(0.0663)	(0.0766)	(0.1412)
Instruments	b	b	b	b	b	b
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Large_1970s		0.0812**			0.0812	
		(0.0342)			(0.1012)	
Share_1970s			0.7850***			0.7850
			(0.2001)			(0.9599)
St. Errors	robust	robust	robust	cluster-robust	cluster-robust	cluster-robust
Observations	11191	9623	9623	11191	9623	9623
R-Squared	0.074	0.045	0.019	0.074	0.045	0.019
IV OI test score(p-value)	6.879(0.032)	1.586(0.453)	3.161(0.206)	na	na	Na

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; IV OI test: Instrumental Variables Over-identification test. na = not available since IV OI test is not available with cluster robust errors.

The main message from Tables 5.10 and 5.11 is that the positive effects of TT (with neighboring countries) are still present. The results suggest that German municipalities or countries twinning with France have on average about 2 percent higher population growth than non-twinning municipalities over the sample periods (see the top half of Table 5.10). The effect is around 1.3 percent when we look at twinning with all neighboring countries (see the top half of both Table 5.11); and when we look at intensity of twinning, the effects are smaller in both cases

(see the bottom half of both the tables). This is because of the fact that the dummy compares twinning cities with non-twinning cities; whereas, intensity measures the effect per unit of twinning.

5.6. Conclusions

Although Town Twinning (TT) has been around for a long time it really took off after WWII. In the post-WWII period, TT was aimed at political reconciliation and enhancing mutual understanding between former enemies, in particular so for Germany. If successful, TT could be looked upon as reducing the economic distance between the cities that are involved in these initiatives, which can be seen as to stimulate the growth of the cities involved in TT. Existing research on TT is to a large extent descriptive and we add to this literature by explicitly focusing on the quantitative consequences of TT, that is, for the case of Germany we estimate whether TT stimulates population growth in the cities that are involved in TT.

We focus on Germany because Germany became the main actor in TT after WWII. Applying a difference-in-differences approach, and distinguishing between the extensive margin of TT (whether TT exist at all for a given city) and the intensive margin (the number of TT relationships), **o**ur results show that German counties and municipalities that engage in town twinning often have had a significantly higher population growth compared to German cities that do not have twinning partners. Especially the number or intensity of twinning relations as well as town twinning with French cities, and with neighboring countries more generally, turn out to have had a positive effect on city growth. We also find that the positive population growth effects of town twinning are confined to the larger German cities. Town twinning could facilitate relocation or migration of workers and firms to more optimal locations for their skills and business, respectively. Thus, as the cities get more productive, they are likely to grow faster. As future research use of data on population flow could be very useful in establishing the exact mechanism as to how TT leads to city growth.

5.7. Appendices

Table 5A.1: Twinning with France, IV estimates (With IV set b variables)

Variables	partnerships + friendships		partnerships only		Friendships only	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
$Twinning_{mt}$	− 0.737***	− 0.153***	− 0.774***	− 0.180***	−1.523***	− 0.694***
	(0.108)	(0.0261)	(0.111)	(0.0311)	(0.345)	(0.133)
$Twinning_{mt} \times France_{mt}$	2.049***	0.324***	2.027***	0.357***	11.26***	6.719***
	(0.287)	(0.0526)	(0.286)	(0.0590)	(2.347)	(1.240)
Instruments	b	b	b	b	b	b
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.072	---	0.071	---	---	---
Sargan score (p-value)	2.26(0.322)	4.23(0.121)	2.99(0.224)	5.23(0.073)	1.36(0.51)	0.34(0.844)
Basmann score(p-value)	2.26(0.324)	4.21(0.122)	2.98(0.225)	5.21(0.074)	1.35(0.51)	0.34(0.844)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; dum = dummy; inten = intensity. Consistent with the results in the main sections, twinning with France remains to have strong and significant effects.

Table 5A.2: Twinning with France (small vs large)

Variables	partnerships + friendships		partnerships only		friendships only	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
Small Municipalities						
$Twinning_{mt}$	0.249	− 0.00727	0.242	− 0.0117*	0.111***	0.0275**
	(0.168)	(0.00530)	(0.166)	(0.00632)	(0.0347)	(0.0112)
$Twinning_{mt} \times France_{mt}$	0.235*	0.0214**	0.236*	0.0265***	− 0.0879	− 0.0311
	(0.137)	(0.00873)	(0.130)	(0.00961)	(0.0596)	(0.0396)
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,588	4,588	4,588	4,588	4,588	4,588
R-Squared	0.083	0.082	0.083	0.082	0.081	0.081
Large municipalities						
$Twinning_{mt}$	− 0.242***	0.00535**	− 0.264***	0.00639**	0.123***	0.0152**
	(0.0520)	(0.00210)	(0.0526)	(0.00256)	(0.0251)	(0.00668)
$Twinning_{mt} \times France_{mt}$	0.643***	0.0152***	0.661***	0.0159***	− 0.0703	0.00014
	(0.0621)	(0.00372)	(0.0607)	(0.00425)	(0.0513)	(0.0300)
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,526	4,526	4,526	4,526	4,526	4,526
R-Squared	0.443	0.439	0.445	0.440	0.430	0.428

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; dum = dummy; inten = intensity

Table 5A.3: Twinning with France, IV estimates (small vs large)

Variables	partnerships + friendships		partnerships + friendships		partnerships + friendships	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
Small Municipalities						
$Twinning_{mt}$	0.0351 (0.343)	− 0.0355 (0.0934)	0.0353 (0.343)	− 0.0429 (0.0991)	0.0258 (0.344)	0.0932 (0.151)
$Twinning_{mt} \times France_{mt}$	0.691 (0.675)	0.0641 (0.141)	0.690 (0.675)	0.0753 (0.150)	0.710 (0.676)	− 0.0548 (0.100)
Instruments	a	a	b	b	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,588	4,588	4,588	4,588	4,588	4,588
R-Squared	0.053	0.053	0.053	0.052	0.053	0.051
Sargan score (p-value)	1.20(0.753)	2.72(0.436)	1.20(0.549)	2.67(0.263)	0.86(0.355)	1.82(0.178)
Basmann score(p-value)	1.19(0.756)	2.70(0.440)	1.19(0.552)	2.65(0.266)	0.85(0.357)	1.80(0.180)
Large municipalities						
$Twinning_{mt}$	− 0.961*** (0.0736)	− 0.102*** (0.0114)	−1.011*** (0.0766)	− 0.202*** (0.0234)	−1.012*** (0.0767)	− 0.203*** (0.0235)
$Twinning_{mt} \times France_{mt}$	2.308*** (0.137)	0.229*** (0.0224)	2.423*** (0.145)	0.430*** (0.0465)	2.426*** (0.145)	0.431*** (0.0467)
Instruments	a	a	b	b	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,526	4,526	4,526	4,526	4,526	4,526
R-Squared	0.260	0.048	0.243	---	0.242	--
Sargan score (p-value)	8.76(0.033)	75.72(0.000)	1.25(0.535)	5.32(0.070)	0.85(0.355)	4.97(0.026)
Basmann score(p-value)	8.70(0.034)	76.23(0.000)	1.24(0.539)	5.28(0.071)	0.85(0.357)	4.93(0.026)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; dum = dummy; inten = intensity. Large municipalities benefit more, confirming earlier results.

Table 5A.4: Twinning with France (early vs late twinners)

Variables	reference year 1960		reference year 1970	
	(early) (1)	(late) (2)	(early) (3)	(late) (4)
$Twinning_{mt}$	− 0.398*** (0.0385)	− 0.0551 (0.0535)	− 0.31*** (0.0430)	0.0520 (0.0916)
$Twinning_{mt} \times France_{mt}$	0.878*** (0.0869)	0.240** (0.104)	0.601*** (0.0586)	0.0354 (0.193)
Year effects	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191
R-Squared	0.122	0.119	0.123	0.119

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; the effects are larger among the earlier twinners.

Table 5A.5: Twinning with France, IV estimates (early vs late twinners)

Variables	reference year 1960		reference year 1970		reference year 1960		reference year 1970	
	(early) (1)	(late) (2)	(early) (3)	(late) (4)	(early) (5)	(late) (6)	(early) (7)	(late) (8)
$Twinning_{mt}$	−1.240***	−1.83***	− 0.855***	− 4.67***	−1.319***	−1.973***	− 0.870***	−11.41***
	(0.177)	(0.292)	(0.114)	(1.372)	(0.186)	(0.310)	(0.116)	(4.213)
$Twinning_{mt} \times France_{mt}$	3.319***	4.609***	2.105***	14.15***	3.547***	4.953***	2.148***	34.30***
	(0.499)	(0.711)	(0.295)	(4.094)	(0.524)	(0.756)	(0.301)	(12.58)
Instruments	a	a	a	a	c	c	c	c
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
Location effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.086	---	0.086	---	0.081	---	0.085	---
Sargan score (p-value)	7.34 (0.062)	2.69 (0.441)	2.70 (0.441)	15.43 (0.002)	5.13 (0.024)	0.02 (0.890)	2.02 (0.154)	0.27 (0.600)
Basmann score (p-value)	7.32 (0.063)	2.68 (0.443)	2.69 (0.443)	15.39 (0.002)	5.11 (0.024)	0.02 (0.890)	2.015 (0.156)	0.28 (0.600)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 5A.6: Twinning with the EC and EU countries, (whole sample)

Variables	EC6		EC12		EU15		EU25	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)	(dum=1) (7)	(inten=n) (8)
$Twinning_{mt}$	− 0.44***	0.01***	− 0.47***	0.012***	− 0.48***	0.013***	− 0.53***	0.013***
	(0.0724)	(0.00195)	(0.0835)	(0.00238)	(0.0870)	(0.00246)	(0.0898)	(0.00285)
$Twinning_{mt} \times EC(U)_j$	0.529***	− 0.0001***	0.55***	− 0.0002***	0.57***	−0.0002***	0.64***	− 0.0001**
	(0.0653)	(5.25e-05)	(0.0858)	(5.63e-05)	(0.0920)	(5.38e-05)	(0.0969)	(5.46e-05)
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
Loc. fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	0.122	0.119	0.122	0.119	0.122	0.119	0.122	0.119

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; $EC(U)_j \in (EC6, EC12, EU15, EU25)$; dum = dummy; inten = intensity. Twinning with whole EC/EU as seen before seems to have been winning over Germany (negative effects). The same holds in the next tables.

Table 5A.7: Twinning with the EC and EU countries, IV estimates (whole sample, IV c)

Variables	EC6 (dum=1) (1)	EC6 (inten=n) (2)	EC12 (dum=1) (3)	EC12 (inten=n) (4)	EU15 (dum=1) (5)	EU15 (inten=n) (6)	EU25 (dum=1) (7)	EU25 (inten=n) (8)
$Twinning_{mt}$	−5.14*** (1.023)	0.529*** (0.146)	17.92** (6.995)	0.589*** (0.146)	19.72** (8.076)	0.575*** (0.139)	5.106*** (1.154)	0.569*** (0.129)
$Twinning_{mt} \times EC(U)_i$	7.268*** (1.463)	−0.019*** (0.00521)	−25.35** (9.852)	−0.017*** (0.00437)	−27.80** (11.34)	−0.02*** (0.00385)	−7.27*** (1.616)	−0.013*** (0.00303)
Instruments	c	c	c	c	c	c	c	c
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
Location effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	---	---	---	---	---	---	---	---
Sargan score (p-value)	7.86 (0.005)	1.80 (0.179)	0.004 (0.952)	0.33 (0.566)	0.005 (0.944)	0.77 (0.379)	14.38 (0.000)	0.66 (0.418)
Basmann score (p-value)	7.84 (0.005)	1.80 (0.180)	0.004 (0.952)	0.33 (0.567)	0.005 (0.944)	0.77 (0.380)	14.33 (0.000)	0.65 (0.419)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; $EC(U)_j \in (EC6, EC12, EU15, EU25)$

Table 5A.8: Twinning with the EC and EU countries, IV estimates (early vs late)

Variables	EC6 (early) (1)	EC6 (late) (2)	EC12 (early) (3)	EC12 (late) (4)	EU15 (early) (5)	EU15 (late) (6)
$Twinning_{mt}$	2.364*** (0.715)	− 0.402*** (0.0717)	16.44*** (6.149)	− 0.403*** (0.0730)	19.72** (8.076)	− 0.343*** (0.0718)
$Twinning_{mt} \times EC(U)_j$	−4.352*** (1.268)	0.0516*** (0.00723)	−23.34*** (8.687)	0.0616*** (0.00879)	−27.80** (11.34)	0.112*** (0.0171)
Instruments	c	c	c	c	c	c
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	11,191	11,191	11,191	11,191	11,191	11,191
R-Squared	---	0.082	---	0.057	---	---
Sargan score (p-value)	17.70 (0.000)	2.84 (0.092)	0.002 (0.958)	3.25 (0.071)	0.005 (0.944)	4.02 (0.045)
Basmann score (p-value)	17.65 (0.000)	2.83 (0.093)	0.003 (0.958)	3.24 (0.072)	0.005 (0.944)	4.00 (0.046)

Note: Standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; $EC(U)_j \in (EC6, EC12, EU15)$;
early(late) = before(after) joining EC6/EC12/EU15

Table 5A.9: Twinning with neighboring countries (small vs large)

Variables	partnerships + friendships		partnerships only		friendships only	
	(dum=1) (1)	(inten=n) (2)	(dum=1) (3)	(inten=n) (4)	(dum=1) (5)	(inten=n) (6)
	Small Municipalities					
$Twinning_{mt}$	0.142 (0.216)	− 0.0186*** (0.00610)	0.156 (0.213)	− 0.0204*** (0.00753)	− 0.0521 (0.0402)	− 0.038*** (0.0141)
$Twinning_{mt} \times Neighbor_{mt}$	0.322* (0.187)	0.0317*** (0.00859)	0.292 (0.179)	0.0326*** (0.00994)	0.294*** (0.0443)	0.164*** (0.0255)
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,588	4,588	4,588	4,588	4,588	4,588
R-Squared	0.084	0.082	0.083	0.082	0.082	0.082
	Large municipalities					
$Twinning_{mt}$	− 0.494*** (0.0568)	− 0.0190*** (0.00318)	− 0.523*** (0.0585)	− 0.0229*** (0.00392)	0.0122 (0.0322)	− 0.024*** (0.00866)
$Twinning_{mt} \times Neighbor_{mt}$	0.869*** (0.0567)	0.0477*** (0.00469)	0.895*** (0.0589)	0.0538*** (0.00561)	0.201*** (0.0365)	0.118*** (0.0197)
Year effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	4,526	4,526	4,526	4,526	4,526	4,526
R-Squared	0.464	0.449	0.464	0.449	0.433	0.431

Note: Robust standard errors in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; twinning with neighbors have positive and significant effects again as opposed to whole EC/EU members in the above tables.

Table 5A.10: Correlations: twinning and the instruments

	twinning	residential buildings loss %	rubble per capita tons	tax revenue loss %	# of casualties by war
twinning	1.0000				
residential buildings loss %	0.1503***	1.0000			
rubble per capita	0.1288***	0.9223***	1.0000		
tax revenue loss %	0.1291***	0.8429***	0.8755***	1.0000	
# of casualties by war	0.0740***	0.4593***	0.5274***	0.5090***	1.0000

*** = significance at 1% level

Table 5A.11: Merging twinning and population data

(1) Twinning data: 2614 cities and towns and 610 of them involved in twinning latest

	City,town /year	……..	1975	1976	1977	1978	1979	……..
		……..	……..					
1	Abtsgmünd	……..	……..	0	0	0	0	……..
2	Achberg	……..	……..	0	0	0	0	……..
3	Achern	……..	……..	0	0	1	1	……..
4	Adelberg	……..	……..	0	0	1	1	……..
5	Adelmannsfelden	……..	……..	0	0	0	0	……..
6	Adelsdorf	……..	……..	0	0	0	0	……..
7	Adendorf	……..	……..	0	0	0	0	……..
8	Adenstedt	……..	……..	1	1	1	1	……..
9	Adlkofen	……..	……..	0	0	0	0	……..
10	Affalterbach	……..	……..	0	0	0	0	……..
11	Ahlen	……..	……..	0	0	0	0	……..
12	Ahorn	……..	……..	1	1	1	1	……..
13	Aicha vorm	……..	……..	0	0	0	1	……..
14	Aichach	……..	……..	0	0	0	0	……..
15	Aidenbach	……..	……..	0	0	0	0	……..
16	Aken (Elbe)	……..	……..	0	0	0	0	……..
17	Albbruck	……..	……..	1	1	1	1	……..
18	Albersdorf	……..	……..	0	0	0	0	……..
19	Albersweiler	……..	……..	0	0	0	0	……..
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2601	Zeulenroda-	……..	……..	0	0	0	0	……..
2602	Zeven	……..	……..	0	0	0	0	……..
2603	Zierenberg	……..	……..	1	1	1	1	……..
2604	Zirndorf	……..	……..	1	1	1	1	……..
2605	Zittau	……..	……..	1	1	1	1	……..
2606	Zornheim	……..	……..	0	0	0	0	……..
2607	Zschopau	……..	……..	1	1	1	1	……..
2608	Zülpich	……..	……..	2	2	3	3	……..
2609	Zuzenhausen	……..	……..	2	2	2	2	……..
2610	Zweibrücken	……..	……..	1	1	2	2	……..
2611	Zwickau	……..	……..	1	1	1	1	……..
2612	Zwiefalten	……..	……..	1	1	1	1	……..
2613	Zwingenberg	……..	……..	1	1	1	1	……..
2614	Zwönitz	……..	……..	0	0	0	0	……..

(2) Population data: 440 municipalities/ counties

	Muncipalty,county(kreis)/year	1976	…	2006	2007
1	Aken (Elbe)	287619	…..	310267	310093
2	Aachen, Stadt	242453	…..	258208	258770
3	Ahrweiler	109435	…..	130467	129520
4	Aichach-Friedberg	91399	…..	127446	127531
5	Alb-Donau-Kreis	155694	…..	190233	190189
6	Altenburger Land		…..	106365	104721
7	Altenkirchen (Westerwald)	122066	…..	136425	135752
8	Altmarkkreis Salzwedel		…..	96040	94545
9	Altötting	92825	…..	109227	108789
10	Alzey-Worms	95552	…..	126328	126058
11	Amberg	46934	…..	44618	44394
12	Amberg-Sulzbach	94605	…..	108159	107683
13	Ammerland		…..	115891	116626
.	.	.	.	.	.
435	Wuppertal	405369	…..	359237	358330
436	Würzburg (Land)	146046	…..	159978	160222
437	Würzburg (Stadt)	112584	…..	133906	134913
438	Zollernalbkreis	173554	…..	192722	192138
439	Zweibrücken	35978	…..	35219	34842
440	Zwickau		…..	97832	96786

Table 5A.11: continued.

(3) # 1 and #2 merged: one or more rows of twinning data from #1 are added and matched with data in #2, resulting in:

	muncipalty/county(kreis)	population				twinning				
		1976	…..	2006	2007	…..	1976	1977	1978	1979	….
1	Aken (Elbe)	287619	…..	310267	310093	…..	0	0	0	0	….
2	Aachen, Stadt	242453	…..	258208	258770	…..	0	0	0	0	….
3	Ahrweiler	109435	…..	130467	129520	…..	3	4	4	4	….
4	Aichach-Friedberg	91399	…..	127446	127531	…..	2	2	2	2	….
5	Alb-Donau-Kreis	155694	…..	190233	190189	…..	1	2	2	3	….
6	Altenburger Land	na	…..	106365	104721	…..	0	0	0	0	….
7	Altenkirchen (Westerwald)	122066	…..	136425	135752	…..	3	3	3	3	….
8	Altmarkkreis Salzwedel		…..	96040	94545	…..	0	0	0	0	
9	Altötting	92825	…..	109227	108789	…..	1	2	2	2	….
10	Alzey-Worms	95552	…..	126328	126058	…..	3	3	4	4	….
11	Amberg	46934	…..	44618	44394	…..	0	0	0	0	….
12	Amberg-Sulzbach	94605	…..	108159	107683	…..	0	0	0	0	….
13	Ammerland	na	…..	115891	116626	…..	1	1	1	1	….
.	.		.	.	.	.	.	.	.	.	….
.	.		.	.	.	.	.	.	.	.	….
.	.		.	.	.	.	.	.	.	.	….
.	.		.	.	.	.	.	.	.	.	….
434	Wuppertal	405369	…..	359237	358330	…..	2	3	3	3	….
435	Würzburg (Land)	146046	…..	159978	160222	…..	0	2	2	2	….
436	Würzburg (Stadt)	112584	…..	133906	134913	…..	4	4	4	5	….
437	Zollernalbkreis	173554	…..	192722	192138	…..	3	3	3	4	….
438	Zweibrücken	35978	…..	35219	34842	…..	1	1	2	2	….
439	Zwickau	na	…..	97832	96786	…..	1	1	1	1	….
440	Zwickauer Land	na	…..	128630	127192	…..	0	0	0	0	….

Chapter Six

Long-run Effects of Improved Transportation Links on Size of Dutch Cities[54]

6.1. Introduction

Cities are prime locations of economic activities and have become increasingly important to policy makers and researchers. Different types of economic integration affect the growth of cities by changing their market access. In previous chapters, we analyzed the effects of national border integration and integration through international town twinning (TT) on cities' population growth. There are also other forms of integration. One of them is (improving) integration of cities and regions through improved transportation links. In this chapter, we look at this third type of integration and its effects on cities growth.

The economic wellbeing of population of a city depends, among other things, upon its own characteristics such as sector-structure, the population size, and its skilled population (see Glaeser et al., 1995). Moreover, it depends on the city's location relative to other cities and transportation routes. Economic activities tend to cluster in large urban areas due to positive agglomeration effects, which do not exist in small towns. There are, however, other factors or repulsion forces that make large cities less attractive and may lead to the spreading of economic activities. These include higher wages and other production costs, higher living costs such as housing, and congestion. The size of these economic activities can be reflected in the size of cities. The size and distribution of cities are determined by the relative strength of such positive forces of attraction to agglomerated locations and the repulsion forces (Krugman, 1991a, 1995; Fujita and Mori, 2005; and Fujita et al., 1999).

Very high or very low trade costs favor the dispersion of economic activities while agglomeration would emerge for intermediate values of these costs once the spatial mobility of workers is low (Fujita and Thisse, 1996). Various natural as well as policy induced interventions can change the center of balance between the two forces. Depending on the degree of the shift in the balance, this may trigger relocation of economic activities with mainly firms and workers which, in turn, affects the size of the cities. The outcomes are either further agglomeration or dispersion of economic activities. An example of such intervention is the construction of new or improving existing transportation routes connecting cities. Such an investment reduces transportation or trade costs between the cities or regions.

In this chapter, we use a simulations approach to analyze the long-run effects of four transportation projects in the Netherlands using the New Economic Geography (NEG) model based on Krugman (1991a), Helpman (1998) and Hanson (1998). We specifically use the Core-Periphery (CP) model and mainly focus on its extension called the Core-Periphery Congestion (CPC) model of the New Economic Geography with interregional factor mobility by Krugman (1991a).

Figure 6.1: Randstad, the Netherlands
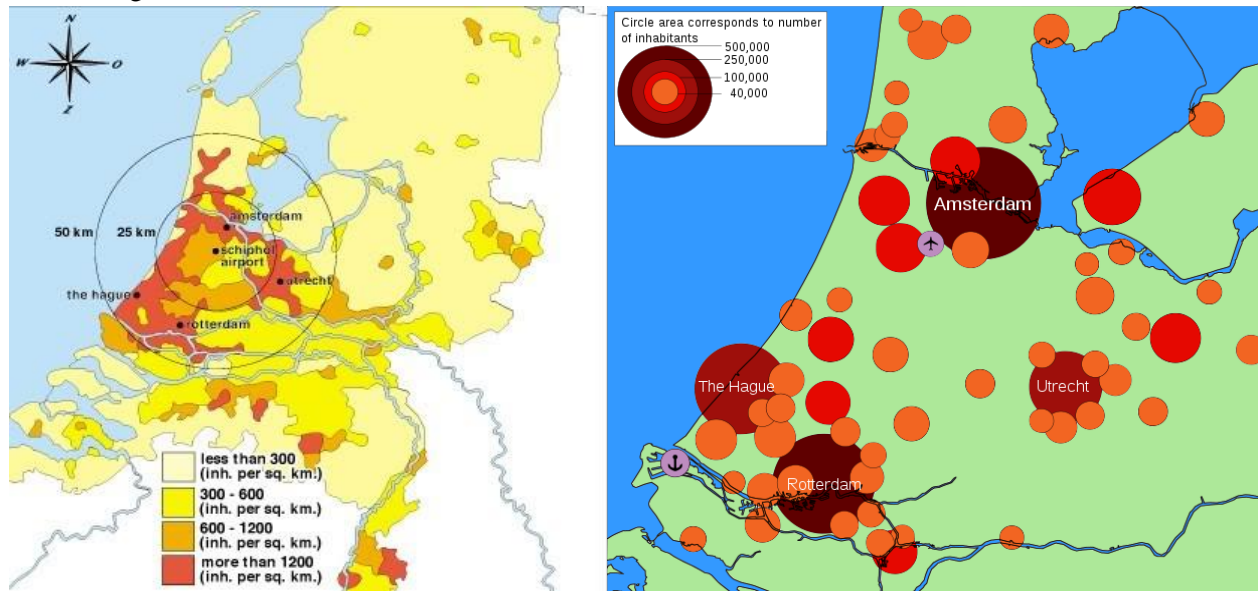
We analyze the long-run implications of four road and railway projects that are aimed at improving transportation between the large cities in the west of the Netherlands called Randstad and nearby smaller municipalities in Flevoland (e.g. the new towns Almere and Lelystad). With the simulation analysis, we try to answer the following questions. Does this intervention lead to relocation of firms and workers into the municipalities near the projects at the expense of the other municipalities? Do all municipalities benefit from this intervention or do only large municipalities gain over small ones in the vicinities of the projects? Does the intervention lead to divergence or convergence between the large and small cities as well as between the municipalities in the Randstad and the cities outside? How do the effects differ across municipalities of different sizes and across municipalities that are at different distances from the project locations?

The rest of this chapter is arranged as follows. In Sections 6.2 and 6.3, we discuss the NEG models that we use in our analysis. In Section 6.4, we discuss alternative policy scenarios. We use four potential policy interventions that are aimed at the reduction of travel time and the subsequent transportation cost within the Randstad area of the Netherlands and the transportation routes connecting them with smaller neighboring municipalities. The simulation results of the policy intervention are given in Section 6.5. Section 6.6 gives the summary and conclusions.

6.2. The model

Various models have been used over time to analyze the spatial distribution (agglomeration versus spreading) of economic activities and the effects of policy interventions. In this chapter, we use the New Economic Geography (NEG) model based on Krugman (1991a), Helpman (1998) and Hanson (1998). In the NEG model, there are two opposing forces, i.e., one leading to agglomeration and the other leading to the spreading of economic activities. The existence of such forces affects the outcome of man-made or natural disasters or constructive investment in an infrastructure. A number of papers in economic geography investigate this by using models that involve the combination of Dixit and Stiglitz (1977) monopolistic competition and 'iceberg' transport costs. In a world characterized both by increasing returns and transportation costs, there will obviously be an incentive to concentrate production of a good near its large markets, i. e., agglomeration (Krugman 1991a). The consequence of the agglomeration, according to Krugman, is that economically strong regions (core) become increasingly stronger, and the weak regions (periphery) become increasingly weaker. Home market effect (the ability to sell a large proportion of products in the same place of production) emerges in cities and agglomerated regions which are densely populated by people who have a preference for a varied supply of products and services called love-for-variety (see Brakman et. al. (2009)). Large scale production for such a market helps those firms to reduce production costs and make profits. Agglomeration also provides a wide range of employees with various skills called labor market pooling. These further attract more firms to large cities and agglomerated areas. Furthermore, Davis and Weinstein (1999), for instance, show the positive effect of agglomeration on the economic growth of cities.

However, according to Hanson (1998) such an agglomeration process has limits. After some level of agglomeration, economic centers become too crowded, resulting in a situation in which the agglomeration becomes a disadvantage due to high wages, traffic congestion, and high housing prices. If such agglomeration disadvantages outweigh the agglomeration advantages, the concentration of economic activities may stop growing and start to disperse to the cities outside the economic centers (see Brakman et al. 2009). Similarly, expansion of manufacturing activities in such markets increases wage cost which leads to relocation of the firms to the areas with lower wages and other input costs (Puga and Venables 1996). In addition to such congestion forces, some external shocks can also break the pattern detected by Krugman (1991a). These shocks can be the destruction of cities' infrastructures during conflict (for example, see Brakman et al. 2004a) or positive shocks of policy interventions such as construction of housing that reduces housing costs or transportation routes that reduce congestion. This chapter focuses on the latter, i. e., construction of roads and railways. Ceteris paribus, improved transportation between the core and the periphery, may lead to both relatively higher population and economic growth of the periphery. Models that involve the combination of Dixit and Stieglitz's (1977) monopolistic competition and 'iceberg' transport costs are often used in analyzing related issues. In these models, agglomeration is caused by the desire to overcome transport costs when selling products or making purchases. This similar desire on the side of producers and consumers leads to a feedback loop, resulting in self-reinforcing agglomeration (see Knaap 2004). The precise form of the loop and the resulting degree of agglomeration differs between models. These models often

lead to too much agglomeration than real world distribution of economic activities, i.e., agglomeration bias. In the NEG, it is possible to account for real geographical factors and congestion factors that are resistant to full agglomeration and produce a more realistic distribution of economic activities.

We use the extension of the Core-Periphery (CP) model, namely the CP with congestion (CPC), of the New Economic Geography with interregional factor mobility by Krugman (1991a) to investigate the long-run implications of the four road and railway projects which are intended to improve transportation between the large cities in the west of the Netherlands called Randstad and nearby smaller municipalities (see section 6.3 for detail). The general CP model for M municipalities is given by equations (6.1) through (6.4). See Brakman et al., (2009) for the detailed derivation the equations and for some normalization process of the parameters to get the compact form of the model:

$$Y_a = \delta \lambda_a W_a + (1 - \delta) \phi_a \tag{6.1}$$

$$I_a = \psi_a^{1/(1-\varepsilon)} \quad \text{and} \quad \psi_a = \sum_{i=1; i \neq a}^{N} \left(\lambda_i T_{ai}^{1-\varepsilon} W_i^{1-\varepsilon} \right) = \sum_{i=1; i \neq a}^{N} \left(\lambda_i T^{D_{ai}(1-\varepsilon)} W_i^{1-\varepsilon} \right) \tag{6.2}$$

$$W_a = \Phi_a^{1/\varepsilon} \quad \text{and} \quad \Phi_a = \sum_{i=1; i \neq a}^{N} \left(Y_i T_{ai}^{1-\varepsilon} I_i^{\varepsilon-1} \right) = \sum_{i=1; i \neq a}^{N} \left(Y_i T^{D_{ai}(1-\varepsilon)} I_i^{\varepsilon-1} \right) \tag{6.3}$$

$$T_{ai} = T_{ia} = T^{D_{ai}} \tag{6.4}$$

Equations (6.1) through (6.3) for each municipality $a = 1, 2, \ldots, A$ together determine the income level Y_a, price index I_a, and wage rate W_a for each municipality a. The economy has two sectors. One is the manufacturing sector with employment share of λ_m and the other is the agricultural sector with employment share of ϕ_m for each municipality. $\sum_i \lambda_s = \lambda_1 + \lambda_2 + \ldots + \lambda_a = 1$ and, similarly, $\sum_i \phi_s = \phi_1 + \phi_2 + \ldots + \phi_a = 1$. A household spends δ fraction of income on manufacturing goods and the remaining $(1 - \delta)$ on agricultural commodities, i.e. food. $T_{ai} = T_{ia} = T^{D_{ai}}$ is the iceberg transport costs indicating the number of units needed to be shipped from municipality a so that one unit of the good arrives in municipality s and vice versa where D_{ai} is the unit of distance between municipality a and i, for instance, road distance in kilometers or travel time in minutes. $\varepsilon = 1/(1 - \rho)$ is the elasticity of substitution between manufacturing goods where $\rho \in (0, 1)$ is the substitution parameter representing the love-of-variety effect in the aggregate consumption function of manufacturing goods (see Brakman et al., 2009):

$$C = \left(\sum_{j=1}^{N} c_j^\rho \right)^{1/\rho} \tag{6.5}$$

The derivation of the CP model is based on production function of the form:

$$l_j(w_j) = w_j(\alpha + \beta x_j) \tag{6.6}$$

and the demand for variety $x_j = \theta p_j^{-\varepsilon}$ where $l_j(w_j)$ is the amount of labor required to produce x_i units of manufacturing output depending on real wage cost; and α and β are the fixed and marginal labor input requirements, respectively; p_j is the unit price of the variety, and θ is a constant. The real wage rate in municipality a is defined as $w_a = W_a I^{-\delta}$. Given the L total labor force of the economy, the model assumes that a fraction $\gamma \in (0, 1)$ of the proportion of the labor force work in the manufacturing sector whereas the remaining $(1-\gamma) \in (0, 1)$ work in the food sector. As opposed to some research evaluating the impacts on the transportation infrastructure (for instance Knaap, 2002), we assume that, in the short-run, the wage rate varies across municipalities. However, we adopt similar assumptions with such works based on several aspects. For instance, like many other works, we assume that there are no constraints in labor supply. This means that each community has a sufficiently large pool of unemployed people to use in times of increased labor demand.

We extended the CP model by accounting for congestion cost and obtain the congestion (CPC) model. The CP and CPC model are more or less the same except for the use of the congestion parameter in the CPC model; we can call both CP models. The CP model, in general, explains agglomeration (and spread) of economic activities in terms of demand linkage (Forslid and Ottaviano, 2003). When a firm moves its production facilities to a new site, the local market is affected through two channels: (i) Given the trade costs, the presence of a new competitor reduces local prices which reduces the demand per firm (market crowding effect) and increases consumer surplus (cost-of-living effect); (ii) local expenditures grow, increasing the demand per firm (market size effect) if the extra income generated by the new firm is spent locally. The first effect discourages geographical agglomeration whereas the other two effects encourage it by creating circular causation among firms' and workers' location decision. This is based on the assumption of employing only local workers and labor is the only factor of production. This is solely the case in the CP model whereas the CPC models reveal some additional effects. In the CPC model, we see extra spreading force of congestion cost that can be seen as a second force that discourages agglomeration. The congestion model is based on the idea that it is disadvantageous to locate production in an area that are already crowded by other firms. The increase in the congestion cost as more and more firms locate in one place raises the incentive of the firms to relocate to less crowded areas. The size of congestion depends on the number of manufacturing firms N_a located in municipality a. The extra cost due to congestion is reflected in the production function of the variety x_j given as:

$$l_{ja}(w_j) = N_a^{\tau/(1-\tau)} w_j(\alpha + \beta x_j) \tag{6.7}$$

where $\tau \in (-1, 1)$ is the congestion parameter. Note that the labor requirement $l_{ja}(w_j)$ for each unit of x_j differs for each municipality depending on congestion. $\tau = 0$ means no congestion, and the

model remains the same as the CP model; $\tau \in (0, \ 1)$ means the cost increases as more and more firms locate in the same area and so congestion is harmful; whereas $\tau \in (-1, \ 0)$ means firms benefit from locating together. Note that the difference in all of the CP, CPC and FE models arise from the cost of production and are reflected in the production function (see below for more on the FE model). After incorporating the production function with congestion, equation (6.1) above remains the same whereas the right hand expressions of equations (2) and (6.3) become equations (6.8) and (6.9).

$$I_a = \psi_a^{1/(1-\varepsilon)} \quad \text{and} \quad \psi_a = \sum_{i=1; \ i\neq a}^{N}\left(\lambda_i T_{ai}^{1-\tau\varepsilon} W_i^{1-\varepsilon}\right) = \sum_{i=1; \ i\neq a}^{N}\left(\lambda_i T^{D_{ai}(1-\tau\varepsilon)} W_i^{1-\varepsilon}\right) \tag{6.8}$$

$$W_a = \Phi_a^{1/\varepsilon} \quad \text{and} \quad \Phi_a = \lambda_a^{-\tau}\sum_{i=1; \ i\neq a}^{N}\left(Y_i T_{ai}^{1-\varepsilon} I_i^{\varepsilon-1}\right) = \lambda_a^{-\tau}\sum_{i=1; \ i\neq a}^{N}\left(Y_i T^{D_{ai}(1-\varepsilon)} I_i^{\varepsilon-1}\right) \tag{6.9}$$

In the CPC model with a positive congestion parameter, some places become less attractive since the degree of competition increases as the number of firms locating there increases. Thus, the newcomers, or even some of the existing firms, may locate in new and less populated locations. A similar argument holds for consumers as well. The living cost is higher in more crowded locations, and thus consumers prefer to live outside such locations. Thus, the CPC model has a spreading effect and is more realistic than the CP model where all the firms tend to end up in one location. Papageorgiou and Thisse (1985) describe the process of interaction between the two classes of agents as follows: "Households are attracted by places where the density of firms is high because opportunities there are more numerous, and they are repulsed by places where the density of households is high because they dislike congestion. Firms are attracted to places where the density of consumers is high because there the expected volume of business is large, and they are repulsed by places where the density of sellers is high because of the stronger competition. So, by adopting a congestion model, we add an additional spreading factor (see also Bosker et al. 2007b) to the core-periphery model where agglomeration is most likely a stable long-run equilibrium. High transportation costs representing all kinds of barriers (see Brakman et al., 2009) are also a spreading factor. Before the simulation of the effects of the actual policy scenarios, we will have a closer look at the effects of transportation cost and congestion in a multiple region scenario.

6.3. Agglomeration effects of transportation cost and congestion

In this sub-section, we analyze the effects of different transportation costs and different levels of congestion in the case of multiple locations. We use actual population size of the 418 municipalities of the Netherlands representing the size of economic activities in 418 different locations or regions. Figure 6.2a below shows the results for changing transportation cost at a given level of congestion factor. It shows that, at very high congestions factors such as $\tau = 0.30$ or $\tau = 0.20$, positive and increasing transportation cost (for instance from $T_{ij} = T_{ai} = 1.01$ to $T_{ij} = T_{ai} = 1.30$) leads to more spreading. Moreover, perfect spreading becomes the long-

run equilibrium when the transportation is totally free ($T_{ij} = T_{ai} = 1.00$). In general, the finding of the changes in transportation cost and congestion factor are in line with theory. The absence of congestion and low transportation costs lead to agglomeration as is indicated by steep or fast falling curves. The lower the congestion, the higher the agglomeration (fast falling curves) even with positive transportation costs. With positive congestion and positive transportation cost, higher transportation cost leads to a much greater spread (flatter curves). Moreover, with any positive congestion $(\tau > 0)$, free transportation always leads to spreading equilibrium. With free transportation and zero congestion, the initial distribution remains a long-run equilibrium (no redistribution).

Figure 6.2a: Changing transportation $T_{ij} = T_{ai}$, fixed congestion factor (τ)[55]
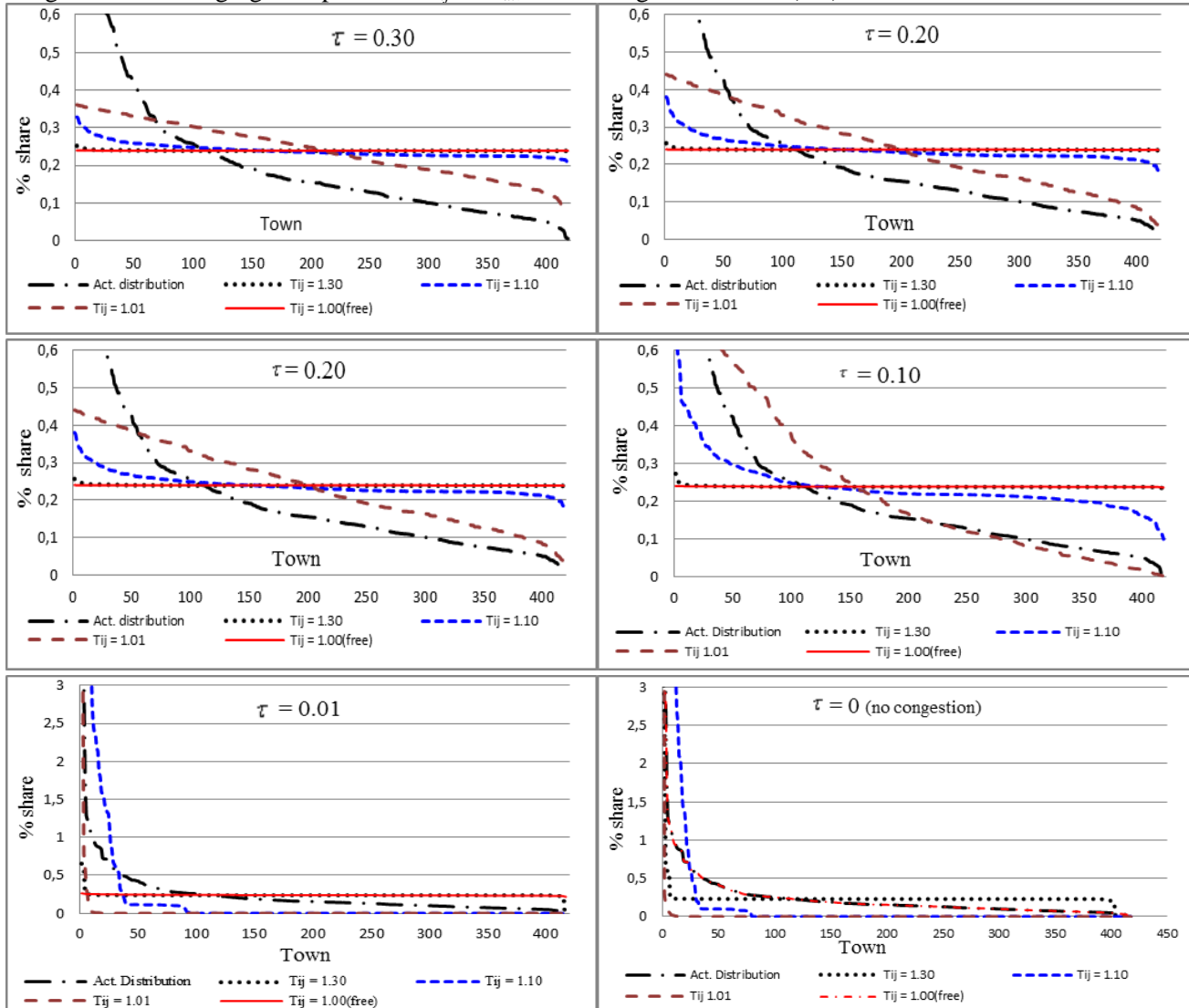
Note: #,## (Dutch style decimals) are the same as #.## (international style)

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[55] $T_{ai} = T_{ia} = T$ in the equations and T_{ij} in the figures are the same and measures the iceberg transportation cost.

Figure 6.2b shows the results for changing congestion factor at a given level of transportation cost. With positive transportation cost, higher congestion always leads to a spread. However, the lower the positive transportation cost, the smaller congestion as 0.01 leads to agglomeration (see $\tau = 0.01$ curve as we go from figure for $T_{ij} = T_{ai} = 1.30$ to $T_{ij} = T_{ai} = 1.20$ to $T_{ij} = T_{ai} = 1.10$ and to $T_{ij} = T_{ai} = 1.10$). Absence of congestion and lower transportation costs lead to agglomeration (fast falling curves). The lower the congestion, the higher the agglomeration (fast falling curves) even with some positive transportation costs. With positive congestion and positive transportation cost, higher transportation costs lead to a spread (flatter curves). Similarly, with positive congestion, free transportation also leads to spreading equilibrium. With high transportation costs, absence of congestion leads to agglomeration whereas positive small, as well as high, congestion leads to a spread.

Figure 6.2b: Changing congestion factor (tau, τ), fixed transportation $T_{ij} = T_{ai}$
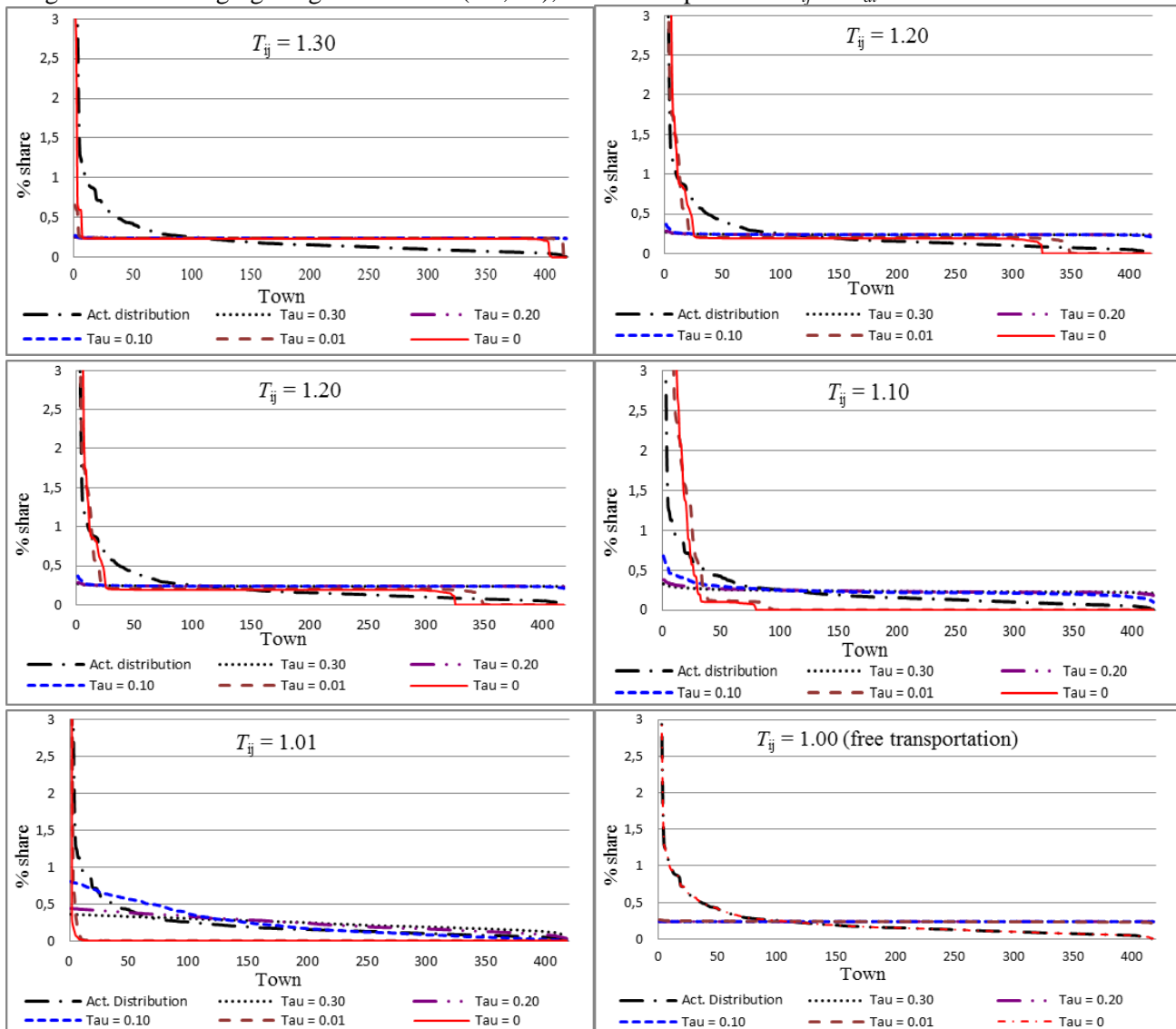
Note: #,## (Dutch style decimals) are the same as #.## (international style)

Poor transportation infrastructure can account for 40 to 60 percent of transport costs; obviously, improved transportation infrastructure reduces transport cost (see Limao and Venables, 2001) as does the reduction in travel time accomplished through the projects aimed at improving the transportation infrastructure. New infrastructure may lead to further agglomeration in the core area and dispersion to the nearby smaller municipalities. Although it is argued that dispersion is usually unfavorable when compared to agglomeration, from a welfare point of view, dispersion necessarily takes place when the transportation cost is sufficiently low (Tabuchi, 1998). Dispersion also exists with very high transportation costs. Baldwin et al. (2003) also show that infrastructural developments have non-linear effects in the presence of agglomeration effects. Very high or very low trade costs would favor the dispersion of economic activities while agglomeration would emerge for intermediate values of these costs once the spatial mobility of workers is low (Fujita and Thisse, 1996).

6.4. The policy scenarios: abolition of traffic congestion

The Dutch government and municipalities have recently been working on policies that are aimed at developments and integration of cities by reducing or abolishing traffic congestion among and between these cities. These development initiatives may have different outcomes for different cities. Whether cities benefit from such projects depends on whether the cities are competitive or complementary (for example, see Tabuchi, 1998). If the cities are complementary, all of the cities will gain from the intervention. However, if they are competitive, some cities may gain at expense of others. It is also possible that the policy intervention may change the competitive position of the Randstad compared to the other cities in the country as well as large cities compared to smaller cities.

In this chapter, we focus on the distribution effects of the projects in terms of population. The projects change the transportation and trade costs that lead to relocation of firms and workers. This means that some municipalities inevitably lose whereas others gain. In the projects that we are analyzing in this chapter, the improvement in infrastructure implies reduction in traffic congestion as well as reduction in trade cost among municipalities that use the particular transportation routes. The questions that we try to address are the following. Does this intervention lead to more agglomeration in the Randstad at the expense of the other cities? Do only large cities in the Randstad and in its vicinities gain over the small ones or vice versa? Does the intervention lead to divergence or convergence between the large and small cities? This intervention may benefit smaller cities in close range with the improved transportation links over the large ones since people can live in cheaper cities and easily access the large city for work, recreation, and shopping. In this chapter, we focus on simulation analysis of long term population effects on the municipalities resulting from four road and railway construction projects aimed at reduction or elimination of traffic congestion at selected trajectories within the Randstad area and in its vicinities conurbation:

a) Railway Construction (OVP1), [De aanleg van de Hanzelijn]

b) Road Widening (AUTOP2), [De verbreding van de A1/A6]

c) Railway Construction (OVP3), [De IJmeerverbinding]

d) Road Widening (AUTOP4), [De verbreding van de A27/AGU]

The first project (OVP1) is the construction of a new railway from Lelystad through Dronten to Zwolle which opened at the end of 2012. This project will shift at least part of the traffic between the northern Dutch cities and Amsterdam through Dronten, Lelystad, and Almere as opposed to the former route through Amersfoort. These municipalities along this route are expected to grow relatively faster if the reduction in transportation cost due to this project is higher than the benefit of agglomeration in the Amsterdam area. The second project (AUTOP2) is widening the highway between Almere and Amsterdam. This project is also expected to benefit smaller nearby municipalities connected to Amsterdam through this road if the reduced transportation cost is large enough. The third project (OVP3) is construction of a railway at the trajectory from Schiphol through Amsterdam and Almere to Lelystad. This is aimed at improving the economic wellbeing of population of the cities by better integrating them with the main Randstad area. In this project, we look at the effect of such further integration of Lelystad and Almere into the Randstad in comparison with expectation of the cities. Thus, we try to answer whether these cities benefit as intended by such measures or if the cities in the Randstad become more competitive and capture the benefit. The fourth project (AUTOP4) is about increasing the width of the existing road between Utrecht and Almere through the Gooi region. The aim of this project is also to better integrate Almere and other cities in the area with the Randstad by improving transportation through Utrecht.

To simulate the effects of these projects, we use the road distance data between all municipalities of the Netherlands and their population data in 2009. Changes in travel time due to these projects were constructed with the kind cooperation of the cities of Almere and Lelystad, two of the cities which are expected to benefit most from these projects in terms of attractiveness. The new route of the first project (OVP1) reduces the travel time of 161 municipalities who would travel through this route to other cities (see table 6.1 below indicating a summary of all of the projects). Similarly, the projects AUTOP2, OVP3, and AUTOP4 change, respectively, the travel times of 133, 55, and 161 Dutch municipalities. The largest reduction in travel time by project 1 is about 71 percent which is between Dronten and Zwolle; whereas the smallest reduction is 0.012 percent between Schiermonnikoog and Maassluis. The largest change due to AUTOP2 is about 10.9 percent (between Diemen and Muiden) whereas the smallest change is approximately 0,002 percent (between Amsterdam and Dongeradeel). The largest and the smallest change due to OVP3 is 37.1 percent (between Almere and Diemen), and the largest change due to AUTOP4 is 23.3 percent (between Eemnes and De Bilt). All of the projects are located on transportation routes within the Randstad area and its vicinity. We analyze the implications of these for different cities within the vicinities of the Randstad such as Almere, Lelystad, and Dronten in terms of population distribution. Moreover, we investigate whether there are different implications for smaller cities

compared to large cities and for cities that are far away from the project locations compared to nearby cities.

Table 6.1: Summary of the projects travel time (T_{ai}) effects

Projects	pair of affected roads (T_{ai})	Affected municipalities	the largest change in T_{ai}	the Smallest change in T_{ai}	Mean sum change in T_{ai}
OVP1	4790	161	0.71122	0.000122	1.624446
AUTOP2	3401	133	0.10877	0.000020	0.361751
OVP3	204	55	0.37103	0.032050	0.100537
AUTOP4	4630	161	0.23277	0.000150	1.166299

For the empirical analyses and simulations, we use the spatial data that include indicators of the spatial location of 427 Dutch municipalities and the degree of agglomeration of cities and urban regions. Before we go to the simulation of the long run effects, we show the description of the short run effects of the projects on market potential based on Harris (1954). We calculate the changes in the market potential due to the changes in travel time following the different projects. The change in the market potential for municipality m is calculated as $\Delta MP_a = \sum_{i=1}^{N}\left(\frac{Q_a}{T_{ai(t=1)}}\right) - \sum_{i=1}^{N}\left(\frac{Q_a}{T_{ai(t=0)}}\right)$; where, $T_{ai(t=0)}$ and $T_{ai(t=1)}$ are travel times between the two municipalities a and i before and after the projects, respectively; Q_a is a measure of economic size, for instance, population, of municipality m; and ($N = 427$ in this case) is the number of municipalities in the sample. In this way, the short run effects of the infrastructural interventions policy can be calculated. The emphasis here is not on the effects on transportation flows but on the impacts on the spatial allocation of economic activities measured by population distribution. Figure 6.3 shows the map of the changes in the market potential in terms of population and employment under each project.

The darker the shade appears for the maps in the figure, the larger the gain in the market potential. These changes are short-run gains in the market potential as the result of immediate changes in the travel time in the denominator of the market potential. The gains in terms of population and employment are slightly different, but both are the largest at and near the location of the projects since these places also experience the largest reduction in the travel time to other municipalities. The gain in the market potential in terms of population implies improved access of the firms to households, i.e., consumers; whereas the gain in the market potential in terms of jobs implies easier access of the household to companies due to improved transportation. The improved transportation changes the transport costs of both firms and workers.
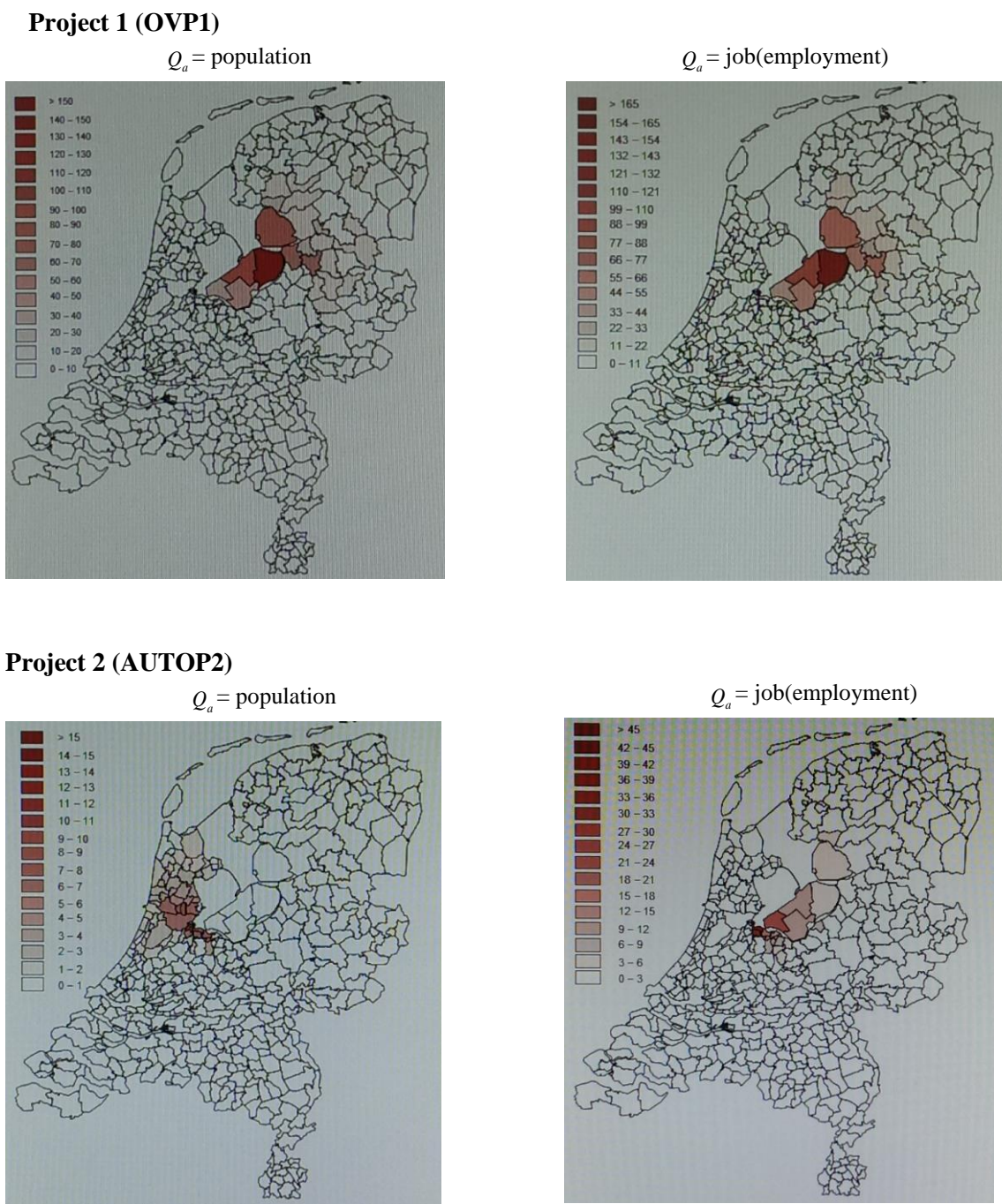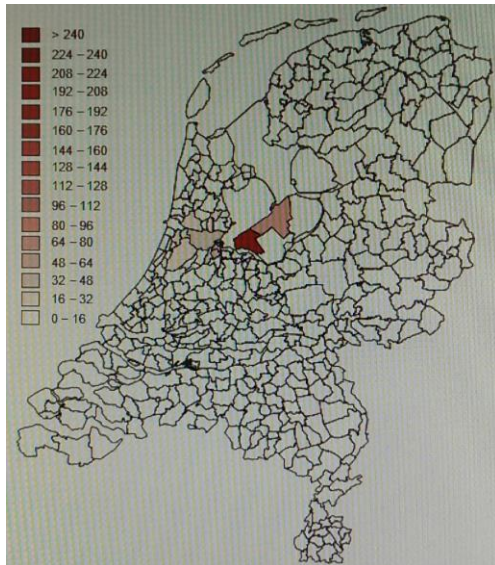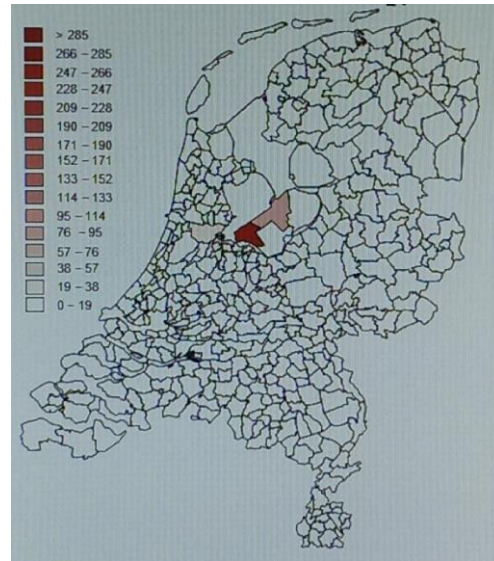
Figure 6.3: Changes in the market potential

Project 1 (OVP1)

Q_a = population

Q_a = job(employment)

Project 2 (AUTOP2)

Q_a = population

Q_a = job(employment)

Figure 6.3: continued.

Project 3 (OVP3)

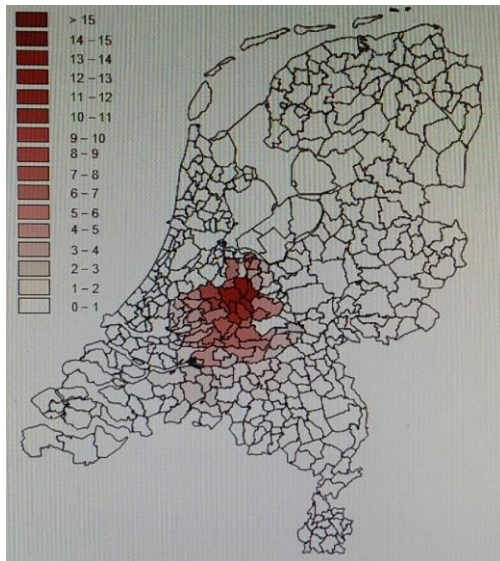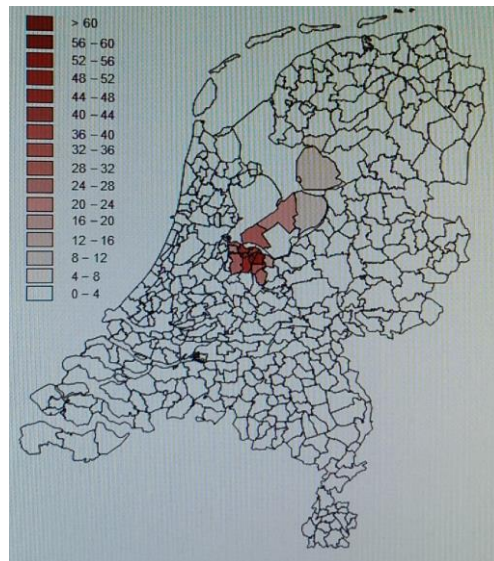Q_a = population

Q_a = job(employment)

Project 4 (AUTOP4)

Q_a = population

Q_a = job(employment)

The figures show only short-run effects without relocation of firms or workers. However, the changes may also lead to relocation of the firms and the workers in the long run since transportation cost is one of the major determinants of firms' locations with respect to the location of the workers and consumers (for instance, see Krugman and Venables, 1995; Tabuchi and Yoshida, 2000; Puga and Venables, 1996; and Wen, 2004). Obviously, reduced travel time

through improved transportation means reduced transportation cost and lower trade cost. Moreover, lower trade cost means less agglomeration (Puga, 2002) because, with lower trade cost, some firms relocate from industrial agglomeration to regions with lower wages (see Krugman and Venables, 1995). Therefore, these projects aimed at reducing travel time and transportation cost may lead to less agglomerated municipalities. Thus, we next need to look at the long-run effects using a simulation approach based on the NEG long-run equilibrium model discussed above in section 6.2.

6.5.   The long-run effects

Here, we use computer simulation of the long-run effects of the proposed projects based on the NEG model described in the earlier section. This baseline simulation analysis is based on the 427 municipalities of the Netherlands. Many estimation and simulation works based on NEG models use straight line distances between two locations (for instance, see Stelder, 2005). However, we use the shortest path road network and actual travel times between municipalities since these are a better measurement of the distances that the commodities and workers travel. Obviously, the shortest path road distance between two municipalities is the same whether we measure it from city a to city i or from city i to city a, i.e., $D(a, i) = D(i, a)$. We also assume that the travel time of going and returning between two municipalities is the same, i.e., $T(a, i) = T(i, a)$. This assumption is realistic for almost all pairs of municipalities in the Netherlands since most of the country's topography is almost flat. In case of mountainous countries, driving up the hill and driving down the hill may take different travel times between the same two municipalities. However, travel times between two cities can differ when congestion is only in one direction (e.g. Almere $\rightarrow$Amsterdam) and not in the other direction (e.g. Amsterdam$\rightarrow$Almere). In this analysis, we do not account for that possibility.

Moreover, both the road distance and travel time include the internal (within a municipality) distance and/or travel time since the municipalities cover the area of more than one city in almost all of the cases. As described in the earlier section, there are two types of projects, namely, the road projects and railway projects. We use the road network to account for changes in distance and travel time effects of both types of projects since the complete railroad connecting all of the 427 municipalities is not available since some towns have not railroad connection. This means that we assume that everyone travels by car or train, depending on the shortest travel time of either of these modalities. Finally, we assume the initial distribution of manufacturing workers is proportional to the initial distribution of the population. For instance, if the municipality of Amsterdam accounts for 5 percent of the total Netherlands population, the municipality also accounts for 5 percent of the national manufacturing workers.

In the simulation process, we start with a parameter configuration that reproduces the current level of agglomeration as close as possible. We use four different combinations of the models and different distance options. These are two core model (CP) options, i.e., one with distance in kilometers and another with distance measures by travel time in minutes and two

congestion (CPC) model options with positive congestion parameter (τ) in combination with the two distance options. The parameters' combinations (given in Table 6.2) are chosen in such way that different parameter configurations reproduce the actual distribution as close as possible under different model options. For instance, at low or medium transport cost, the fact that there is no congestion problem in the core models leads to agglomeration at one place as the long-run equilibrium, leading to agglomeration bias. Thus, ceteris paribus, an approximate real distribution of the cities is possible only at high iceberg transportation costs of about 33 percent with travel time as a measure of distance and at about 40 percent with actual road distance. On the contrary, under the congestion model, the closest realistic distribution happens even at a very low transportation cost of about 5 percent. Figure 6.4 shows the approximated distribution under the congestion model.

Table 6.2: the parameters configuration

Model	Distance options	Parameters configuration			
		$\gamma(=\delta)$	$\varepsilon(=\rho)$	T	τ
Core model (no congestion)	road distance (in kilometers)	0.5	5(0.8)	1.40	0
	Travel time (in minutes)	0.5	5(0.8)	1.33	0
Congestion model ($\tau > 0$)	road distance (in kilometers)	0.5	5(0.8)	1.05	0.10
	Travel time (in minutes)	0.5	5(0.8)	1.05	0.10

Note: Tolerance = 0.001; and the number of regions/municipalities M = 427 in all the model scenarios.

Moreover, we fix some parameters in advance according to the definitions of the models (for instance $\tau = 0$ in the core model by definition). Moreover, the proportion of manufacturing workers remains the same throughout the model options. Thus we largely use the iceberg transportation level that reproduces close distribution with the real agglomeration level based on the 2009 population. High transportation cost of up to 40 percent is required to keep the spread near actual distribution. However, consistent with falling transportation cost (example see McCann and Shefer 2004), a very low cost of 5 percent is sufficient for this with the congestion model. The proportion of the labor force working in the manufacturing sector $\gamma = 0.5$ is also assumed to be equal with the proportion of the income spent on manufacturing goods (δ). The elasticity of substitution $\varepsilon = 1/(1-\rho) = 5$ is calculated from the substitution parameters $(\rho = 0.8)$ meaning the consumption goods are substitutes but less than perfect. The transportation parameter $(T > 1)$ implies that more than 1 unit of goods should be shipped from one municipality so that 1 unit arrives in another municipality. The congestion parameter $(\tau = 0)$ and $(\tau > 0)$ represents the absence of congestion effect and existence of congestion with negative effects on firms and workers, respectively. The tolerance level of 0.001 is used as a cut-off point. It is the ratio of the difference between the real wage in a current location of a worker and another location to the current real wage the worker is receiving, i.e., $((w_i - w_a)/w_a)$, where $(w_i > w_a)$, w_a is a real wage that a worker is receiving in municipality *a,* and w_i is the real wage in municipality *s*. This ratio should be large enough to motivate the workers to relocate to the higher real wage municipality. In other words, this means that when the ratio is too small, the workers stay with their current job and the long run equilibrium is reached. Tolerance = 0.001 $\equiv ((w_i - w_a)/w_a) < 0.001$ means that it is

no longer attractive for a worker to relocate when the ratio falls below 0.001. Figure 6.4 shows the relative size distribution of the municipalities after the replication. We checked for the effect of changing the tolerance level from 0.001 to 0.00001, and the results remained very much the same. Changing the tolerance level only leads to the relatively different length of times that were needed to reach the long run equilibrium. The final distribution and other relationships, for instance, between the distribution effects and changes in travel time or distance from the project locations as discussed below (see for example, Table 6.5 and Table 6.7), generally remain robust. We further discuss the simulation results of the two model options based on the discussion in Section 6.2 above, namely, the core model and the congestion model.

Figure 6.4: Approximate initial distribution
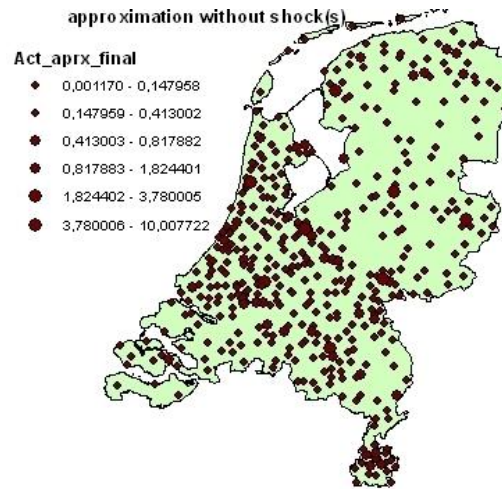
In all of the model options, the long-term equilibrium is achieved through mobility of firms due to changes in transportation and trade costs and the mobility of workers from one municipality to another due to differences in real wage. The workers migrate to municipalities with higher real wage. This higher supply of labor reduces the real wage in that municipality below that of another municipality which triggers another wave labor migration to those municipalities with higher real wage. This process continues until the real wage becomes the same in all of the municipalities, and there is no further incentive to migrate. Thus, the long-term equilibrium is achieved when the real wage becomes very much similar in all of the municipalities. The simulation results are summarized in Table 6.3 and Table 6.4.

Table 6.3: Summary: Mean gains within each model option and across the models

Model	Distance options	Mean/net gains?			
		OVP1	AUTOP2	OVP3	AUTOP4
Core model	road distance	yes	no	yes	yes
(no congestion)	Travel time	no	no	no	no
Congestion model	road distance	yes	yes	yes	yes
(positive tau)	Travel time	no	yes	yes	no
"net number of gains/affirmative"		0	0	3	0

Note: the distance option are that road distance is in kilometers and travel time is in minutes in all cases.
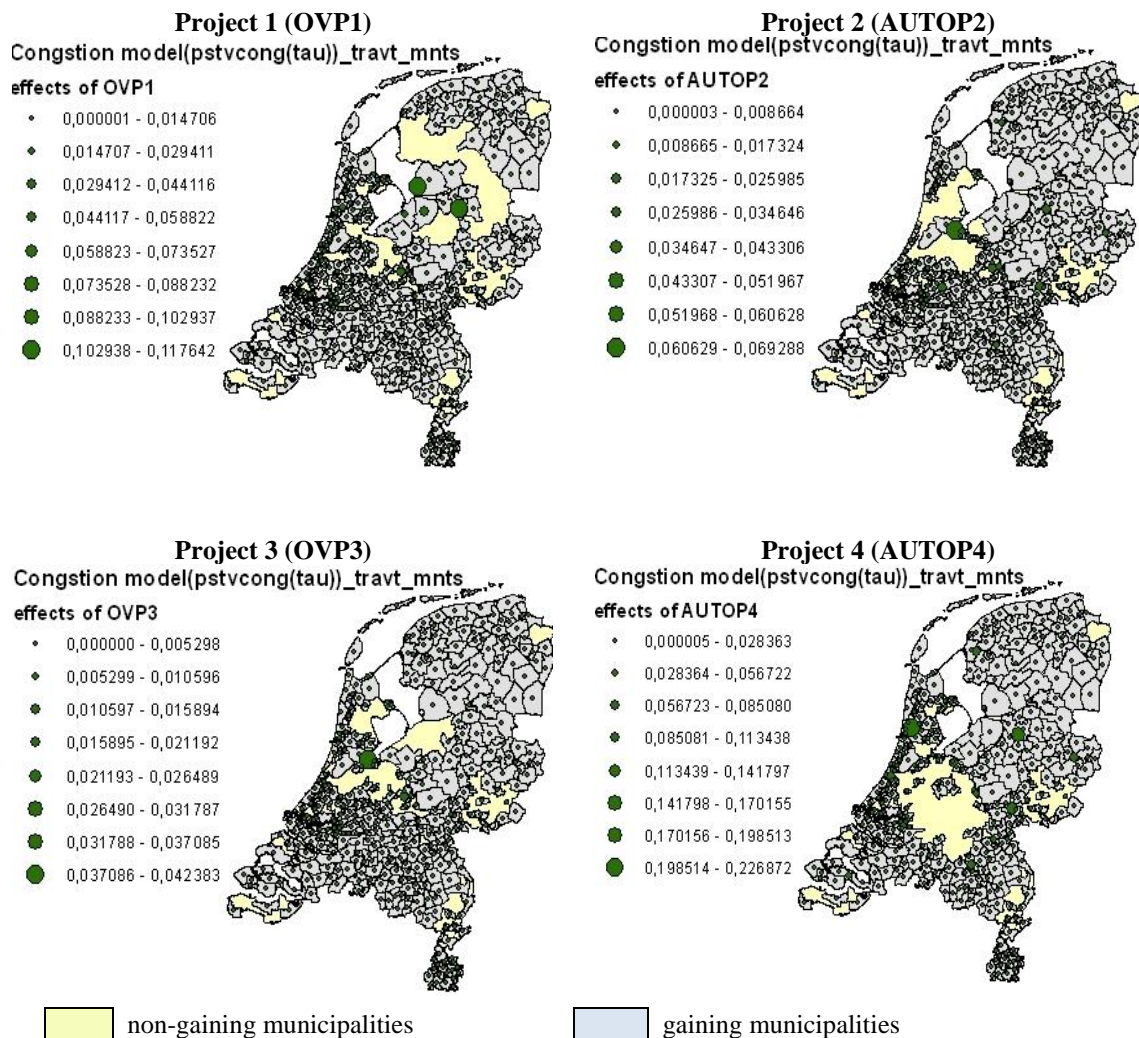
Table 6.3 shows the mean effects of each project on the final distribution of the municipalities' size as a whole under different model options. The value is '*yes*' if the sum of the changes in the municipalities' population share is positive following each project and '*no*' otherwise. This can happen due to large increases of only a couple of municipalities or small increases in several municipalities. Table 6.4 gives the number of municipalities with positive effects following the projects' simulated implementation under the different model options. The detailed individual effects of selected models based on a travel time distance option are also given by a geographical map demonstrating the effects (see Figures 6.5a and 6.5b for the core model and congestion model, respectively). The size of the circular balls shows the percentage gain for the gaining municipalities. The figures show a wide range of results showing different effects of the different projects simulated using the two models. The code model (Figure 6.5a) demonstrates its high agglomeration effects even with such a high transportation cost of 33 percent compared to the congestion model (Figure 6.5b) with 5 percent transportation cost still resulting in a stronger spreading effect.

Figure 6.5a: Long-run effects (changes) in the cities size (core-periphery model)
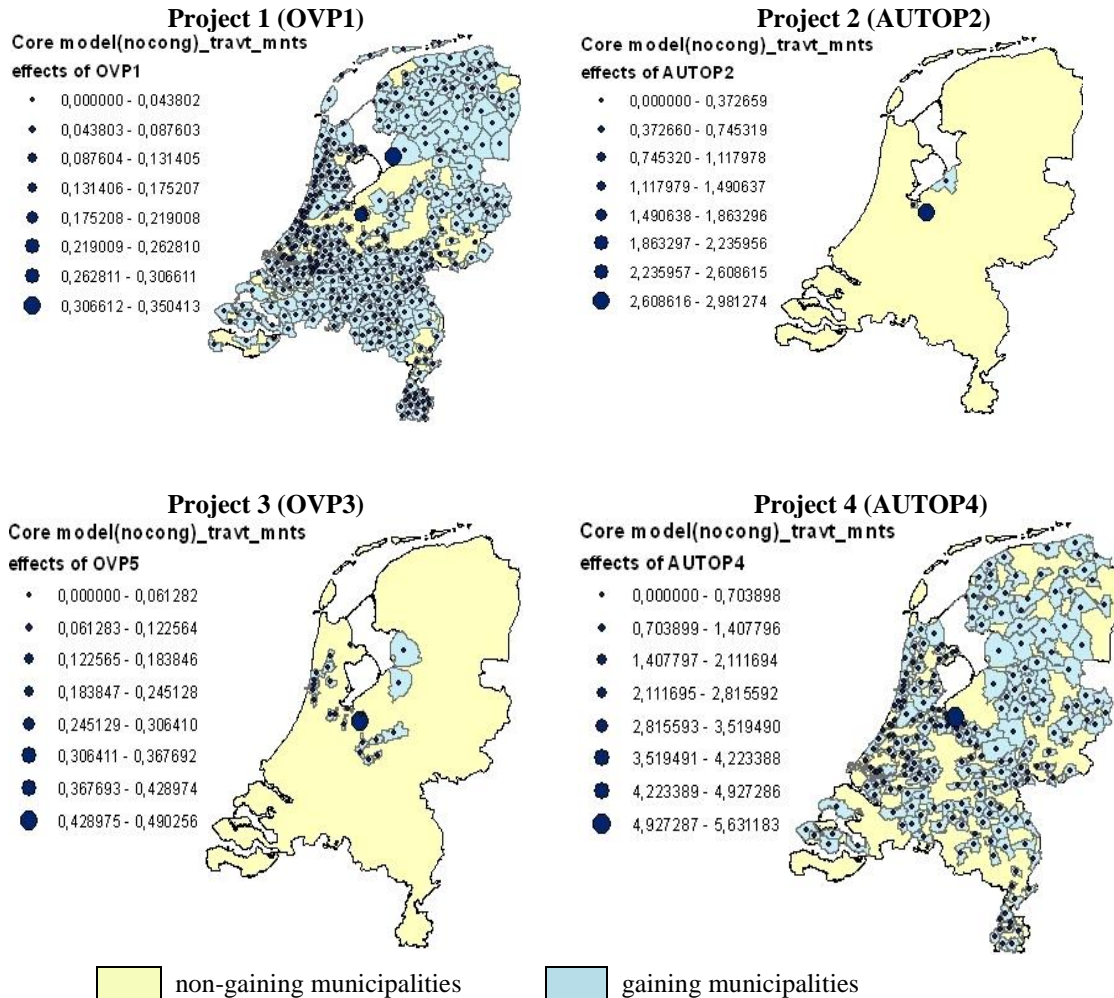
Note: the size of the circular balls represents the percentage change in the long-run; and #,## (Dutch style decimals) are the same as #.## (international style)

Figure 6.5b: Long-run effects (changes) in the cities size (congestion model)

Project 1 (OVP1)
Congstion model(pstvcong(tau))_travt_mnts
effects of OVP1

- · 0,000001 - 0,014706
- ◆ 0,014707 - 0,029411
- 0,029412 - 0,044116
- 0,044117 - 0,058822
- 0,058823 - 0,073527
- 0,073528 - 0,088232
- 0,088233 - 0,102937
- 0,102938 - 0,117642

Project 2 (AUTOP2)
Congstion model(pstvcong(tau))_travt_mnts
effects of AUTOP2

- · 0,000003 - 0,008664
- ◆ 0,008665 - 0,017324
- 0,017325 - 0,025985
- 0,025986 - 0,034646
- 0,034647 - 0,043306
- 0,043307 - 0,051967
- 0,051968 - 0,060628
- 0,060629 - 0,069288

Project 3 (OVP3)
Congstion model(pstvcong(tau))_travt_mnts
effects of OVP3

- · 0,000000 - 0,005298
- ◆ 0,005299 - 0,010596
- 0,010597 - 0,015894
- 0,015895 - 0,021192
- 0,021193 - 0,026489
- 0,026490 - 0,031787
- 0,031788 - 0,037085
- 0,037086 - 0,042383

Project 4 (AUTOP4)
Congstion model(pstvcong(tau))_travt_mnts
effects of AUTOP4

- · 0,000005 - 0,028363
- ◆ 0,028364 - 0,056722
- 0,056723 - 0,085080
- 0,085081 - 0,113438
- 0,113439 - 0,141797
- 0,141798 - 0,170155
- 0,170156 - 0,198513
- 0,198514 - 0,226872

non-gaining municipalities   gaining municipalities

Note: the size of the circular balls represents the percentage change in the long-run; and #,## (Dutch style decimals) are the same as #.## (international style)

The summary Table 6.3 shows that project OVP3 is the best in terms of net gain (all municipalities' average effect) whereas Table 6.4 shows that OVP3 and AUTOP4 are the top in terms of the number of individual municipalities gaining from the projects.

Table 6.4: Number of net gaining municipalities within each model option and across the models

Model	Distance options	Number of municipalities with net gain					
		OVP1	AUTOP2	OVP3	AUTOP4	OVP5	AUTOP6
Core model	road distance	3	4	408	416	333	417
(no congestion)	Travel time	391	3	136	223	23	222
Congestion model	road distance	59	62	373	390	25	23
(positive tau)	Travel time	381	378	380	363	58	80
"mean number of gaining municipalities"		209	112	324	348	110	186

Note: the distance option are that road distance is in kilometers and travel time is in minutes in all cases.

For a better reading and interpretation of the results, we next look at more detailed aspects of selected two models, as suggested in an earlier section, in a comparative way. These two versions of the NEG model are the most commonly used. Other forms of the model are closely related to either of them. Moreover, the effect under the congestion model is much in line with what we would expect in reality from such projects. For instance, the results under this model reflect that a number of municipalities gain marginally as opposed to a big flow of firms and workers creating big changes in one or a few municipalities. This is because the real world is more complex than these models, and there are a lot of resistance factors to triggering relocation. Both the core and the congestion models have some limitations. For instance, they do not take into account issues such as the value of amenities of landscape and climate; no region has a superior resource base or technology; there are no intermediate goods; and so on (see Schmutzler, 2002). The major difference between the core and the congestion model is that there are no direct negative externalities between firms under the core model assumptions, e.g., due to pollution or congestion in the former. In general, the simulated results for the congestion model show a spread away from the project locations especially when the big municipalities such as Amsterdam are part of the location of the project.

On the contrary, the agglomeration in bigger municipalities is relatively higher under the core model (see Figure 6.6). The figures show the changes in the municipalities' size following the simulated interventions under the two models over different distance ranges. Under each project, the congestion model (the red-dashed curve) lies below the core model result (the black solid line) near the project locations, but the opposite at further distances from the project locations. This implies that the projects aimed at integrating the Randstad with the municipalities in the vicinities, in general, benefit more than the municipalities outside the project locations in the Randstad. These results are more realistic compared the core model because the former accounts for the congestion factor and since it is also based on a more realistic transportation cost of around 5 percent compared to above 30 percent in the core model.

Figure 6.6: Long-run effects of the projects (T = travel time in minutes)
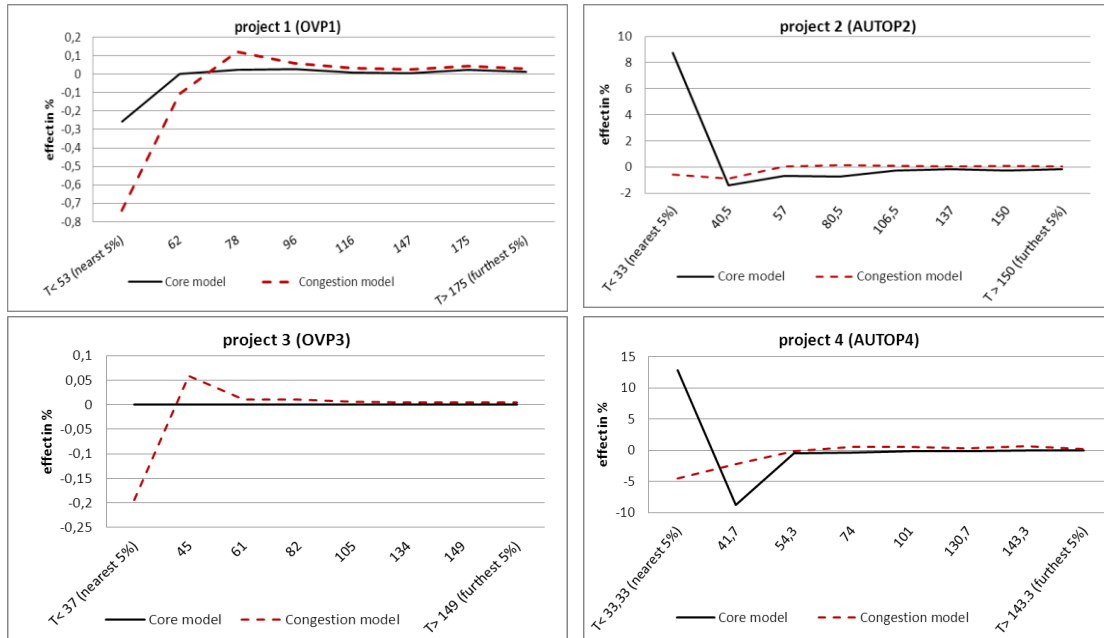
Note: #,## (Dutch style decimals) are the same as #.## (international style)

We break down this investigation between the large and small municipalities to check whether these results are derived by the project location or by the size of agglomeration at the project location compared to the neighboring vicinities or the rest of the country. Table 6.5 gives the pair-wise correlation of the simulated effects of the projects with travel time from the project location for small and large municipalities separately. The congestion model shows that, in general, small municipalities grow as they move away from most of the project location whereas the large municipalities shrink. This implies that the reduction in transportation cost is large enough in those cases to lead to a spread. In these results, there are some exceptions (for example, see AUTOP4) where large cities gain significantly as we travel far away from the project locations.

Table 6.5: correlation between changes in the population share and travel time from the projects location

the projects	(1) Core model ($\tau = 0$)	(2) Congestion model ($\tau > 0$)	(4) Core model ($\tau = 0$)	(5) Congestion model ($\tau > 0$)
OVP1	0.0528	0.1235*	− 0.1114	− 0.1439**
AUTOP2	− 0.0435	0.1203*	− 0.0132	− 0.0661
OVP3	0.0102	0.0977	0.0094	− 0.1013
AUTOP4	− 0.0167	0.1205*	0.0847	0.1487**
sample	small municipalities[56]		large municipalities	

Note: *, ** and *** show significance at 10%, 5% and 1%, respectively

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[56] Small municipalities are those with less than median population whereas large municipalities are those with larger population than median population.

In this case, one can argue that the reduction in the transport costs is not sufficient to lead to a spread. The effects of infrastructure depends on several factors (see for example, McCann and Shefer, 2004). Cities possess characteristics including size and the composition of its activities. We look at further detail of these projects by dividing cities into more groups based on their size instead of just two groups, small and large (see table 6.6). The results show that the significant gainers are not the top large municipalities; rather, they are medium size municipalities. We also look at the correlation of the effects of simulated projects with the sum[57] of changes in travel time of a municipality to other municipalities and population size or population density as a measure of agglomeration.

Table 6.6: detailed version of table 6.5 for AUTOP4

sample	(1) Core model ($\tau = 0$)	(2) Congestion model ($\tau > 0$)
smallest 5%	− 0.1715	− 0.1085
next 5%	− 0.3073	− 0.3073
next 15%	0.3361***	0.2967**
next 25%	0.1233	0.0781
next 25%	0.1232	0.2405**
next 15%	0.1472	0.0908
next 5%	− 0.7703***	0.3592
largest 5%	0.4605	− 0.1572

Note: *, ** and *** show significance at 10%, 5% and 1%, respectively

Although there are some slight variations across the projects, the total population and population density have a similar relationship with the project effects within each project. This is because there is high correlation between the total population and density themselves, i. e., the municipalities with high total population are also densely populated municipalities. The more important thing we want to look at here is the relationship between the sum of changes in the travel time (so transportation cost) and the effects on the city sizes.

This helped us to check whether or not the cities with the largest reduction transport cost measured in terms of reduction in travel time are also those who gained the most. The answer is affirmative for all of the projects (see Table 6.7 column 2). The spread to small and medium municipalities as indicated above means that much of the spread is to those better connected to nearby municipalities[58]. Looking at more detailed aspects, we discover communalities among all

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[57] Sum of changes in travel time of municipality A is the sum of all changes in travel time between Municipality A and any other Municipality B if the travel time changes. The larger this value, the higher degree of improvement in connection of the city with other cities.

[58] We also simulated opening national borders to neighboring countries (Belgium and Germany) and the results show that municipalities in the border locations gain relatively more than non-border municipalities following opening up (better connection) to the neighboring markets.

of the results. Here, we also look at the results by dividing the sample in two different ways. First, we divide the sample into losing and gaining municipalities following the simulated interventions (see Table 6.8).

Table 6.7: correlation of % effects of projects with the change sum in the travel time and agglomeration

the projects	variables	(1) Core model ($\tau = 0$)	(2) Congestion model ($\tau > 0$)
OVP1	sum of % changes in travel time	0.0636	0.1098**
	population	0.0073	0.0549
	population density	0.0684	0.0382
AUTOP2	sum of % changes in travel time	0.1953***	0.1289***
	population	− 0.0084	0.0158
	population density	− 0.0282	0.0900
OVP3	sum of % changes in travel time	0.0223	0.0739
	population	0.0107	0.0284
	population density	0.0443	0.0097
AUTOP4	sum of % changes in travel time	− 0.1810***	0.0058
	population	− 0.0140	− 0.0115
	population density	− 0.0094	− 0.0189

Note: *, ** and *** show significance at 10%, 5% and 1%, respectively

Table 6.8: more detailed version of table 6.7

the projects	variables	(1) Core model ($\tau = 0$)	(2) Congestion model ($\tau > 0$)	(3) Core model ($\tau = 0$)	(4) Congestion model ($\tau > 0$)
OVP1	sum of % change in travel time	0.2634	0.3892***	− 0.0326	− 0.2033***
	population	− 0.5447	0.1785	0.1241**	0.0234
	population density	0.9299	0.0512	− 0.0543	0.0402
AUTOP2	sum of % change in travel time	1.000***	0.3404***	− 0.0793	− 0.0530
	population	− 0.6843	− 0.0302	0.0723	0.0646
	population density	− 0.5669	0.1578	− 0.0432	− 0.0142
OVP3	sum of % change in travel time	0.0804*	0.1037**	0.0706	0.1237
	population	− 0.0387	0.0057	0.1098	0.1856
	population density	0.0681	0.0690	0.1794	− 0.0653
AUTOP4	sum of % change in travel time	0.1149**	0.2831***	− 0.4526	− 0.0251
	population	− 0.0902*	− 0.0571	0.3091	− 0.0834
	population density	0.0273	0.0719	0.0920	− 0.2596
	sample	gaining municipalities		losing municipalities	

Note: *, ** and *** show significance at 10%, 5% and 1%, respectively

Table 6.9: more detailed version of table 6.7

the projects	variables	(1) Core model ($\tau = 0$)	(2) Congestion model ($\tau > 0$)	(3) Core model ($\tau = 0$)	(4) Congestion model ($\tau > 0$)
OVP1	Sum of % change in travel time	− 0.0644	0.2739***	0.0941	0.0375
	population	0.0682	0.0114	− 0.0254	0.0362
	Population density	− 0.4361***	− 0.0661	0.0583	0.0239
AUTOP2	Sum of % change in travel time	0.2689***	0.1937***	0.0723	0.0741
	population	− 0.0814	0.0783	0.1109	− 0.0209
	Population density	− 0.0501	− 0.0166	− 0.1375	0.0957
OVP3	Sum of % change in travel time	0.0024	0.0526	0.0537	0.0768
	population	0.0935	0.0723	− 0.0394	0.0031
	Population density	0.0275	− 0.1135*	0.0458	− 0.0010
AUTOP4	Sum of % change in travel time	− 0.2478***	0.1205*	− 0.0742	− 0.1211*
	population	0.0014	− 0.0266	0.0010	0.0228
	Population density	− 0.0153	0.1155*	0.0260	− 0.0213
	sample	small municipalities		large municipalities	

The detailed results show more consistent changes. In general, the larger the reduction in transport cost, i. e., travel time, the higher the gains are among the gaining municipalities (see Column 2) whereas the larger the reduction in transport cost, the higher the losses are among the losing municipalities (see Column 4). This holds across both the core model and the congestion model. Second, we divide the sample into small and large municipalities (see Table 6.9). Here again focusing on the congestion model, the results show that, in general, the larger the reduction in transport cost following the simulated policy intervention, the higher the gains in the city sizes among the smaller municipalities (see Table 6.9, column 2). On the contrary, the larger the reduction in transport cost following the projects, the higher the loss in the city sizes among the large municipalities (see Column 4).

Baldwin et al. (2003) show that, in the core-periphery equilibrium, for instance, a small improvement in infrastructure within less agglomerated regions has no effect if the difference in public infrastructure between the core and periphery is large or if the trade cost between the two is already very low. This is because it does not make investment in the periphery profitable. The results in the core model are, in general, in agreement with this line of argument. The level of the spread from the large to the smaller municipalities implied by the results from the congestion model leaves large municipalities large and small ones small. According to Baldwin et al. (2003) better public infrastructure in the more agglomerated core compared to the periphery is one of the reasons that the disparity continues to exist.

Table 6.10: Correlation between changes in the cities size and sum of % changes in travel time

the projects	(1) Core model ($\tau = 0$)	(2) Congestion model ($\tau > 0$)	(3) Core model ($\tau = 0$)	(4) Congestion model ($\tau > 0$)
OVP1	0.0129	0.1242*	− 0.0944	− 0.0724
AUTOP2	0.0777	− 0.0722	0.1047	− 0.0476
OVP3	0.0336	0.0698	0.00031	− 0.0011
AUTOP4	0.1232*	− 0.2317***	0.0693	− 0.0430
location	near (T < median travel time)		far (T > median travel time)	

The effects of the simulated projects have different levels of changes in the travel time for different municipalities. The municipalities that are closer to the project locations have a larger reduction in the travel time and also in transportation cost. The effect of the policy intervention on the cities' size and its relationship with the change in the sum of the percentage of the reduction in transportation cost can also be different. The core model results in Table 6.10, in general, show an increase in and near improved transportation locations; whereas the results from the congestion model, in general, show a spread from better connected locations. Figure 6.7 below shows the long-run effects of the simulated projects on the size of some of the large municipalities in the polder area based on the congestion model. The right hand panel of the figure is just more zoomed to the axis view of the same figure on the left to show a more detailed view of smaller changes. Much more pronounced changes are observed among the smaller municipalities in the polder. The changes resulting from different projects are mixed depending on the level of the changes in the travel time and location of the projects. Most of these cities near the project locations and in the polder area all gained population under at least three of the four projects.

Figure 6.7: Long-run effects of the projects on large and polder municipalities
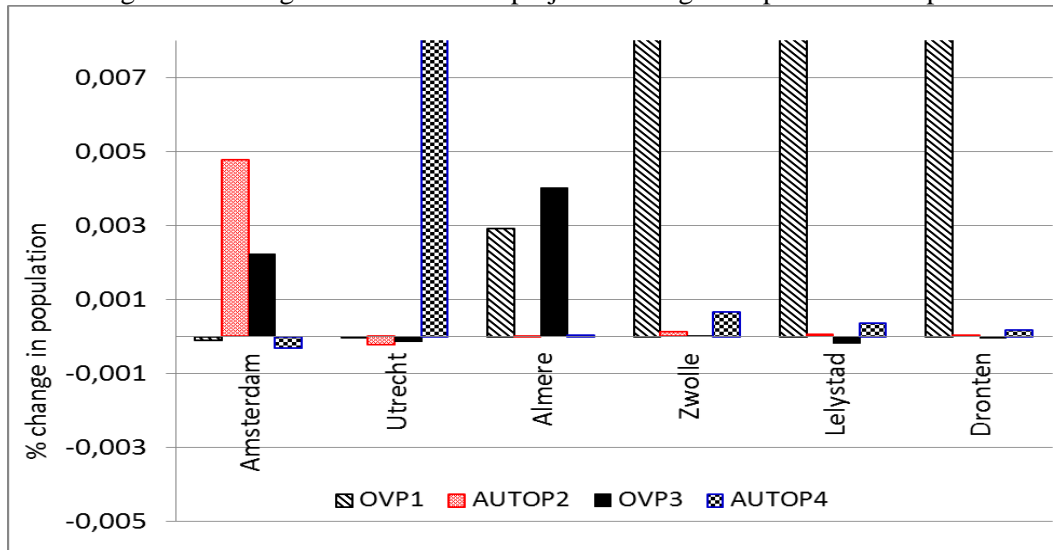
Note: #,### (Dutch style decimals) are the same as #.### (international style)

Figure 6.8 shows the percentage change in the population size of the municipalities that have gained the most under the four projects. These top gaining municipalities are the municipalities that are, in general, located within close distance to the project locations. However, this does not mean that all of the municipalities that are located closer to the project locations gain at the expense of other municipalities. Rather, as we have discussed earlier in this section, a considerable proportion of the relocation process takes place between the municipalities that are within closer range of the project locations. Thus, the municipalities with the most loss are also within closer range of the projects. Since we use a congestion model, municipalities with low population as proxy for low congestion would gain as long as they are not too far from the locations of improved transportation projects. For example, see Woudenberg in Figure 6.8 below. This implies that commuting from such a place through the old as well as the improved transportation links to the larger markets would be cheap enough or more optimal for some of the workers. This is one of unintended consequences of such projects. Moreover, the realization of such a gain by such municipalities depends on the municipalities' capacity to provide housing and public amenities for the new residents.

Figure 6.8: Long-run effects of the projects (top gains)
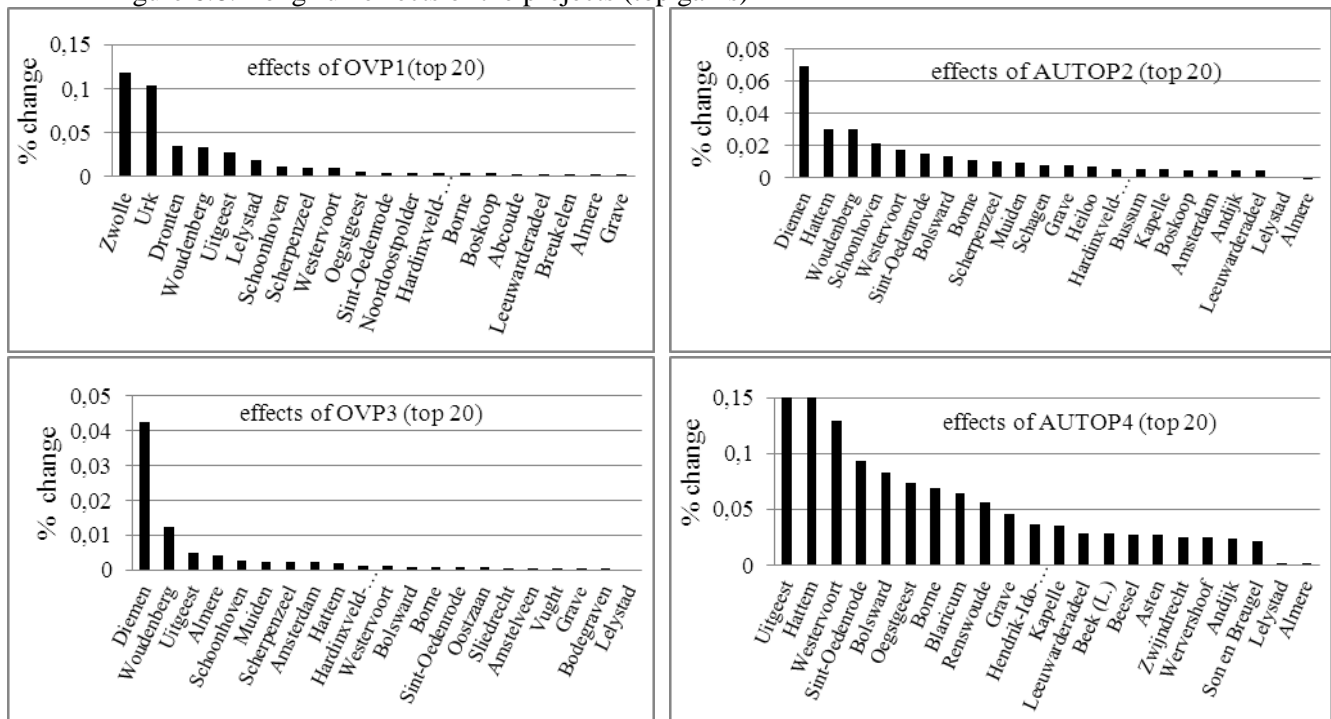
Note: #,## (Dutch style decimals) are the same as #.## (international style); 'Hardinxveld-….' stands for the Hardinxveld - Giessendam municipality.

6.6. Conclusions

In this chapter, we analyzed the long-run effects of improved transportation on the Dutch municipalities. We use the population data of the 418 municipalities of the Netherlands as indicators of the distribution of economic activities. We mainly use a congestion model of the NEG model in simulating the effects. Our first task was simulating for the theoretical effects of changing the transportation cost and congestion factor in the case of multiple regions. The results are consistent with the results of the two regions from earlier studies and consistent with the theory. These include that very high congestions as well as positive and increasing transportation costs are a factor in leading to more spreading of economic activities. Moreover, perfect spreading becomes the long-run equilibrium when the transportation is totally free ($T_{ij} = T_{ai} = 1.00$) as long as there is some positive congestion factor. With free transportation and zero congestion ($\tau=0$), equivalent of the core model, the initial distribution remains a long-run equilibrium (no redistribution). With zero or positive transportation cost, the lower the congestion factor, the higher the agglomeration and the opposite, i.e., greater spread, the higher the congestion factor. After establishing this, we simulate the improved transportation links. Improved transportation facilities generally benefit the municipalities that are located reasonably close to the projects locations but not necessarily the locations of the projects themselves, i.e., the gains measured by higher agglomeration occur neither too close nor too far from the project locations. Previous works find that the cities closest to the integration line, for example, national borders, gain the most from the integration. In this chapter, i.e., along the improved transportation links, this generally holds but not always. The cities closest to the transportation locations are not always those that gain the most. We see spreading effects to near distance cities but not too far. In this sense, the projects may also have unintended consequences for the stakeholders of spreading away from the target municipalities. This is likely because of certain reasons. First, the use of the congestion model leads to spreading to smaller municipalities. Another reason is that living in places outside large agglomerations, the cost of living is cheaper and commuting for work becomes much easier following the improved transportation links. Third, such further integrating projects of already very agglomerated areas seems to result in a spreading effect more than if it happens in less agglomerated areas such as border locations, as was the case in the earlier studies.

Chapter Seven

Conclusions

The significance of shocks to the urban system has been emphasized by a number of studies over the last decade. These shocks can be either negative or positive. In this thesis we have focused on the (policy induced) changes in the degree of economic integration as our example of a "shock". We have done so by analyzing the impact of changes in economic integration on EU cities and regions and with an emphasis on border locations. Various forms of barriers to movements of workers and commodities have been abolished over past few decades, especially in Europe. Two major examples are the internal market adopted within the EU member countries which allow free movement of workers and commodities and the improved transportation routes within and between the member nations. However, the effects of abolition of the various forms of border or other transportation barriers have not been extensively studied. Among the existing studies, only a few focus on border locations which are abruptly cut from the markets in their proximity through the existence of national borders.

This thesis attempts to make a contribution in this direction by focusing on different types of economic integration in the EU urban and regional system. We provide new empirical evidence on the consequences of economic integration "shocks" which can be employed as inputs into future research as well as for policy directions. We learned that not only border effects are present but also explicitly affect border cities. Border effects come in different forms and sizes. Economic integration initiatives are important but diminish over time, borders have two sides that are not effected symmetrically, some effects also have an influence on borders that are only indirectly affected. Cities can also individually reduce 'borders' between them and other (foreign cities); Town-twinning is an another important example. Both border integration and town-twinning favor larger cities over smaller ones. Furthermore, transportation projects can effect growth potential of cities in non-trivial ways.

This thesis shows that especially border cities might benefit from economic integration which can (partly) compensate for the negative effect of being a border location as such. Using data for Belgium, Germany and The Netherlands, we demonstrate in Chapter Two that opening up national borders to neighboring markets is more important for cities close to the borders than for other cities, mainly because of the increase of market access, implying higher wages. The results demonstrate that foreign market access is more important for border cities (geographical proximity matters) than for the non-border cities. We also show that the negative border effect is stronger across some borders more than others, i.e. asymmetric effects. These findings can be further substantiated in future research by investigating cross border economic activities such as commuting.

Applying the approach of Redding and Sturm (2008), who analyzed the effects of the post WWII division of Germany into East and West Germany on border cities along the new border,

Chapter Three analyzes the border population effects of the entire EU integration process. At both the urban and regional levels, we find that there has been a positive effect of the EU integration process on population growth along the integration borders. Integration compensates to some extent the negative border location. Moreover, the effects are of a limited duration, and certain forms of integration such as the adoption of the euro has no effect on border locations. One of the questions that remain to be answered is what plays the main role in the border locations gains after the abolition of national border barriers: relocation of business and production, commuting and shopping across the borders or both? This can be a topic for future research.

Chapter Four deals with the possibility of asymmetric border effects. With the use of detailed data, we find that borders in different countries, different borders of the same country, and different sides of the same border are affected differently. The positive border effects seem to continue longer in some border locations more than in others. The difference in the duration of the effects is consistent with the existence indirect integration effects of newly abolished borders. These findings introduce an interesting question for further research; whether the positive border integration effects come only from neighboring countries or from more distant borders. This can also be related to the duration of positive border integration effects which might also be affected by more distant borders. Whether the causes of the asymmetric effects are geographical or socio-economic factors is a potential question that can be addressed in future research.

In Chapter Five, we extend the border discussion by including various forms of community integration that are not exclusively aimed at borders. We examined the impact of the partnerships between Germany's individual cities and towns with cities and towns around the world. This so-called Town-twinning (TT) facilitates accessibility to twinning cities for people and businesses. Proximity strengthens the effects since they are stronger between nearby countries. Given the availability of relevant data, looking at the actual flow of people, jobs and other social and economic activities between the partner cities can help establishing the exact mechanisms through which TT leads to growth. Expanding the analysis to more countries is also one of the potential future areas of research.

The main focus of Chapter Two through Chapter Five is to estimate the effects of integration on border and non-border locations. Chapter Six investigates a very different form of integration and geographical location. We use a simulation approach to analyze the effect of improved transportation links within the same national boundary. Employing the congestion model of the NEG model in a multiple regions setting, we confirm the predictions of the theoretical two-regions results from earlier studies that high levels of congestion and increasing transportation costs lead to more spreading. With free transportation and zero congestion, the initial distribution remains a long-run equilibrium (no redistribution). From the simulation of improved transportation links, we ascertain that improved transportation facilities generally affect a wide geographical range of municipalities that are located reasonably close to the locations of the projects and benefit those neither too close nor too far from the project. The results are sensitive to parameter choice. Simulating movements or relocation of more types of economic activities (beyond population) using more realistic models would be very important in this direction.

In summary, throughout the thesis we demonstrate that the abolition of various forms of barriers of trade improve the growth potential of border or peripheral regions. This might lead to relatively more economic activity in the periphery. For further research, investigating the mechanisms through which various forms of integration affect the border cities and regions is very important. Moreover, investigating whether the importance of the integration shocks remain the same in the face of reduced trade costs over wider geographical ranges in an extensively globalizing world would be very interesting from both a research and policy perspective.

Samenvatting (Summary in Dutch)

De ontwikkeling van steden is in de geschiedenis vaak beïnvloed door negatieve en positieve schokken, zoals oorlog en economische integratie. Met name de effecten van negatieve schokken zijn uitgebreid onderzocht. De effecten van positieve schokken voor de grensregio's, zoals de Europese integratie en de aanleg van nieuwe transportinfrastructuur tussen Europese landen, is echter nog nauwelijks onderzocht. Vandaar dat dit proefschrift zich richt op de effecten van maatregelen die erop zijn gericht om de economische integratie tussen Europese landen en regio's te bevorderen. De nadruk ligt daarbij op de effecten voor de steden in de grensregio's.

Dit proefschrift probeert een bijdrage te leveren aan de stand van de wetenschappelijke literatuur door te focussen op verschillende soorten economische integratie binnen de EU. Nieuw empirisch bewijs voor de effecten van economische integratie kan worden gebruikt als input voor toekomstig onderzoek, en voor aanbevelingen voor beleid. Steden in de grensregio hebben aantoonbaar nadeel van die ligging aan de grens, hoewel de grenseffecten per locaties verschillen. Dit proefschrift toont tegelijkertijd aan dat vooral grenssteden kunnen profiteren van economische integratie, en dat integratie daarmee (deels) kan compenseren voor de negatieve effecten die een grenslocatie ondervindt. De effecten van economische integratie nemen door de tijd wel af. Ook is er sprake van asymmetrie; soms profiteren de steden aan de ene kant van de grens, terwijl de steden aan de andere kant negatieve gevolgen ondervinden van verdergaande economische integratie. Tot slot geeft dit proefschrift aanwijzingen voor de effectiviteit van grensoverschrijdende stedenbanden; ook paren van individuele steden die verder van de grens liggen kunnen op die manier grensbarrières slechten. Grotere steden profiteren overigens meer van economische integratie en stad-verbanding dan kleinere.

In hoofdstuk twee van dit proefschrift worden de gevolgen van de openstelling van de grenzen op de grenssteden in vergelijking met niet-grenssteden geanalyseerd. Met behulp van gegevens voor België, Duitsland en Nederland, is aangetoond dat het openstellen van grenzen belangrijker is voor steden dichtbij de grens dan voor andere steden, vooral als gevolg van de toegenomen toegang tot de markt, hetgeen hogere lonen impliceert. De resultaten tonen aan dat buitenlandse markttoegang belangrijker is voor grenssteden (geografische nabijheid speelt een rol) dan bij de niet-grenssteden. Deze bevindingen kunnen verder worden onderbouwd door in toekomstig onderzoek grensoverschrijdende economische activiteiten, zoals woon-werkverkeer, te analyseren.

Gebruikmakend van de aanpak van Redding en Sturm (2008), die de effecten op de grenssteden langs de nieuwe grens van de naoorlogse opdeling van Duitsland in Oost en West Duitsland analyseren, analyseert hoofdstuk drie de gevolgen van het gehele EU-integratieproces op de grensbevolking. Op zowel stads- en regioniveau, zien we dat er een positief effect van het EU-integratieproces op de bevolkingsgroei heeft plaatsgevonden langs de integratiegrenzen. Integratie compenseert tot op zekere hoogte de negatieve effecten op de grenslocaties. Bovendien zijn de effecten van beperkte duur, en bepaalde vormen van integratie, zoals de invoering van de

euro, hebben geen effect gehad op de grensregio's. De vraag wat de belangrijkste rol speelt na het verlagen van grensbarrières moet nog worden beantwoord: verplaatsing van bedrijfs- en productieprocessen, woon-werkverkeer en het winkelen over de grens, of allemaal? Dit kan een onderwerp zijn voor toekomstig onderzoek.

Hoofdstuk vier gaat over de mogelijkheid van asymmetrische en indirecte grenseffecten. Met gebruik van gedetailleerde gegevens dat hoofdstuk zien dat de grenzen in verschillende landen, verschillende grenzen van hetzelfde land, en de verschillende kanten van dezelfde grens anders worden beïnvloed. De positieve grenseffecten lijken zich in bepaalde grensregiolocaties meer en langer voort te zetten dan in andere. Het verschil in duur van het effect is consistent met het bestaan van indirecte integratie-effecten van pas opgeheven grenzen. Deze bevindingen werpen een interessante vraag op voor verder onderzoek; namelijk of de positieve integratie-effecten alleen van de buurlanden komen, of ook van verder weg gelegen grenzen. Dit kan ook worden gerelateerd aan de duur van de positieve grensoverschrijdende integratie-effecten die ook zouden kunnen worden beïnvloed door meer afgelegen grenzen.

Vervolgens is in hoofdstuk vijf gekeken naar een andere manier waarop individuele steden en gemeenten de grenzen tussen hen en andere internationale steden en dorpen laten afnemen. De grensdiscussie wordt uitgebreid door diverse vormen van integratie in de samenleving met internationale partners, die niet uitsluitend gericht zijn op steden in de grensregio's, erbij te betrekken. De impact van de partnerschappen tussen de afzonderlijke steden en dorpen van Duitsland met steden en dorpen in de rest van de wereld is onderzocht. Deze stedenbanden vergemakkelijken de toegankelijkheid van de verbonden steden voor mensen en bedrijven. Nabijheid versterkt de effecten, omdat ze sterker zijn tussen nabijgelegen landen. Gezien de beschikbaarheid van relevante gegevens zijn er een aantal toekomstige onderzoekingen mogelijk, zoals het kijken naar de werkelijke stroom van mensen, banen en andere sociale en economische activiteiten tussen de partnersteden, alsmede de uitbreiding van de analyse naar meer landen.

De belangrijkste focus van hoofdstuk twee tot en met hoofdstuk vijf zijn de effecten van integratie voor zowel grens- als niet-grensregio's. In hoofdstuk zes is een heel andere vorm van integratie onderzocht. Met een simulatiebenadering is het effect van verbeterde transportverbindingen tussen steden binnen de landsgrenzen onderzocht. Gebruikmakend van het NEG-model, met congestie en met meerdere regio's, kan worden geconcludeerd dat een hoge mate van congestie en toenemende transportkosten leiden tot meer spreiding. Uit de simulatie met verbeterde transportverbindingen blijkt dat betere transportfaciliteiten over het algemeen positief van invloed zijn op de ontwikkeling van gemeenten die daarmee ontsloten worden. Maar er zijn ook gemeenten die nadeel ondervinden van de nieuwe verbindingen. En bovendien zijn er opvallend veel verder weg gelegen gemeenten die beïnvloed worden door de nieuwe transportinfrastructuur. De resultaten zijn overigens zeer gevoelig voor de parameterkeuze. Het simuleren van meer soorten economische activiteit, met realistischer modellen (inclusief amenities), is een belangrijke aanbeveling voor toekomstig onderzoek in deze richting.

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