Regional Labor Market Disparities
A New Economic Geography Perspective

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A New Economic Geography Perspective

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Work on this dissertation began when I entered my occupation as a research assistant for Prof. Dr. Jochen Michaelis at the University of Kassel, working on a third-party funded project by the Hamburg Institute of International Economics (HWWI) in Hamburg. I encountered the topic of regional labor markets when I wrote my master thesis on the spatial dependency of regional employment development in Germany under the supervision of Prof. Dr. Reinhold Kosfeld (University of Kassel). While I was working on the empirics of regional labor markets, I recognized that combining the arguments of the New Economic Geography with labor market frictions might be a fruitful approach to explain how disparities in regional labor markets arise endogenously.

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\(^1\)See, for example, the survey article by Feldman (2003).
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Of course, the usual disclaimer applies and I am solely responsible for all remaining errors and imprecisions.

²See the PhD Comic from 5/30/2007 (www.phdcomics.com) for the effect of time on the sense of humor during a dissertation project.
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<th>Description</th>
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<tr>
<td>CBD</td>
<td>Central business district</td>
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<tr>
<td>CES</td>
<td>Constant elasticity of substitution</td>
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<tr>
<td>DID</td>
<td>Differences-in-Differences</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<tr>
<td>GG</td>
<td>German basic constitutional law (Grundgesetz)</td>
</tr>
<tr>
<td>GRW</td>
<td>Improvement of the regional economic structure (Gemeinschaftsaufgabe “Verbesserung der regionalen Wirtschaftsstruktur”)</td>
</tr>
<tr>
<td>IAB</td>
<td>Institute for Employment Research (Institut für Arbeitsmarkt- und Berufsforschung)</td>
</tr>
<tr>
<td>IABS</td>
<td>IAB Employment Sample (IAB-Beschäftigtenstichprobe)</td>
</tr>
<tr>
<td>NEG (NÖG)</td>
<td>New Economic Geography (Neue Ökonomische Geographie)</td>
</tr>
<tr>
<td>NUTS</td>
<td>Nomenclature of Territorial Units for Statistics (Systematik der Gebietseinheiten für die Statistik)</td>
</tr>
<tr>
<td>TFEU (VAEU)</td>
<td>Treaty on the Functioning of the European Union (Vertrag über die Arbeitsweise der Europäischen Union)</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
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1. Introduction

1.1. The Relevance of Regional Labor Market Disparities

Disparities between regional economies are a key concern of economic policy. In the European Union, for example, harmonious development and regional cohesion are formulated as explicit objectives in the Treaty on the Functioning of the European Union (TFEU):

In order to promote its overall harmonious development, the Union shall develop and pursue its actions leading to the strengthening of its economic, social and territorial cohesion.

In particular, the Union shall aim at reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions. (Art. 174 TFEU)

The regional policy of the European Union is therefore guided by the objective of balancing regional development. It focuses on regional growth, and the improvement of regional competitiveness, to achieve convergence of income and employment (Karl; 2012). For the European cohesion policy in the current period, 2007-2013, a budget of 347 billion Euros is provided. This is accompanied by about 160 billion Euros of national public and private co-financing. 80 % of the budget is allocated to the Convergence Objective, supporting less developed regions in the European Union. 16 % of the budget is devoted to the Regional Competitiveness and Employment Objective (Commission of the European Communities; 2007).

The Convergence Objective aims to support regions that have low income and employment so that they catch up, through enhanced growth, with the more developed regions. In the remaining regions, which are not subject to the Convergence Objective, the Regional Competitiveness and Employment Objective applies. This policy is devoted to supporting regional competitiveness and employment through innovation, research and development, environmental protection, and the formation of enterprises (Karl; 2012).
1. Introduction

Similarly, regional policy in Germany focuses on the support of economically backward regions in a catching-up process. This objective is codified in the basic German constitutional law (Grundgesetz, GG), which formulates, as a goal for federal policy, the creation of equivalent living conditions (“Herstellung gleichwertiger Lebensverhältnisse”) (Art. 72 II GG). Through the European treaties, the regional policies of the member states are closely tied to European regional policy. The state aid control of European competition policy constrains the granting of state aid to those regions where income is below, and unemployment is above, certain thresholds (Karl, 2012).

Regional policy in Germany is based on the “Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur” (GRW, improvement of the regional economic structure) and the Länderfinanzausgleich (German Länder fiscal equalization scheme). The aim of the GRW is for the backward regions to catch up with the overall development, by compensating for their competitive disadvantages. The GRW focuses on economic growth and on facilitating structural change through the creation of jobs. Therefore the GRW is closely related to labor market policy. The GRW and labor market policy complement each other by applying active labor market policy instruments, especially in the target regions of the GRW (Deutscher Bundestag, 2009).

The target regions for the GRW in the current period are chosen using four weighted indicators: the average unemployment rate between 2002 and 2005 (weighted at 50 %), the average wage in 2003 (40 %), an employment prognosis for 2004 to 2011 (5 %) and an infrastructure indicator (5 %) (Deutscher Bundestag, 2009). This procedure for choosing the target regions highlights the emphasis of regional economic policy on regional labor markets.

Hence regional labor market disparities are a key concern in regional economic policy. This is especially true in Germany where regional policy aims to make living conditions, which are closely tied to the labor market situation of the inhabitants, equivalent. Labor market conditions shape the opportunities of the inhabitants of a region to find employment and to earn the income necessary to cover their living expenses. Büttner and Ebertz (2009) find that regional labor market conditions in Germany are definitely an important factor for regional living conditions. This explains why German regional policy in particular concentrates strongly on regional labor market conditions. This thesis focuses on regional labor market disparities as a key indicator of regional living conditions.
1.2. The Size and Persistence of Regional Labor Market Disparities

Whereas regional policy in the European Union and in Germany aims at the convergence of the economic situation and living conditions between regions, there remain huge disparities in labor market indicators. Figure 1.1 highlights the disparities in regional unemployment rates in Germany for June 2012 at the NUTS 3 level ("Kreise"). In Eastern Germany, unemployment is much higher and more prevalent than in Western Germany. Further, a North-South divide is visible, although these disparities are less pronounced than those between the East and the West. The unemployment rate ranges from 1.1 % in Eichstätt to 15.9 % in Uckermark, so that the unemployment rate in the region with the highest unemployment is about 15 times that of the region with the lowest unemployment.

Such disparities are not limited to Germany, but apply to the European Union as well. Figure 1.2 shows these disparities at the NUTS 2 level for the year 2011. At the NUTS 2 level the unemployment rates in 2011 range from 2.1 % in Salzburg (Austria) to 27.8 % in Andalucía (Spain). These unemployment rates are, of course, strongly influenced by the current crisis.

Regional unemployment disparities are empirically well studied.\(^2\) Starting with the seminal contribution of Blanchard and Katz (1992) on regional labor market dynamics, a huge number of studies appeared, analyzing the size and persistence of regional labor market disparities. Blanchard and Katz (1992) focus on the United States of America (USA), and find that some states of the USA experienced consistently above-average growth rates, whereas others have rates that were consistently below average. This points to the persistence of regional labor market disparities. The results show that the adjustment to regional labor demand shocks mainly works through labor migration. Decressin and Fatás (1995) study these adjustment processes in Europe. They find that the extent to which labor market shocks are common across regions is lower in Europe than in the USA. Further, their results show that the adjustment to shocks in Europe is mainly triggered by participation, rather than migration as in the USA. The unemployment rate, however, only plays a small role in the adjustment process, which suggests that disparities in natural regional unemployment rates exist. Their results also point to the persistence of regional labor market disparities.

---

\(^1\)NUTS is the Nomenclature of Territorial Units for Statistics in Europe. It is a hierarchical system of regional classification which is separated into three levels. Level 1 is the highest level and reflects “major socio-economic regions”, level 2 reflects “basic regions for the application of regional policies” and level 3 is the lowest level reflecting “small regions for specific diagnoses” (Eurostat; 2012b).

\(^2\)See, for example, the summary article by Elhorst (2003).
1. Introduction

Source: Bundesagentur für Arbeit (2012), authors own illustration.

Figure 1.1.: Unemployment Rates in Germany
1.2. The Size and Persistence of Regional Labor Market Disparities

Figure 1.2.: Unemployment Rates in Europe

Source: Eurostat (2012a), authors own illustration.
1. Introduction

To illustrate the persistence of regional unemployment rates, Figure 1.3 arranges the regional unemployment rates in the German NUTS 3 regions ("Kreise") for the years 2001 and 2011 in a scatter plot. The points are located close to a straight line with positive slope, which implies that regions change only marginally in their relative position. Regions that initially suffered from high unemployment in 2001 had not improved relative to other regions ten years later. In other words, the disparities between the regions are highly persistent.

Overman and Puga (2002) study unemployment clusters in Europe. They observe a polarization of unemployment rates since the mid-1980s: while unemployment rates changed only marginally for regions with initially high or initially low unemployment, regions with medium unemployment rates moved to either high or low unemployment. Overman and Puga (2002) find that labor demand has caused these increasing disparities between regional unemployment rates. Figure 1.4 illustrates employment growth, as an indicator of labor demand, between 2007 and 2011 at the NUTS 2 level. The disparities imply that employment growth has been strongest in the core economic regions of Europe, although the figures are contaminated by the degree to which countries are affected by the current crisis.

Source: Bundesagentur für Arbeit (2012) and BBSR and BBR (2011), authors own illustration.

Figure 1.3.: Persistence of Unemployment Rates in Germany
1.2. The Size and Persistence of Regional Labor Market Disparities

Source: Eurostat (2012a), authors own illustration.

Figure 1.4.: Employment Growth in Europe
1. Introduction

Figure 1.5.: GDP in Europe

Source: Eurostat (2012a), authors own illustration.
1.3. Approach and Structure of the Thesis

The disparities in unemployment rates are closely linked to disparities in income, as an indicator for the regional wage level. Figure 1.5 maps the Gross Domestic Product (GDP) per capita at the NUTS 2 level for the year 2009. Income per capita ranges from 2,900 Euros in Yugozapaden (Bulgaria) to 75,900 Euros in inner London (United Kingdom). High income per capita is also concentrated at the economic core of Europe, known as the 'Blue Banana', and declines with the distance from this economic core, except for the Scandinavian countries. Further, results by Bräuninger and Niebuhr (2008) suggest that there is a club-convergence of regional income in Europe. Agglomerations converge to a higher income level than peripheral regions, which implies that the disparities in income between core regions and peripheral regions are persistent.

The 'Blue Banana' is also characterized by a high population density compared to the rest of Europe, as illustrated by Figure 1.6. Population is strongly concentrated in a few regions, most of which are located in the economic core of Europe, and ranges from 2 people per square kilometer in Lapland (Finland) to 21,258 people per square kilometer in Paris (France).

1.3. Approach and Structure of the Thesis

Against this background, the present thesis is concerned with two central questions:

- How do disparities between regional labor markets arise?
- Why are these disparities so persistent?

Overman and Puga (2002) find that the polarization of regional unemployment rates in Europe was driven by labor demand. If labor demand is responsible for regional labor market disparities, the question remains why labor demand differs across regions. Labor demand represents the choices of firms to hire workers. Therefore it crucially depends on the location decisions of firms, and the regional economic situation. The New Economic Geography (NEG) explains how disparities between regional economies, including the location decisions of firms, arise endogenously. However, NEG models usually assume perfectly functioning labor markets with full employment. They are therefore usually not suited for a discussion of the questions of how regional labor market disparities arise endogenously and why they persist.

The term 'Blue Banana' was originally introduced by the press, following a study made by GIP Reclus. GIP Reclus was a group of French geographers who studied Europe’s industrial core and identified an axis from Manchester over the Benelux countries, western Germany and Switzerland to Milan, which is now known as the 'Blue Banana' due to its shape and the color used by GIP Reclus (Delamaide; 1994).
1. Introduction

Figure 1.6.: Population Density in Europe

Source: Eurostat (2012a), authors own illustration.
The fundamental idea of the present thesis is therefore to introduce labor market frictions into the NEG in order to discuss how regional labor market disparities arise endogenously and why they are persistent.

The previous descriptive statistics already point to the relevance of NEG arguments. The NEG explains how people, firms and economic activity endogenously agglomerate in the core, and how the periphery falls behind. From the figures, one can see how people and income per capita concentrate at the core, and that unemployment is, in general, lower on average in the core regions. Whereas other authors have introduced search frictions on the labor market into the NEG, this thesis focuses on wage-setting frictions. The subsequent chapters individually deliver a motivation for the various elements of the theory used to explain regional labor market disparities.

The thesis is structured as follows. Chapter 2 presents a basic model for introducing wage-setting frictions into the NEG, which is comparable to Francis (2007). This provides the basic framework upon which regional labor markets are modeled during the thesis, and is extended in the two subsequent chapters. The model is presented in some detail, so that the reader can build on this discussion in the subsequent models where the approach of the basic model is required.

Chapter 3 extends the basic model by congestion externalities. Congestion externalities are influences, other than the influences of wages and unemployment, that affect the migration decisions of individuals, thus shaping the agglomeration pattern of the regional system. The regional system is thus not restricted to either symmetry or full agglomeration, as in the basic core-periphery model of Fujita et al. (1999). Instead, partial agglomerations occur, so that labor market frictions can affect the extent of agglomeration and thus might influence regional labor market disparities.

Chapter 4 introduces monocentric cities into the basic framework. This model shows how commuting costs affect the agglomeration process and labor market disparities. Through this framework it is possible to explain why and under what conditions the agglomeration of economic activity might be accompanied by higher or lower unemployment in the core than in the periphery. This model also presents a link between the Harris and Todaro (1970) model and the wage curve literature, which were previously usually seen as opponents.

Chapter 5 provides empirical results on the relevance of NEG arguments for regional labor markets, most importantly on the relevance of market access as the key element of the core-periphery model. It relies on German reunification as an exogenous shock to market access in order to discuss its effects on labor market disparities.

These contributions are briefly introduced in the literature reviews of the respective chapters in this thesis.
1. Introduction

outcomes. Through this framework, the usual endogeneity problems of empirical analysis on the effects of market access can be avoided. The results show that market access does indeed matter for regional labor markets, although the market access shock of German reunification was accompanied by a labor supply shock caused by migrants and commuters.

The chapters of this thesis build on each other. This is because the basic model is used in the two following chapters and because the empirical analysis relies on this theory. However, the chapters are written such that they may be read independently. Each chapter contains an individual introduction to present the respective research question, explain the approach used, and an individual literature review to relate the discussion of that chapter to the relevant literature.

A final chapter is devoted to the conclusions. It relates the results to the two central questions of this thesis, highlights the contribution of this thesis to the literature, derives policy implications and provides an outlook on areas of further research.
2. Basic Model

2.1. Abstract

Regional labor markets are characterized by huge disparities. The literature on the wage curve argues that there exists a negative relationship between unemployment and wages. However, this literature cannot explain how the disparities in these variables between regions arise endogenously. By contrast, the New Economic Geography analyzes how the disparities in regional goods markets arise endogenously, but usually ignores unemployment. Therefore, this chapter discusses regional unemployment disparities by introducing efficiency wages into the New Economic Geography. This model shows how the disparities in regional goods and labor markets arise endogenously through the interplay of increasing returns to scale, transport costs and migration. It also presents the basic theoretical framework on which the subsequent two chapters are based on.

**JEL Classification:** J64, R12, R23  
**Keywords:** regional unemployment, new economic geography, core-periphery, wage curve, labor migration

2.2. Introduction

Regional labor markets are characterized by huge disparities in employment development, unemployment and wages. The scale of such regional disparities is comparable to that between nation states. While institutional differences are often held to be responsible for the disparities between national labor markets (Blanchard and Wolfers; 2000), they can only account for a minor proportion of the disparities between regional labor markets. This goes back to the fact that labor market institutions vary only marginally between the regions of a nation state (Blien and Sanner; 2006).

In the literature, different approaches for modeling regional labor markets exist. Blanchard and Katz (1992) present perhaps the most comprehensive model for explaining the disparities between regional labor markets (Elhorst; 2003). Blanchard and Katz (1992) regionalize a wage-/price-setting model. They discuss how
2. Basic Model

Regional labor markets adjust to shocks in labor demand via the reactions of employment, participation, unemployment and migration. The model is based on the wage curve approach of Blanchflower and Oswald (1990). Since labor market institutions vary only marginally at the regional level, the wage curve has to be similar for all regions as well. Under this assumption, the disparities in regional labor markets are predominantly the result of differences in labor demand between these regions. Regional labor demand in turn is derived from regional production. However, Blanchard and Katz (1992) do not explain how regional disparities in labor demand and production arise endogenously. Instead, the authors discuss the impacts of shocks in labor demand on regional labor markets.

Overman and Puga (2002) empirically show that the disparities in regional unemployment rates in Europe are ascribed to labor demand. If differing labor demand is the reason for regional labor market disparities, then differences between regional goods markets play a key role in these disparities. The New Economic Geography (NEG) analyzes how the disparities in regional goods markets arise endogenously. Models of the NEG are traced back to the basic core-periphery model presented by Krugman (1991). Krugman (1991) models centrifugal and centripetal forces and discusses how the disparities in regional goods markets arise endogenously through their interaction. However, such models usually assume cleared labor markets and ignore unemployment.

Many empirical studies supply evidence in favor of the existence of a wage curve in western economies (Blanchflower and Oswald; 1990). The concept of the wage curve is a prevalent concept in economic theory and is frequently applied for modeling frictions in (regional) labor markets. It therefore stands to reason that combining NEG models with theories of unemployment could explain the disparities in regional labor markets.

In this chapter, the disparities in regional labor markets are discussed in the framework of the NEG. The core-periphery model of Krugman (1991) forms the basis for modeling the disparities in regional goods markets in this chapter, and its labor market is adjusted to cover wage-setting frictions. Therefore, the present model consists of two regions and two sectors, agriculture and manufacturing. The manufacturing sector is characterized by increasing returns to scale and monopolistic competition, whereas the agricultural sector is a competitive market with constant returns to scale. Both agricultural and manufactured goods are traded freely between regions. However, iceberg transport costs exist for manufactured goods. While in the Krugman model employment in a region is determined by the labor force (due to full employment), in the present model there is unemployment. Employment is therefore endogenous not only in the long run due to migration (as in the Krugman model), but also in the short run due to unemployment. Unemployment is modeled by efficiency wages, based on Shapiro and Stiglitz (1984). Efficiency
wage models are especially useful for modeling the wage curve at a regional level.\textsuperscript{1} Blien (2001), for example, argues that they are particularly suitable for modeling a wage curve for German regions.

The efficiency wage model of Shapiro and Stiglitz (1984) is based on the utilities of the unemployed, as well as shirking and non-shirking employees. Employers only imperfectly observe shirking. Therefore, there is an incentive to shirk in the case of competitive wages. In order to prevent shirking, employers pay efficiency wages. Since efficiency wages are higher than competitive wages, unemployment arises as a result. However, this efficiency wage model is modified to account for the fact that the unemployed can migrate between regions: they compare their expected lifetime utilities between both regions and decide to migrate if their utility in the neighboring region is higher than that in their home region.

The aim of this model is to build a basic framework for discussing wage-setting frictions within the NEG. The subsequent chapters build on this framework and extend it in order to discuss regional labor market disparities.

The remainder of the chapter is organized as follows. In Section 2.3, an overview of the related literature is delivered. The basic model is presented in Section 2.4. Subsequently, the equilibrium is discussed with a special focus on migration in Section 2.5. Section 2.6 covers the stability of the equilibria. The results are interpreted and discussed in Section 2.7 and conclusions are drawn in the final section.

### 2.3. Related Literature

Several authors discuss labor market rigidities within the NEG or related models for the comparison of nation states. However, owing to their focuses on the international level these models assume immobile labor. For example, Méjean and Patureau (2010) discuss the influence of minimum wages on the location decisions of firms. Strauss-Kahn (2005) studies — in the framework of the NEG — how fixed wages and heterogeneous labor leads to vertical specialization and further increases the disparities in high- and low-skilled labor. Picard and Toulemonde (2006) present a core-periphery model in which labor unions bargain over wages. Higher wages can increase purchasing power in a country under certain conditions and an effect on the domestic market might result, stimulating agglomeration. However, the authors ignore unemployment. Monford and Ottaviano (2002) discuss a NEG model in which agglomerative forces result from the labor market. Chen and Zhao (2009) choose

\textsuperscript{1} Cahuc and Zylberberg (2004) summarize the empirical relevance of the wage curve approach. Nijkamp and Poot (2005) present a meta-analysis.
2. Basic Model

a two-country two-sector approach with inter-sectorally mobile but internationally immobile labor. They analyze the impact of wage subsidies in the industry sector when wages in the neighboring country are flexible. However, all these models assume immobile labor between regions and therefore concentrate on the international level.

Peeters and Garretsen (2004) model heterogeneous labor and rigid wages within the NEG. They analyze the impact of globalization (in the form of decreasing transport costs) on high- and low-qualified labor. High-qualified labor is mobile. Nevertheless, the authors assume full employment in one of the two countries. Therefore, their model is unable to explain why unemployment rates develop differently in the two countries. Furthermore, they discuss institutional differences between labor markets. Therefore, their approach is adequate for discussing the disparities between nation states, but it is less suitable for analyzing those in the regional labor markets of a nation state since labor market institutions vary only marginally at the regional level.²

In contrast to the papers introduced above, this chapter focuses on the regional level, where labor migration is a key factor. Epifani and Gancia (2005) apply a similar approach: they model regional labor markets and interregional labor migration within the framework of the NEG. The rigidities in regional labor markets are based on job matching and lead to equilibrium unemployment. Through the goods market, based on the NEG, agglomeration might result (for medium and low transport costs). If agglomeration occurs, this affects regional labor markets, leading to lower unemployment in the agglomeration than in the periphery. In the short-term, migration lowers unemployment disparities since the unemployed leave the lagging region. However, in the long-term migration intensifies unemployment disparities by enforcing agglomeration.³ Epifani and Gancia (2005) assume flexible wages and concentrate on labor market rigidities in the form of job matching. They argue that future research needs to discuss the integration of wage-setting frictions into the framework of the NEG.

Südekum (2005) models a wage curve based on efficiency wages within the framework of a goods market that is characterized by monopolistic competition and increasing returns to scale. However, the author concentrates exclusively on

²Three further models should be mentioned here. Haaland and Wooton (2007) model the location decisions of multinational companies when there is wage bargaining with labor unions. Pflüger (2004) discusses firms location decisions when there is monopolistic competition and when differences exist in the social insurance and tax systems. Dewit et al. (2003) analyze the location decisions of oligopolistic companies when dismissal costs differ between countries (using game theory).
agglomerative forces and prevents full agglomeration only by assuming a home bias for migration. He views his model as a first step to including unemployment into the NEG but does not refer to his model as a NEG model because of the omission of centrifugal forces. The model of Südekum (2005) is based on an earlier model of Matusz (1996). 4

Thus, Südekum (2005) took the first step of introducing efficiency wages into a model of monopolistic competition. However, Südekum only includes centripetal but not centrifugal forces. Against this background, the present chapter introduces efficiency wages into a full NEG model and discusses the impacts of agglomeration on regional labor markets.

Egger and Seidel (2008) deliver a related approach. They integrate a “fair wage” approach into the NEG. The work effort of low-qualified workers is influenced by the fairness of their wages. This leads to a link between wages and unemployment. However, only low-qualified workers can become unemployed. Furthermore, low-qualified workers (in contrast to high-qualified ones) are inter-regionally immobile. In addition, the wages of low-qualified workers are fixed to one in both regions. Thus, a wage curve exists only in the sense that the unemployment of such workers is linked to the wages of high-qualified employees. The model presented here instead shows a link between wages and unemployment in the same labor market group, with the unemployed also allowed to migrate between regions. This model is based on the core-periphery framework of Fujita et al. (1999) and the efficiency wage framework of Shapiro and Stiglitz (1984). A comparable model, combining the same elements, was developed independently by Francis (2007). The aim of the present model is to develop a basic theoretical framework, which is extended in the subsequent chapters to discuss regional labor market disparities.

2.4. Basic Model

The present chapter develops a NEG model with labor market rigidities based on efficiency wages (and thus a wage curve). The model is constructed to discuss how the disparities in regional labor markets arise endogenously. The NEG part of this model is derived from Fujita et al. (1999). Their household model is extended to include the disutility of work effort, which is fundamental for modeling efficiency wages. Efficiency wages are based on the approach of Shapiro and Stiglitz (1984). The goods market in turn is based on Fujita et al. (1999). However, the assumption of full employment is dropped and unemployment results as a consequence of efficiency wages.

4Matusz (1996) discusses a wage curve based on efficiency wages within the framework of the New Trade Theory. He focuses on the international level and ignores migration for this reason.
2. Basic Model

There exist two regions, \( r \) and \( s \), as well as two sectors, agriculture \( A \) and manufacturing \( M \). Agriculture is characterized by perfect competition on both the goods and the labor market. Manufacturing instead is characterized by monopolistic competition on the goods market and efficiency wages on the labor market. Labor is immobile between the sectors. Labor in manufacturing is mobile between the regions whereas labor in agriculture is not.

2.4.1. Households

Households \( j \) receive utility \( \mathcal{U} \) through the consumption of agricultural goods \( C_A \) and through the consumption of varieties of manufactured goods \( c_i \). \( C_M \) represents a composite index of these varieties. Utility is lowered by work effort \( e \),

\[
\mathcal{U} = C_M^\mu C_A^{1-\mu} - e. \tag{2.1}
\]

The composite index of manufactured goods is a constant-elasticity-of-substitution (CES) utility function of the varieties,

\[
C_M = \left[ \int_0^n c_i^\theta \, di \right]^{\frac{1}{\theta-1}}. \tag{2.2}
\]

The number of firms is \( n \) and the elasticity of substitution between the varieties of the manufactured goods is \( \theta > 1 \). Households maximize their utility in two stages. They decide upon the optimum division of their income between agricultural and manufactured goods. In addition, they choose the optimum composition of the varieties of the manufactured good. The budget constraint of household \( j \) is

\[
p_M C_{Mj} + p_A C_{Aj} = Y_j. \tag{2.3}
\]

Household \( j \) uses all its income \( Y_j \) for the consumption of agricultural goods \( C_A \) at a price \( p_A \equiv 1 \) and for the consumption of the composite index of manufactured goods \( C_M \) at a price index \( p_M \). Owing to the standardization \( p_A \equiv 1 \), the prices of manufactured goods (and all wages) are measured relative to agricultural prices. Inserting the budget constraint into the utility function delivers

\[
\mathcal{U}_j = C_M^\mu (Y_j - p_M C_{Mj})^{1-\mu} - e. \tag{2.4}
\]

Utility maximization \( (\partial \mathcal{U}_j / \partial C_{Mj} = 0) \) leads to the consumption expenditure shares of agricultural and manufactured goods. Note that the result of the utility maximization is independent of work effort,
2.4. Basic Model

\[ C_{Mj} = \mu \frac{Y_j}{p_M}, \quad (2.5) \]
\[ C_{Aj} = (1 - \mu)Y_j. \quad (2.6) \]

The optimum division of expenditures for manufactured goods on the individual varieties results from utility maximization over the varieties. This is equal to minimizing the expenditures for the varieties (Shephard’s (1953) Lemma),

\[
\min \int_0^n p_i c_i \, di \; s.t. \; \left[ \int_0^n c_i^{\frac{\theta+1}{\theta}} \, di \right]^{\frac{\theta}{\theta-1}} = C_M, \quad (2.7)
\]

and leads to the CES manufacturing price index \( p_M \),

\[
p_M = \left[ \int_0^n p_i^{1-\theta} \, di \right]^{\frac{1}{1-\theta}}. \quad (2.8)
\]

In the two-region case with identical firms and iceberg transport costs \( \tau \geq 1 \), this leads to the manufacturing price index \( P_r \) in region \( r \),

\[
P_r = \left[ n_r p_r^{1-\theta} + n_s (\tau p_s)^{1-\theta} \right]^{\frac{1}{1-\theta}}, \quad (2.9)
\]

whereas \( n_r \) and \( n_s \) represent the number of firms (=varieties) in the corresponding region. The demand for variety \( i \) by household \( j \) follows from minimizing the expenditures for the varieties,

\[
c_{ij} = \left( \frac{p_i}{p_M} \right)^{-\theta} C_{Mj} = \left( \frac{p_i}{p_M} \right)^{-\theta} \mu Y_j. \quad (2.10)
\]

2.4.2. Labor Market

Rigidities in wage setting are introduced into the NEG framework by relying on efficiency wages based on Shapiro and Stiglitz (1984). In the present model, the efficiency wage framework of Zenou and Smith (1995) is applied.\(^5\) These authors extend the Shapiro and Stiglitz (1984) model to a two-city case with inter-city migration and intra-city commuting. The present model focuses on the inter-city migration part of their model and drops the intra-city commuting part. Subsequently, the

\(^5\)See also Zenou (2009).
2. Basic Model

derivation of efficiency wages for region $r$ is presented. Efficiency wages for region $s$ follow analogously.

Employed households in region $r$ receive the nominal wage $w_r$ for being employed, whereas unemployed households do not receive any income. Thus, the income of employed households $Y_j$ consists of the nominal wage $w_r$, whereas the income of unemployed households is zero. In any period, the utility of a household then depends on its employment status. Furthermore, households decide whether they shirk at work or not. Non-shirking households suffer from the work effort $e$, whereas shirking households avoid this effort. In any period, the utility of a non-shirking household then is

\[
\begin{align*}
U_{NS}^r &= C^\mu C_A^{1-\mu} - e \\
&= C^\mu (w_r - P_r C_M)^{1-\mu} - e \\
&= (\mu w_r P_r^{-1})^\mu (w_r - \mu w_r)^{1-\mu} - e \\
&= w_r \frac{K}{P_r} - e \text{ where } K = \mu^\mu (1 - \mu)^{1-\mu}.
\end{align*}
\]

(2.11) (2.12)

Accordingly, the utility of shirking households is $\Omega_S^r = w_r \frac{K}{P_r}$ and the utility of unemployed households is $\Omega_0^r = 0$ in any period. Households face the risk of losing their jobs depending on the exogenous job destruction rate $\psi$. New jobs arise at the endogenous job generation rate $\delta_r$. Additionally, shirking households face the risk of being detected shirking and hence being fired with a probability $1 - \gamma$.

Households base their labor market decisions on their expected lifetime utilities. That is, depending on the corresponding expected lifetime utilities, they decide whether to shirk or not. The discount rate of utility is $\rho$. Then, the expected lifetime utilities of non-shirking, shirking and unemployed households are\(^6\)

\[
\begin{align*}
\rho V_{NS}^r &= w_r \frac{K}{P_r} - \psi (V_{NS}^r - V_0^r), \\
\rho V_{S}^r &= w_r \frac{K}{P_r} - (\psi + 1 - \gamma)(V_S^r - V_0^r), \\
\rho V_0^r &= \delta_r (V_{NS}^r - V_0^r).
\end{align*}
\]

(2.13) (2.14) (2.15)

\(^6\)See, for example, Zenou (2009, Appendix B) for a detailed derivation of these Bellman equations.
Employers pay efficiency wages to prevent shirking at the margin. The wages are thus at a level where households are indifferent between shirking and not shirking ($V_r^{NS} = V_r^S$),

$$w_rK = e^{\rho + \psi + \delta_r + 1 - \gamma}. \quad (2.16)$$

Furthermore, in equilibrium the inflow into unemployment $\psi L_r$ must be equal to the outflow to employment $\delta_r(N_r - L_r)$. Here $L_r$ represents the number of manufacturing employees and $N_r$ represents the manufacturing labor force. Hence the endogenous job generation rate in equilibrium is $\delta_r = \psi L_r/(N_r - L_r)$. Then, efficiency wages in region $r$ are

$$w_r = P^u e^{1 + \frac{\rho}{1 - \gamma} + \frac{\psi}{(1 - \gamma)U_r}}. \quad (2.17)$$

This equation presents a negative relationship between unemployment $U_r$ and wages $w_r$ at the regional level and thus delivers a wage curve, whereas the unemployment rate is given by $U_r = (N_r - L_r)/N_r$.

### 2.4.3. Goods Market

The goods market is based on the core-periphery model of Fujita et al. (1999) and is separated into agriculture and manufacturing. The agricultural sector produces a homogeneous good under perfect competition, and trade between regions is free and costless, i.e. a single price results. The labor market of the agricultural sector is characterized by perfect competition, which leads to full employment. Labor input $L_A$ and output in agriculture $C_A$ are linked through the production function $C_A = L_A$. Owing to marginal productivity payments in the agricultural labor market, the price of agricultural goods is equal to one: $p_A = \partial C_A/\partial L_A = w_A = 1$. Prices and wages in agriculture are fixed to one and thus they serve as a reference for prices and wages in manufacturing.

Firms in manufacturing instead produce under increasing returns to scale and monopolistic competition. There is trade in manufactured goods at iceberg transport costs $\tau$. The production function in manufacturing is

$$L_i = \beta + \phi q_i + s_i. \quad (2.18)$$

Firm $i$ needs a fixed labor input $\beta$, a variable labor input $\phi$ per unit of output $q_i$ and an additional labor input $s_i$ because of shirking employees. The labor demand
2. Basic Model

$L_i$ of firm $i$ is the sum of these three components. Owing to efficiency wages, there is no shirking and hence no additional labor input is needed, $s_i = 0$. Owing to the love of variety, no combination of firms producing the same variety exists. The yield of firm $i$ is

$$\pi_i = p_i q_i - w_r (\beta + \phi q_i). \quad (2.19)$$

Firms maximize their profits through prices and ignore their influence on the price index $p_M$. This leads to the price-setting rule for the price $p_i$, which is identical for all firms in a region (because of the identical wages within a region and identical firms),

$$\frac{\partial \pi_i}{\partial p_i} = 0 \Rightarrow p_r = \frac{\theta}{\theta - 1} w_r \phi. \quad (2.20)$$

The number of firms is endogenous. New firms enter the market until the profits decrease to zero (zero-profit condition),

$$\pi_i = \frac{\theta}{\theta - 1} w_r \phi q_i - w_r (\beta + \phi q_i) = 0 \Rightarrow 0 = w_r \left( \frac{\phi q_i}{\theta - 1} - \beta \right). \quad (2.21)$$

Then, the production and employment of a firm in equilibrium are

$$q_i = \frac{\beta (\theta - 1)}{\phi}, \quad (2.22)$$

$$L_i = \beta + \phi \frac{\beta (\theta - 1)}{\phi} = \beta \theta. \quad (2.23)$$

Production and employment per firm in equilibrium are constant and equal for all firms irrespective of their regions. This leads to the number of firms in a region being

$$n_r = \frac{L_r}{L_i} = \frac{L_r}{(\beta \theta)}. \quad (2.24)$$

The labor input per unit of output is normalized to $\phi \equiv (\theta - 1)/\theta$, so that price and production reduce to
The fixed labor input is normalized to $\beta \equiv \mu / \theta$. Then, the number of firms (=varieties) in a region and the production of a firm is

$$n_r = \frac{L_r}{\mu},$$  \hspace{1cm} (2.27)

$$q_i = L_i = \mu.$$  \hspace{1cm} (2.28)

In equilibrium the production of a firm is equal to the sum of regional demand for the variety of the firm and import demand of the neighboring region for the firm’s variety (taking into account iceberg transport costs $\tau$),\footnote{If one unit of the manufactured good is transfered to the neighboring region, only $1/\tau$ units arrive. Therefore, $\tau$ units have to be sent for one unit to arrive.} so that

$$q_i = \mu Y_r \rho^\theta - 1 + \mu Y_s (\tau p_r)^{-\theta} P^\theta - 1 \tau,$$  \hspace{1cm} (2.29)

$$\Rightarrow w_r = \left[ Y_r \rho^\theta - 1 + Y_s P^\theta - 1 \tau^{-1 - \theta} \right]^{\frac{1}{\theta}}.$$  \hspace{1cm} (2.30)

The latter equation represents the goods market equilibrium in the form of the wage equation. It represents the wage at which the condition of zero profits is fulfilled and no firms enter or leave the market. For lower wages, the profit of an additional firm is greater than zero so that new firms enter the market. Since the number of firms is directly linked to employment, this equation also represents labor demand. When wages are lower than the wage that fulfills the zero-profit condition, this results in increased employment, decreased unemployment and increased shirking. To prevent shirking, firms increase wages (wage curve). This process continues until the wage fulfilling the zero-profit condition is equal to the wage preventing shirking.

### 2.4.4. Normalizations

Some words need to be said about the two normalizations, $\phi \equiv (\theta - 1)/\theta$ and $\beta \equiv \mu / \theta$. Fujita et al. (1999, p. 54-55) and Baldwin et al. (2003, p. 22-24) argue that one only chooses the units of measurements through these normalizations. For example, Fujita et al. (1999, p. 54) say that “we are free to choose units of...
measurement for output – be it units, tens of units, kilos, or tons.” In their point of view these normalizations only affect measures, so that there is no loss in generality. Basically, the first normalization defines the units of measurement for output. The second normalization requires more discussion.

Neary (2001, p. 548-552) criticizes these normalizations. He argues that, due to the normalizations, \( \theta \) not only refers to the elasticity of substitution between the varieties of manufactured goods, but also affects the relation of fixed to variable input factors in the production function of firms. Thus, one cannot distinguish the two effects.

However, Baldwin et al. (2003, p. 24) directly address Neary’s critique. They argue that “dual normalization is not problematic in the continuum of varieties version of the model (i.e. it implies no loss of generality), but it is not OK in the discrete version (which is the version Neary (2001) works with). [...] Thus, the continuum gives us an extra degree of freedom that can be absorbed in an extra normalization. In the discrete varieties version, firms have a natural metric (defined by the size of the fixed labour requirement), so the second normalization does reduce generality” (Baldwin et al.; 2003, p. 24). Hence, in the continuous version of the model, there is an infinite number of firms in the continuum of varieties, so that there is no natural unit of measurement for firms. Accordingly one can choose a unit of measurements for firms which is done by choosing a normalization for the fixed labor input \( \beta \), because this fixed input defines firms.

Since the present model relies on a continuum of varieties, the critique of Neary (2001) does not apply here, the normalizations only reflect the choice of measures and there is no loss in generality. Hence, Fujita et al. (1999, p. 75) and Baldwin et al. (2003, p. 31) interpret changes of \( \theta \) and \( \mu \) only as changes in the elasticity of substitution/price markups and the share of manufacturing in the economy, respectively, when discussing their influences on the regional system.

2.5. Equilibrium and Migration

The simultaneous equilibrium in both regions is defined by the price indexes, price-setting functions, incomes and wage curves of both regions (only equations for region \( r \) are presented, equations for region \( s \) follow analogously),
2.5. Equilibrium and Migration

\[
P_r = \left[ \frac{1}{\mu} \left( L_r w_r^{1-\theta} + L_s (\tau w_s)^{1-\theta} \right) \right]^{1/\theta} \quad , \tag{2.31}
\]

\[
w_r = \left[ Y_r P_r^{\theta-1} + Y_s P_s^{\theta-1} (1-\tau)^{1-\theta} \right]^{1/\theta} \quad , \tag{2.32}
\]

\[
Y_r = w_r L_r + L_{Ar} \quad , \tag{2.33}
\]

\[
w_r = \frac{P_r^\mu}{K} e \left[ 1 + \frac{\rho}{1-\gamma} + \frac{\psi}{(1-\gamma)U_r} \right] \quad . \tag{2.34}
\]

From (2.31), it follows that the region with the larger number of manufacturing employees has a lower price index. This is because a larger number of manufacturing employees results in a larger number of varieties produced, increasing competition. Then, the demand for any individual variety is lower and its price and corresponding revenues decrease, leading to a lower price index. Furthermore, transport costs are lower in the agglomeration, which further reduces the price index in the agglomeration.

The wage equation (2.32) represents the wage (=price) at which firms reach their break-even point (i.e. where profits are zero). The higher incomes and prices and the lower transport costs are the higher is this wage. Regions with a higher income have a higher purchasing power and the break-even point of firms lies at a higher wage. Since the number of firms is directly linked to employment, this equation implicitly reflects labor demand. An increase of income in a region leads to a lower or higher increase of employment, depending on the wage elasticity of labor supply. When the increase in employment is larger, centripetal forces dominate: A region that once managed to gain a higher income will be able to use this advantage to attract new firms, income and demand, enforcing an agglomeration process. This process endogenously leads to agglomeration and regional disparities.

The region with the larger number of manufacturing employees thus has higher nominal wages (backward linkage), so that this region is more attractive for firms because of its higher purchasing power. This region is further characterized by a larger number of varieties and thus a lower price index; it is therefore more attractive for immigration (forward linkage). These forward and backward linkages establish the centripetal forces leading to endogenous agglomeration. These are opposed to the centrifugal forces resulting from demand by agricultural employees.

Equation (2.34) represents the wage curve, which is the extension of this chapter to the core-periphery model. The wage curve is the link between employment and wages, leading to unemployment. It represents the wage set by firms to prevent shirking.
2. Basic Model

For a compact illustration of the model, the labor force (as the sum of agricultural and manufacturing labor force) is standardized to one. This labor force is separated into agriculture and manufacturing \(N\) according to the expenditure shares of agricultural and manufactured goods in income. The agricultural labor force is equal in both regions, whereas the labor force in manufacturing can have different sizes in the two regions. The proportion of manufacturing labor force in region \(r\) is \(\lambda\), and \(1 - \lambda\) in region \(s\) accordingly. Owing to the full employment in agriculture, the corresponding labor force is equal to employment in both regions.

The sectoral and regional labor forces then are

\[
L_{Ar} = \frac{1 - \mu}{2}, \quad (2.35)
\]
\[
L_{As} = \frac{1 - \mu}{2}, \quad (2.36)
\]
\[
N_r = \mu \lambda, \quad (2.37)
\]
\[
N_s = \mu (1 - \lambda). \quad (2.38)
\]

The simultaneous equilibrium in the short-term depends on the exogenous parameters disutility of work effort \(e\), probability to observe shirking \((1 - \gamma)\), job destruction rate \(\psi\), share of expenditures for manufacturing \(\mu\), elasticity of substitution between varieties of manufactured goods \(\theta\) and discount rate \(\rho\). The model cannot be solved analytically but rather numerically, which is standard practice in the NEG.

In the long-term, the unemployed are allowed to migrate between regions. They compare their expected utility in both regions and decide to migrate when their utility is higher in the neighboring region. Their utility depends on their real wages\(^8\) and chances of finding employment.\(^9\) The agglomeration forces are similar to Fujita et al. (1999). Owing to the wage curve, higher real wages in a region are always accompanied by lower unemployment. Migration behavior (expressed as the change in \(\lambda\)) is therefore sufficiently defined by

\(^8\)The real wage in region \(r\) is: \(w_r \frac{K}{P_r}\).

\(^9\)The chance of finding employment depends on the endogenous job creation rate and thus it is directly linked to the unemployment rate.
2.5. Equilibrium and Migration

\[
\dot{\lambda} > 0 \text{ for } \delta_r > \delta_s \text{ or } w_r \frac{K}{P_r} > w_s \frac{K}{P_s} \text{ or } U_r < U_s,
\]

\[
\dot{\lambda} = 0 \text{ for } \delta_r = \delta_s \text{ or } w_r \frac{K}{P_r} = w_s \frac{K}{P_s} \text{ or } U_r = U_s,
\]

\[
\dot{\lambda} < 0 \text{ for } \delta_r < \delta_s \text{ or } w_r \frac{K}{P_r} < w_s \frac{K}{P_s} \text{ or } U_r > U_s.
\]

This definition of migration behavior is motivated by optimal migration decisions, which are based on static expectations of the differences in real wages and unemployment between both regions (Baldwin et al.; 2003, Appendix 2.B.4). This further extends the underlying logic of the basic efficiency wage model to the migration case. In the basic model, the equilibrium is reached when the expected life-time utilities of shirking and non-shirking employees are equal. Analogously, the long-term equilibrium is reached when the expected life-time utilities of the unemployed in both regions are equal. Actually, Baldwin (2001) analytically shows that the break and sustain points are the same in the core-periphery model no matter whether migration behavior is based on static or forward-looking expectations and that global stability properties do not change either. Therefore the analytically more traceable option of static expectations rather than forward-looking expectations is used here.

In the case of symmetry ($\lambda = 0.5$), there is no migration since — due to symmetry — the endogenous variables are equal in both regions. When there is no symmetry ($\lambda \neq 0.5$), the endogenous variables can differ between both regions and migration might occur depending on these differences. For any given $\lambda$, a short-term equilibrium exists. However, if the utility of the unemployed differs between the regions in the short-term equilibrium, they migrate, which leads to a new short-term equilibrium. A long-term equilibrium results when the utility of the unemployed is equal in both regions so that no further migration occurs. Migration takes place from the region with the higher to the region with the lower unemployment rate, or from the region with the lower to the region with the higher real wage, which is identical. The difference in real wages in the short-term equilibrium, depending on $\lambda$, is displayed for different transport costs in Figure 2.1 (for the parameters $e = 0.5$, $\gamma = 0.1$, $\psi = 0.1$, $\mu = 0.6$, $\theta = 4$ and $\rho = 0.05$).

Depending on transport costs $\tau$, different situations result. For low transport costs, the real wage is always higher in the larger region (in the agglomeration). The marginal advantage of a region (compared with the other) then leads to a self-reinforcing agglomeration process until full agglomeration is reached. The symmetric equilibrium at $\lambda = 0.5$ is unstable in this case. For high transport costs, the real wage is always lower in the larger region, so that the system returns to the symmetrical equilibrium at $\lambda = 0.5$ for any initial $\lambda$. For medium transport costs, two additional
2. Basic Model

Multiple equilibria result. The behavior of the system crucially depends on the stability of these equilibria. A long-term equilibrium is reached when there is no incentive to migrate. As discussed above, the symmetrical equilibrium is unstable for low transport costs but becomes stable once a certain transport cost threshold is crossed. This value marks the break point. For the equilibria at full agglomeration, there is a similar but reversed pattern: they are stable for low transport costs but become unstable once transport costs increase over a certain value. The value of the transport costs, where this change takes place, is the sustain point.

Figure 2.1.: Equilibria and Migration

equilibria (i.e. equal real wages in both regions) result — in this case the symmetrical equilibrium is stable as is the equilibrium with full agglomeration. The additional equilibria then present thresholds that have to be crossed for the agglomeration process to be stable (i.e. to reach full agglomeration starting from symmetry).

2.6. Stability
2.6. Stability

2.6.1. Sustain Point

The sustain point lies at \( \lambda = 1 \) (or \( \lambda = 0 \)), i.e. at full agglomeration. In the sustain point, unemployment rates (or real wages) are equal in both regions. If the unemployment rate (real wage) were higher (lower) in the agglomeration, the agglomeration would not be stable. The sustain point therefore is given by those transport costs \( \tau \), at which the unemployment rates of both regions are equal in the full agglomeration equilibrium. In the full agglomeration equilibrium, the unemployment rate of the periphery is not defined. However, one can derive the implicit unemployment rate in the periphery through the chance of finding a job \( \delta \). To solve the system, the unemployment rates (or equally: the chances of finding a job) of both regions are set to be equal and (for region \( r \) being the agglomeration) \( \lambda \) is fixed at 1. The system of equations then is

\[
P_r = \left( \frac{1}{\mu L_r w_r^{1-\theta}} \right)^{\frac{1}{1-\theta}}, \quad P_s = \left( \frac{1}{\mu L_r (\tau w_r)^{1-\theta}} \right)^{\frac{1}{1-\theta}}, \quad (2.40)
\]

\[
w_r = \left( Y_r P_r^{\theta-1} + Y_s P_s^{\theta-1} \right)^{\frac{1}{\theta}}, \quad w_s = \left( Y_s P_s^{\theta-1} + Y_r P_r^{\theta-1} \right)^{\frac{1}{\theta}}, \quad (2.41)
\]

\[
Y_r = w_r L_r + L_{Ar}, \quad Y_s = L_{As}, \quad (2.42)
\]

\[
w_r = \frac{P_r^\mu}{K} \left( \rho + \psi + \delta_r + 1 - \gamma \right), \quad w_s = \frac{P_s^\mu}{K} \left( \rho + \psi + \delta_r + 1 - \gamma \right), \quad (2.43)
\]

\[
\delta_r = \frac{\psi L_r}{N_r - L_r}. \quad (2.44)
\]

Using these equations and \( N_r = \mu \lambda = \mu \), the sustain point can be calculated for all parameter constellations together with the values of the endogenous variables.

When there is full agglomeration, increasing transport costs leads to an increase in the price index in the periphery and the periphery becomes less attractive (the agglomeration becomes more stable). However, at the same time increasing transport costs leads to a decrease in the wage level at which firms reach their break-even points in the periphery. Thus, the periphery becomes more attractive for firms when transport costs increase (the agglomeration pattern becomes more unstable). For low transport costs, the first effect dominates and the agglomeration becomes more stable. For high transport costs, the second effect dominates and the agglomeration pattern becomes unstable. The net effect is illustrated in Figure 2.2 by showing the development of the difference in unemployment rates against transport costs.
2. Basic Model

![Graph showing the sustain point with a vertical axis labeled $u_r - u_s$ and a horizontal axis labeled $\tau$. The graph includes a range of values from -0.3 to 0.05 for $u_r - u_s$ and from 1 to 19 for $\tau$. The graph also indicates regions of agglomeration stable and unstable.](image)

Figure 2.2.: Sustain Point

2.6.2. Break Point

At the break point, transport costs are at the level where the symmetric equilibrium is stable at the margin. The symmetric equilibrium is stable when a marginal increase of $\lambda$ leads to an increase in the unemployment rate in region $r$ (equally: to a decrease in the chances of finding a job in region $r$). In this case, any marginal deviation from symmetry leads to re-immigration into the marginally smaller region — the system returns to symmetry. By contrast, symmetry is unstable if a marginal increase in $\lambda$ leads to a decrease in the unemployment rate in region $r$. Any deviation from symmetry then results in a self-reinforcing agglomeration process. In order to find the break point, the derivative $\partial \delta_r / \partial \lambda$ for the system in the symmetric equilibrium is calculated and the value of $\tau$ is searched to find the point at which the derivative is zero. At this point, the symmetric equilibrium changes from unstable to stable when $\tau$ changes.

A special feature of the symmetric equilibrium is that the endogenous variables share the same values in both regions and the change in these values has an equal
2.6. Stability

value but opposite sign in the two regions. Therefore, changes are expressed in units of region \( r \) and the index for the regions is dropped. Since \( L_r = \mu \lambda \), it is clear that \( dL_r = \mu d\lambda \). The value of \( \tau \) at the break point then is given by the solution to the system

\[
P = \left[ \frac{1 + \tau^{1-\theta}}{\mu} \left( Lw^{1-\theta} \right) \right]^{1/(1-\theta)},
\]

\[
w = \left( (1 + \tau^{1-\theta}) YP^{\theta-1} \right)^{1/\theta},
\]

\[Y = wL + L_A,\]

\[
w = \frac{P\mu}{K} \left( \rho + \psi + \delta + 1 - \gamma \right),
\]

\[
dP = \frac{P^\theta(1 - \tau^{1-\theta})}{\mu} \left[ \frac{w^{1-\theta}}{1 - \theta} dL + Lw^{-\theta} dw \right],
\]

\[dw = \frac{w^{1-\theta} P^{\theta-1}(1 - \tau^{1-\theta})}{\theta} \left[ dY + (\theta - 1)Y \frac{dP}{P} \right],
\]

\[dY = wdL + Ldw,
\]

\[dw = \mu \frac{w}{P} dP,
\]

\[d\delta \equiv 0 = \frac{\psi}{(N - L)^2} (NdL - LdN).
\]

For lower transport costs, a marginal deviation from symmetry leads to a higher nominal wage and a smaller price index in the larger region. Therefore, the real wage (unemployment rate) is higher (smaller) in the larger region and immigration into the larger region sets in. A cumulative agglomeration process begins, leading to a core-periphery structure — the symmetric equilibrium is unstable. For high transport costs, exports are hindered. A marginal deviation from symmetry then does not allow the larger region to export its production. The effect of the larger manufacturing employment in the larger region on income in that region cannot offset the negative effect of the decreased manufacturing employment on income and import demand in the smaller region. The real wage of the larger region therefore is smaller and re-immigration into the smaller region sets in. The system returns to the (stable) symmetric equilibrium. Figure 2.3 illustrates these effects by looking at the change in the unemployment rate (which directly follows from the change in \( \delta \)) compared with transport costs. For low transport costs, the unemployment
2. Basic Model

rate decreases in region \( r \) once region \( r \) has a marginally larger manufacturing labor force. Then, symmetry is unstable. For high transport costs, the opposite is true and symmetry is stable. The break point lies at the value of \( \tau \) where both effects offset each other and where the symmetric equilibrium changes from unstable to stable.

2.6.3. Results and Parameter Variation

The long-term equilibria for the above illustrated parameter constellation are summarized in Figure 2.4 (the so-called bifurcation diagram) by plotting the division of the manufacturing labor force into regions \( \lambda \) against transport costs \( \tau \). The continuous lines represent stable equilibria and the dashed lines unstable equilibria. For small \( \tau \), the symmetric equilibrium at \( \lambda = 0.5 \) is unstable, whereas the agglomeration equilibria at \( \lambda = 1 \) and \( \lambda = 0 \) are stable. Starting at \( \tau = 1 \), increasing transport costs first leads to a stable symmetric equilibrium (the break point marks the border between stable and unstable). Further increasing transport costs then leads to un-
2.6. Stability

The agglomeration equilibria become unstable and disappear (the sustain point marks the border between stable agglomeration and no agglomeration). The break and sustain points are connected by a dashed line representing the unstable additional equilibria discussed earlier. These represent those thresholds that decide whether agglomeration or symmetry results.

The larger the elasticity of substitution, the lower are the values of transport costs for the break and sustain points. Increasing the elasticity of substitution leads to increasing product differentiation and decreasing mark-ups on prices, thus resulting in a decrease of agglomeration advantages. Figures 2.5 and 2.6 represent graphically the corresponding bifurcation diagrams for $\theta = 3$ and $\theta = 6$ (all other parameters remain the same).

In general, the value of transport costs at the sustain and break points are larger when the share of the manufacturing sector $\mu$ increases or the elasticity of substitution $\theta$ decreases. This is illustrated in Table 2.1 where the transport costs at the sustain and break points are plotted against different $\theta$ and $\mu$ values. The underlying parameters are $\epsilon = 0.5$, $\gamma = 0.1$, $\psi = 0.1$ and $\rho = 0.05$. However, a vari-

---

Figure 2.4.: Bifurcation Diagram at $\theta = 4$
2. Basic Model

\[ \theta = 3 \]

Figure 2.5.: Bifurcation Diagram at \( \theta = 3 \)

The goods market of the model is based on Fujita et al. (1999) and hence the agglomeration pattern is qualitatively comparable to their results. For low transport costs, the full agglomeration of manufacturing in one region arises endogenously, even if both regions share the same characteristics. Only when transport costs are large enough does symmetry become a stable equilibrium (break point). When transport costs increase above the sustain point, agglomeration becomes unstable.

2.7. Interpretation and Discussion

The goods market of the model is based on Fujita et al. (1999) and hence the agglomeration pattern is qualitatively comparable to their results. For low transport costs, the full agglomeration of manufacturing in one region arises endogenously, even if both regions share the same characteristics. Only when transport costs are large enough does symmetry become a stable equilibrium (break point). When transport costs increase above the sustain point, agglomeration becomes unstable.
and the regions will return to symmetry for all initial starting values. However, in contrast to Fujita et al. (1999), unemployment exists in both regions as a result of efficiency wages. The unemployment rate in the agglomeration is — as long as the agglomeration is stable — lower or at least equal to the unemployment rate in the periphery. The model presented here is thus able to explain how agglomerations arise endogenously through the interplay of transport costs, increasing returns to scale and migration and how regional labor markets (especially wages and unemployment) adjust to agglomeration. Regional labor market disparities therefore arise endogenously through the interplay of centrifugal and centripetal forces.

The results are comparable to those of Epifani and Gancia (2005). These authors base their regional labor market model on the model of Fujita et al. (1999) as well. The disparities in wages and unemployment arise endogenously through agglomeration in a similar way. However, they focus on labor market frictions in job-matching processes and assume flexible wages, whereas this chapter focuses on frictions in wage setting. Thus, their approach and the model presented here com-
2. Basic Model

\[ \mu = 0.2 \]
\[ \mu = 0.4 \]
\[ \mu = 0.6 \]

<table>
<thead>
<tr>
<th>( \theta )</th>
<th>( \tau(B) )</th>
<th>( \tau(S) )</th>
<th>( \tau(B) )</th>
<th>( \tau(S) )</th>
<th>( \tau(B) )</th>
<th>( \tau(S) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \theta = 3 )</td>
<td>1.669</td>
<td>1.718</td>
<td>3.055</td>
<td>4.471</td>
<td>8.718</td>
<td>3125</td>
</tr>
<tr>
<td>( \theta = 4 )</td>
<td>1.373</td>
<td>1.393</td>
<td>1.972</td>
<td>2.339</td>
<td>3.302</td>
<td>14.62</td>
</tr>
<tr>
<td>( \theta = 5 )</td>
<td>1.257</td>
<td>1.269</td>
<td>1.627</td>
<td>1.807</td>
<td>2.3</td>
<td>5</td>
</tr>
</tbody>
</table>

\( \tau(B) \) and \( \tau(S) \) represent the \( \tau \)-values of the break (B) and sustain points (S).

Table 2.1.: Break and Sustain Points for Several \( \theta \) and \( \mu \)

The results are further comparable to Südekum (2005). He discusses a wage curve based on efficiency wages within the framework of a regional goods market model. In contrast to the present chapter, he exclusively focuses on centripetal forces to be able to solve the model analytically. In his model, agglomeration patterns lead to higher wages and lower unemployment in the core than in the periphery. Nevertheless, without any additional assumptions on migration, full agglomeration necessarily results because of the lack of centrifugal forces. The present model instead discusses the disparities in regional labor markets within the interplay of centrifugal and centripetal forces, and it is therefore able to distinguish under which circumstances disparities arise (or not).

Further, the results are comparable to Francis (2007), who combines the core-periphery model with efficiency wages based on Shapiro and Stiglitz (1984) as well. Whereas he focuses on the effect of asymmetries on regional labor market disparities, the aim of the present chapter is to provide a basic framework, which is extended in the subsequent chapters to discuss regional labor market disparities.

2.8. Conclusions

The disparities in regional labor markets are a key characteristic of Germany (and other countries as well). Their level is comparable to those between nation states. Whereas at a national level the institutional factors of the labor market are often held to be responsible for these disparities, they can only account for a minor proportion of regional disparities, since institutional factors vary only marginally at the regional level (Blien and Sanner; 2006).

The concept of the wage curve plays a key role, especially at the regional level. Empirical evidence indicates that there is a negative relationship between unemployment and wages (Blanchflower and Oswald; 1994). Efficiency wages are
particularly suitable to explain the wage curve for German regions (Blien; 2001). However, in this case the disparities between regional labor markets can only result from those in labor demand. Overman and Puga (2002) deliver empirical evidence in favor of labor demand being the main cause of the regional labor market disparities in Europe. As a result, regional goods markets play a key role in explaining the disparities in regional labor markets. The NEG discusses how such disparities in regional goods markets arise endogenously.

This chapter presents the basic framework to introduce wage-setting frictions based on efficiency wages into the NEG. The subsequent chapters build on this framework. Chapter 3 introduces congestion externalities to show the effect of agglomeration on regional unemployment disparities in the case of partial agglomeration and to discuss the influence of labor market frictions on regional unemployment disparities. Chapter 4 introduces monocentric cities into the basic framework. This extension is used to argue that the wage curve literature does not refute the Harris and Todaro (1970) model and to analyze under which conditions the agglomeration of economic activity is associated with higher or lower unemployment in the economic core than in the periphery.
3. Congestion Externalities

3.1. Abstract

Regional labor markets are characterized by huge disparities between unemployment rates. Models of the New Economic Geography explain how disparities between regional goods markets arise endogenously, but these models usually assume full employment. This chapter discusses regional unemployment disparities by introducing a wage curve based on efficiency wages into the New Economic Geography. The model shows how disparities between regional goods and labor markets arise endogenously through the interplay of increasing returns to scale, transport costs, congestion costs, and migration. Owing to the congestion costs, the periphery is not empty so that, in contrast to the basic model from Chapter 2, the labor market indicators in the agglomeration are compared to non-hypothetical values in the periphery. Further the level and stability of regional labor market disparities depends on the extend of labor market frictions. Labor market frictions reinforce regional labor market disparities.

**JEL Classification:** F15, R12, R23

**Keywords:** Regional unemployment, New Economic Geography, Core-periphery, Wage curve, Labor migration

3.2. Introduction

It is a well-known empirical fact that regional labor markets are characterized by huge and persistent disparities. Furthermore, there is a negative link between unemployment and wages at the regional level, as discussed in the wage curve literature following Blanchflower and Oswald (1994). Several theoretical models exist to explain how a wage curve might arise. However, such models usually rely on exogenous disparities to explain the location of regions on the wage curve. Further, the stability of the wage curve in these models often relies on the assumption of labor immobility (Blien; 2003). This chapter therefore combines efficiency wages with endogenous agglomeration through New Economic Geography (NEG) arguments to discuss how
3. * Congestion Externalities

A wage curve arises endogenously and why it is stable in the presence of migration. The chapter further discusses how labor market frictions affect regional disparities.

Figure 3.1 highlights the disparities in regional unemployment rates and wages in German planning regions. Whereas in 2008 the unemployment rate was 3.2% in Ingolstadt, it amounted to 15.3% in Mecklenburgische Seenplatte (at the level of planning regions). Similar patterns hold true for other countries as well. Empirical studies such as those of Blanchard and Katz (1992), Decressin and Fatás (1995), and Overman and Puga (2002) further show that such disparities between regional unemployment rates are persistent. Disparities in regional unemployment rates are closely linked to disparities in regional wages: in regions where the unemployment rate is comparatively low, wages are comparatively high. This is known as the wage curve and can be seen in Figure 3.1. Following the seminal work of Blanchflower and Oswald (1994), an extensive literature has emerged, providing evidence in favor of the wage curve for a huge number of countries. Results by Eckey et al. (2008) further show that this relationship also applies when using real wages instead of nominal wages.

There are already several theoretical models to explain the wage curve relationship. For example, Campbell and Orszag (1998) use efficiency wages, and Sato (2000) uses search theory, as an explanation for the wage curve. A survey of the theoretical approaches is presented by Blien (2003). Blien (2003) argues that the “most promising” approach to explain the wage curve is the efficiency wage framework. He argues that wage bargaining models might be equally suitable when unions bargain on the local or firm level. Here, however, efficiency wages are applied instead, so that the results of the models also apply to countries where bargaining takes place on the sectoral or national level. Empirical evidence confirms that efficiency wages are relevant, as highlighted by a recent meta-analysis by Peach and Stanley (2009).

A drawback of most theoretical models of the wage curve relationship is that they rely on exogenous disparities between regions. Further, the stability of the relationship usually relies crucially on labor immobility (Blien; 2003) or disparities in the endowment of amenities. For example, the wage curve relationship in the seminal paper by Blanchard and Katz (1992) can only persist because people in regions at the lower tail of the wage curve are compensated for their poorer labor market conditions by local amenities. Without those amenities, people from regions at the lower tail of the wage curve would migrate to regions at the upper tail, which would

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2 Blanchard and Katz (1992) focus on the role of shocks in regional labor market dynamics rather than the wage curve per se. However, according to Elhorst (2003), they present what is probably the most encompassing model of regional labor markets.
result in an adjustment process such that the regional disparities would disappear and the wage curve would collapse into a point.

The idea of this chapter is therefore to use the arguments of the NEG to explain how disparities between regional economies arise endogenously and to combine these with the arguments from the efficiency wage literature to show why this is associated with a wage curve relationship. The basic argument is that, due to a love of variety, monopolistic competition, increasing returns to scale and transport costs, firms in agglomerated regions are able to pay higher wages. Therefore the incentive to shirk is lower for employees in agglomerations, which results in a lower unemployment rate in the agglomeration than in the periphery. Hence lower wages in the periphery are associated with higher peripheral unemployment, since wage-setting frictions are more binding there. The model further shows that regional unemployment disparities increase with the level of wage-setting frictions.
3. Congestion Externalities

3.3. Literature Review

The idea of combining NEG arguments with labor market frictions to explain (regional) labor market disparities has already been put forward by others. For example, there are various papers which explain disparities between national labor markets. These, however, explain national labor market disparities either by relying on institutional differences between nations,\(^3\) or by assuming labor immobility.\(^4\) The present chapter focuses instead on the regional level, and thus uses a framework where there are no institutional differences and where people migrate between regions.

Further, there is a strand of literature combining frictions in job-matching with the arguments of the NEG. Epifani and Gancia (2005), for example, introduce job-matching into the NEG. They show how disparities between regional economies arise endogenously, and how they result in disparities between regional labor markets. In particular they discuss how disparities between regional economies result in disparities between regional unemployment rates. Francis (2009) extends their model to cover endogenous job-destruction. Vom Berge (2011b,a) uses a similar approach. The basic story in this strand of the literature is usually that the likelihood of a match between employers and job seekers is higher in an agglomeration than it is in a periphery, so that the average unemployment rate is lower in the former than in the latter. Nevertheless, Epifani and Gancia (2005) only cover frictions in job-matching, and conclude that further research is necessary to discuss frictions in wage-setting within the NEG. The aim of the present model is to fill this gap in the literature.

Therefore the approach is to model frictions in wage-setting by using efficiency wages. Some comparable models have been presented by others: Südekum (2005) introduces frictions in wage-setting based on efficiency wages into an agglomeration model. Nevertheless, since he focuses exclusively on centripetal forces, full agglomeration is prevented only by relying on labor immobility. Egger and Seidel (2008) combine a wage curve based on a fair wage approach with the NEG. In their model, the work effort of the poorly qualified is influenced by the fairness of their wages. This leads to a link between wages and unemployment. However, the paper is only indirectly linked to the present approach, since it is a story of divided but interrelated labor markets. In Egger and Seidel’s model the unemployment rate of the immobile poorly qualified (who earn fixed wages) is related to the migration behavior of the highly qualified (who are never unemployed). Francis (2007), in turn,

\(^3\)Examples are Chen and Zhao (2009), Helpman and Itskhoki (2010), Helpman et al. (2011), Méjean and Patureau (2010), Monford and Ottaviano (2002), Picard and Toulemonde (2006), and Strauss-Kahn (2005).

\(^4\)Examples are Peeters and Garretsen (2004) and Pflüger (2004).
combines an efficiency wage framework with the core-periphery model of Fujita et al. (1999), but there is only perfect symmetry or full agglomeration. Either there is symmetry, so that there are no disparities, or there is full agglomeration, so that no one is left in the periphery. The unemployment rate in the empty periphery can only be calculated implicitly through the chance of finding a job, as discussed in the previous chapter. This means that the wage curve is either a point, in the case of symmetry, or it only exists implicitly, since there are actually no unemployed people or employees left in the periphery. Francis then concentrates on the case of asymmetric regions.

The distinctive idea proposed in this chapter is therefore that disparities between regional labor markets in the form of the wage curve relationship arise due to endogenous agglomeration and efficiency wages. This is not to say that efficiency wages are relevant and job-matching frictions are not, but rather that both might be important to explain regional labor market disparities. Empirical evidence suggests that efficiency wages are indeed an important mechanism. It is therefore crucial to understand both channels through which regional labor market disparities arise.

The present approach highlights the importance of frictions in wage-setting. Employers in agglomerations are able to pay higher wages, so that shirking is reduced there, the effect of which is that unemployment is lower in the agglomeration than in the periphery. In more general terms, the argument is that employers in the agglomeration are able to pay higher wages, so that the effect of labor market frictions on unemployment is lower there. Vice versa, this means that employers in the periphery can only pay lower wages, so that labor market frictions more strongly affect the unemployment rate in the periphery.

3.4. Basic Model

The present chapter develops a NEG model with labor market frictions based on efficiency wages (and thus a wage curve). The NEG part of this model is based on the model of Fujita et al. (1999). Their household model is extended to the disutility of work effort, which is essential for modeling efficiency wages. Efficiency wages are based on the approach of Shapiro and Stiglitz (1984).

There are two regions, $r$ and $s$, and two sectors, the agricultural sector $A$ and the manufacturing sector $M$. Agriculture is characterized by perfect competition in both the goods and the labor market. Manufacturing, by contrast, is characterized by monopolistic competition in the goods market and efficiency wages in the labor

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5Peach and Stanley (2009) present a meta-analysis of the existing evidence.
3. Congestion Externalities

Labor is inter-sectoral immobile, but labor in the manufacturing sector is inter-regional mobile. Labor in agriculture is considered to be immobile.

3.4.1. Households

Households live in regions $r$ and $s$. They receive utility $U$ through the consumption of agricultural goods $C_A$ and through the consumption of manufactured goods $C_M$. $C_M$ represents a composite of the manufactured goods. Utility $U$ is lowered by work effort $e$. Furthermore, congestion costs $H$ influence utility,

$$U_j = H \left( C_M^{\mu_j} C_A^{1-\mu_j} - e \right). \tag{3.1}$$

The congestion costs are modeled in a similar way to Ricci (1999). That is, given the share of the manufacturing labor force $\lambda$ of region $r$, the congestion costs $H$ for regions $r$ and $s$ are

$$H_r = h^{1-\frac{\lambda}{r}}, \tag{3.2}$$
$$H_s = h^{1-\frac{1-\lambda}{s}}. \tag{3.3}$$

Here, $h$ is a parameter for the relevance of congestion costs. For $h > 1$, increasing agglomeration in one region decreases the utility of households in the agglomeration, but increases the utility of households in the other region, since agglomeration occurs only through the division $\lambda$ of the fixed manufacturing labor force between the regions. The congestion costs can be interpreted as a local fixed supply of goods, such as land or housing, with positive and decreasing marginal utility. The fact that congestion costs increase with the size of the agglomeration is well-known from urban economics. This model relies on a simple version of this fact to ensure the traceability of the arguments. Congestion costs are hence introduced in an analogy to iceberg transportation costs: Both are constructed in a rather simple fashion in order to keep track of how the agglomeration pattern changes when transport costs and congestion costs change.

The composite index of manufactured goods is a constant-elasticity-of-substitution (CES) utility function,

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6By replacing equations 3.2 and 3.3 with housing supply, a housing-market can be explicitly modeled within the same framework, see e.g. Helpman (1998) and Pflüger and Südekum (2008).

7See for example Fujita and Thisse (2002).
3.4. Basic Model

\[ C_M = \left[ \int_0^n c_i^{\frac{\theta-1}{\gamma}} di \right]^{\frac{\theta}{\theta-1}}. \]  

(3.4)

The number of firms is \( n \) and the elasticity of substitution between the varieties of manufactured goods is \( \theta > 1 \). Households maximize their utility in two stages. They decide upon the optimum division of their income between agricultural and manufactured goods subject to the budget constraint \( p_M C_M + p_A C_A = Y_j \), where \( p_M \) is the manufacturing price index, \( p_A \) is the price of the agricultural good \( C_A \) and \( Y_j \) is the income of household \( j \). In addition they decide on the optimum composition of the varieties of manufactured goods. Due to the standardization \( p_A = 1 \), the prices of manufactured goods (and all wages) are measured relative to agricultural prices.

Utility maximization at the first stage decision leads to the consumption expenditure shares of agricultural and manufactured goods by income, \( C_{Mj} = \mu Y_j \) and \( C_{Aj} = (1 - \mu) Y_j \). Note that the result of utility maximization is independent of congestion costs and work effort. The second stage decision is based on Shephard’s (1953) Lemma,

\[ \min \int_0^n p_i c_i \; d_i \text{ s.t. } \left[ \int_0^n c_i^{\frac{\theta-1}{\gamma}} di \right]^{\frac{\theta}{\theta-1}} = C_M. \]  

(3.5)

This leads to the CES manufacturing price index \( p_M = \left[ \int_0^n p_i^{1-\theta} di \right]^{\frac{1}{1-\theta}} \). In the two-region case with identical firms and iceberg transport costs \( \tau \geq 1 \), the manufactured goods price index \( P_r \) in region \( r \) is then

\[ P_r = \left[ n_r p_r^{1-\theta} + n_s (\tau p_s)^{1-\theta} \right]^{\frac{1}{1-\theta}}, \]  

(3.6)

where \( n_r \) and \( n_s \) represent the number of firms (that is, the varieties) and \( p_r \) and \( p_s \) their prices, in the corresponding region. The demand for variety \( i \) by household \( j \) follows from minimizing expenditures for the varieties,

\[ c_{ij} = \left( \frac{P_i}{P_M} \right)^{-\theta} C_{Mj} = \left( \frac{P_i}{P_M} \right)^{-\theta} \mu \left( \frac{Y_j}{p_M} \right). \]  

(3.7)

3.4.2. Labor Market

The labor market is modeled within the efficiency wage framework of Shapiro and Stiglitz (1984). Only the derivation of the wage curve for region \( r \) is presented. The wage curve for region \( s \) follows analogously. Subsequently the definition \( v(w_r) \)
3. Congestion Externalities

is used to abbreviate the derivation of the wage curve. \( v(w_r) \) reflects the utility function (3.1) excluding work effort,

\[
v(w_r) = H_r C_M^\mu C_A^{1-\mu}.
\] (3.8)

Due to the disutility of work effort, employees have an incentive to shirk and hence to avoid work effort. The expected life-time utilities of employees who do not shirk (NS), those who do (S), and the unemployed (0), are (Shapiro and Stiglitz; 1984)

\[
\rho V_r^{NS} = v(w_r) - H_r 
\]
\[
\rho V_r^S = v(w_r) - (\psi + 1 - \gamma) \left( V_r^S - V_r^0 \right),
\] (3.9)

\[
\rho V_r^0 = \delta_r \left( V_r^{NS} - V_r^0 \right),
\] (3.10)

where \( \rho \) is the discount rate of utility, \( \delta_r \) is the endogenous job generation rate, \( \psi \) is the exogenous job destruction rate and \( 1 - \gamma \) is the probability of detecting shirking. The labor market equilibrium is given by two conditions. First, employers pay efficiency wages to prevent shirking at the margin. Therefore, the wages are set at the level required to equalize the utilities of shirking and non-shirking employees \( (V_r^{NS} = V_r^S) \),

\[
v(w_r) = H_r e \left( 1 + \frac{\rho + \psi + \delta_r}{1 - \gamma} \right).
\] (3.12)

Second, in equilibrium the inflow to unemployment \( \psi L_r \) is equal to the outflow of unemployment \( \delta_r (N_r - L_r) \) (where \( L_r \) is the number of manufacturing employees and \( N_r \) is the manufacturing labor force in region \( r \)). Therefore, the endogenous rate of job creation is \( \delta_r = \psi L_r / (N_r - L_r) \). Taking into account the unemployment rate \( U_r = 1 - L_r/N_r \), the endogenous rate of job creation is \( \delta_r = \psi / U_r - \psi \). Using the definition for \( v(w_r) \), the wage curve for region \( r \) (and analogously for region \( s \)) can be rewritten as

\[
w_r = \frac{P_r^\mu}{K} e \left[ 1 + \frac{\rho}{1 - \gamma} + \frac{\psi}{(1 - \gamma)U_r} \right] \text{ where } K = \mu^\mu (1 - \mu)^{1-\mu}.
\] (3.13)
Equation 3.13 directly links wages to the unemployment rate and represents the wage curve resulting from efficiency wages. It represents the wage firms pay in order to prevent shirking at the margin.\footnote{The wage curve hence relates real wages to the unemployment rate. Empirical studies in the wage curve literature usually rely on nominal wages due to lack of regional price data, whereas theoretical models for the wage curve are usually based on real wages. However, empirical analyses using real wages show that the wage curve results also appear when regional price levels are taken into account: see, for example, Eckey et al. (2008).}

Further, migration has to be taken into account. Individuals who migrate are initially unemployed in their region of destination. An individual decides to migrate when her expected lifetime utility as an unemployed person abroad is greater than her utility in her current status at home. However, to monitor whether migration takes place, it is sufficient to compare expected lifetime utilities among the unemployed in both regions. This is due to the fact that the expected lifetime utility of an employee is always larger than that of an unemployed person: $V_{rNS} > V_{r0}$. Therefore, migration takes place when $V_r^0 < V_s^0$. This applies as long as the focus of this work remains on whether someone migrates, instead of on who (an employee or an unemployed person) migrates. In order to observe migration, the present model therefore compares the expected lifetime utilities of the unemployed in the two regions.

Taking the definition of $v(w_r)$ into account, the expected lifetime utility of an unemployed worker in region $r$ is given by

\begin{equation}
\rho V_r^0 = \frac{\delta_r}{\rho + \psi + \delta_r} H_r \left[ w_r K \frac{P_r^e}{P_r^e} - e \right].
\end{equation}

Migration takes place when the expected lifetime utility of the unemployed in the neighboring region is larger than the expected lifetime utility of the unemployed in the home region. This migration behavior is based on static expectations of real wages, unemployment and congestion costs in both regions. This seems to be a drawback of most NEG models. However, Baldwin (2001, p. 25) “shows analytically that the break and sustain points are not affected by the inclusion of forward-looking behavior” for the core-periphery model, on which this chapter is based. Baldwin (2001) even shows that the global stability properties do not change when forward-looking behavior is included in the core-periphery model.\footnote{Baldwin (2001) further shows that the “history vs. expectations” discussion of the core-periphery model needs a re-evaluation when using forward-looking expectations, although this is not relevant in the present case since the present model does not address this discussion. Further results regarding forward-looking expectations in the core-periphery model are presented in Baldwin et al. (2003).} Since more complex
3. Congestion Externalities

forward-looking expectations do not change the basic results, the present analysis is based on static expectations which are more traceable.

3.4.3. Goods Market

The goods market is based on the core-periphery model of Fujita et al. (1999), and is separated into agricultural and manufacturing sectors. The agricultural sector produces a homogeneous good under perfect competition, and trade between regions is free and costless, i.e. a single price results. The labor market of the agricultural sector is also characterized by perfect competition, leading to full employment. Labor input $L_A$ and output in agriculture $C_A$ are linked through the production function $C_A = L_A$. Due to marginal productivity payments in the agricultural labor market, the price of agricultural goods is equal to one: $p_A = \partial C_A / \partial L_A = w_A = 1$. Prices and wages in agriculture are fixed at one and serve as a reference for prices and wages in manufacturing.\(^{10}\)

Firms in manufacturing, on the other hand, produce under increasing returns to scale and monopolistic competition. There is trade in manufactured goods at iceberg transport costs $\tau$. The production function in manufacturing is expressed in terms of labor input $L_i = \beta + \phi q_i + s_i$.

For production, firm $i$ needs a fixed labor input $\beta$, a variable labor input $\phi$ per unit of output $q_i$, and an additional labor input $s_i$ due to shirking employees. Labor demand $L_i$ of firm $i$ is the sum of these three components. Since there are efficiency wages there is no shirking and hence no additional labor input is needed, or $s_i = 0$. Since variety is desired, no combination of firms exists which produce the same variety. The yield of firm $i$ is $\pi_i = p_i q_i - w_r (\beta + \phi q_i)$.

Firms maximize their profit through prices $\frac{\partial \pi_i}{\partial p_i} = 0$, and ignore their influence on the aggregate price index $p_M$. This leads to the price-setting rule for the regional price $p_r = \frac{\theta}{\theta - 1} \frac{\theta}{\phi} w_r \phi$, which is identical for all firms in a region (because there are identical wages within the region and identical firms).

The number of firms is endogenous. New firms enter the market until the profits decrease to zero (zero-profit condition), so that $q_i = \frac{\beta (\theta - 1)}{\phi}$ and $L_i = \beta \theta$. Production and employment per firm in equilibrium are constant and equal for all firms irrespective of their region. The number of firms in a region is then $n_r = \frac{\beta \theta}{\phi} w_r$.\(^{10}\)

\(^{10}\)The basic function of the agricultural sector is to serve as a reference for prices and wages. The present model does not need the sector as a centrifugal force, because of the presence of congestion costs. However, alternative approaches to fix the price levels or to gain a reference for prices are more complex and do not qualitatively change the results. Hence the author decided to keep the agricultural sector in the model to avoid unnecessary complications.
3.5. Equilibrium and Migration

The usual normalizations \( \phi \equiv (\theta - 1)/\theta \) and \( \beta \equiv \mu/\theta \) are applied, so that \( n_r = L_r/\mu \) and \( q_i = \mu \).

In equilibrium, the production of a firm is equal to the sum of the regional demand for the variety of the firm and the import demand of the neighboring region for the variety of the firm (taking into account iceberg transport costs \( \tau \)),

\[
q_i = \mu Y_r P_r^{\theta-1} + \mu Y_s (\tau p_r)^{-\theta} P_s^{\theta-1} r, \quad (3.15)
\]

\[
w_r = \left[ Y_r P_r^{\theta-1} + Y_s P_s^{\theta-1} r^{1-\theta} \right]^{\frac{1}{\theta}}. \quad (3.16)
\]

The latter equation represents the goods market equilibrium in the form of a price-setting function. It represents the wage at which the condition of zero profits is fulfilled and no firms enter or leave the market, and implicitly expresses labor demand, due to the direct link between the number of firms and employment. In the NEG literature, this equation is referred to as wage equation.

3.5. Equilibrium and Migration

The simultaneous equilibrium in the two regions is defined by the price index from equation 3.6, the wage equation 3.16, the wage curve 3.13 and the definition of regional income \( Y_r = w_r L_r + L_{Ar} \) in region \( r \), and the analogous equations for region \( s \).

The labor force (as the sum of the agricultural and manufacturing labor forces) is standardized to one. This labor force is separated into agriculture and manufacturing (\( N \)) according to the expenditure shares on agricultural and manufactured goods from income (\( \mu \)). The agricultural labor force (=employment) is equal in both regions, \( L_{Ar,s} = (1 - \mu)/2 \), whereas the labor force in manufacturing is divided between the regions according to \( \lambda \): \( N_r = \mu \lambda \) and \( N_s = \mu (1 - \lambda) \).

The simultaneous equilibrium in the short term depends on the following parameters: disutility of work effort (\( e \)), probability of observing shirking (\( 1 - \gamma \)), job destruction rate (\( \psi \)), share of expenditure for manufacturing (\( \mu \)), elasticity of substitution between the varieties of manufactured goods (\( \theta \)) and discount rate (\( \rho \)). The model is analytically intractable and the results are derived by simulation, which is standard practice in NEG. Several analytically traceable NEG models exist, but these either lack many of the core features of the basic core-periphery model, or their analytical results rely solely on the immobility of at least one production factor in

\[\text{If one unit of the manufactured good is transferred to the neighboring region, only } 1/\tau \text{ units arrive. Therefore } \tau \text{ units have to be sent if one unit is to arrive.}\]
the manufacturing sector. Since the basic features of the core-periphery model and full mobility are both necessary for the arguments of this chapter, NEG models that are more traceable cannot be used and the model relies on numerical results.

In the long term, the unemployed are allowed to migrate between regions. In contrast to the migration behavior in Fujita et al. (1999), the unemployed compare their expected life-time utilities in both regions and decide to migrate when their utility is higher in the neighboring region. Their utility depends on their real wages,\textsuperscript{12} their chances if finding employment,\textsuperscript{13} and the congestion costs in both regions. The migration behavior is thus given by the difference in expected lifetime utility of the unemployed between the two regions ($M$) (based on equation 3.14),

$$M = \frac{\delta_r}{\rho + \psi + \delta_r} H_r \left[ w_r \frac{K}{P_r} - e \right] - \frac{\delta_s}{\rho + \psi + \delta_s} H_s \left[ w_s \frac{K}{P_s} - e \right].$$ (3.17)\textsuperscript{50}

When there is symmetry ($\lambda = 0.5$), there is no migration since the endogenous variables are equal in the two regions. When there is no symmetry ($\lambda \neq 0.5$), the endogenous variables can differ between the two regions, and migration might occur depending on these differences. For any given $0 < \lambda < 1$, a short-term equilibrium exists. If the utility of the unemployed differs between the regions in the short term, unemployed workers migrate until a long-term equilibrium is reached where there is no incentive to migrate. In the long term, the expected lifetime utility of the unemployed is equal in both regions and therefore there is no incentive to migrate.

Figure 3.2 displays the difference between the expected lifetime utility of the unemployed in region $r$ and the expected lifetime utility of the unemployed in region $s$ ($M$), for different constellations of the parameters (the parameter constellations of all figures are summarized in Table 3.1). Qualitatively, three different situations can be compared. In situation A, the expected lifetime utility of the unemployed is always lower in the larger region. The unemployed migrate back to the smaller region until the symmetrical simultaneous equilibrium in the regions is reached at $\lambda = 0.5$. Then symmetry is the only stable equilibrium. In contrast, in situation B the expected lifetime utility of the unemployed is larger in the larger region for intermediate levels of $\lambda$, and is smaller in the larger region for very small or very large $\lambda$. That is, once a region becomes larger than the other region, an advantage results for the former, and an agglomeration process sets in. Nevertheless, the agglomeration does not attract all labor, since large agglomerations suffer from congestion costs. There are therefore two stable equilibria in this situation, both of

\textsuperscript{12}The real wage in region $r$ is $w_r KP_r^{-\mu}$.

\textsuperscript{13}The chance of finding employment depends on the endogenous job creation rate which is directly linked to the unemployment rate.
which are agglomerations. The symmetry is unstable. Finally, three stable equilibria exist in situation C: both symmetry and agglomeration may result, depending on the initial value of $\lambda$.

### 3.6. Stability

Multiple equilibria exist and three basic situations arise. The stability characteristics of the system – illustrated by the above situations – depend on the transport costs $\tau$ and the congestion costs $h$. As in Fujita et al. (1999), the stability characteristics of the system can be described by the break and sustain points. However, since these points now depend on both transport costs $\tau$ and congestion costs $h$, the stability characteristics are more complex. As illustrated in Figure 3.2, both symmetry and agglomeration might be stable or unstable, depending on transport costs and congestion costs. The break point then describes the point where the symmetry changes from being unstable to being stable, whereas the sustain point describes the point where the agglomeration changes from being unstable to being stable, both with regard to changes in transport costs and congestion costs. However, a
3. Congestion Externalities

Table 3.1.: Parameter Constellations of the Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>$\mu$</th>
<th>$\theta$</th>
<th>$\tau$</th>
<th>$\epsilon$</th>
<th>$\rho$</th>
<th>$\psi$</th>
<th>$\gamma$</th>
<th>$h$</th>
<th>$\lambda$</th>
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<td>4</td>
<td>3.2</td>
<td>0.2</td>
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<td>0.3</td>
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<td>/</td>
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<tr>
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<td>4</td>
<td>2.5</td>
<td>0.2</td>
<td>0.05</td>
<td>0.3</td>
<td>0.2</td>
<td>1.04</td>
<td>/</td>
</tr>
<tr>
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<td>4</td>
<td>3.2</td>
<td>0.2</td>
<td>0.05</td>
<td>0.3</td>
<td>0.2</td>
<td>1.04</td>
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</tr>
<tr>
<td>3.3(a)</td>
<td>0.6</td>
<td>4</td>
<td>/</td>
<td>0.2</td>
<td>0.05</td>
<td>0.3</td>
<td>0.2</td>
<td>1.04</td>
<td>0.5</td>
</tr>
<tr>
<td>3.3(b)</td>
<td>0.6</td>
<td>4</td>
<td>2</td>
<td>0.2</td>
<td>0.05</td>
<td>0.3</td>
<td>0.2</td>
<td>/</td>
<td>0.5</td>
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<tr>
<td>3.4</td>
<td>0.6</td>
<td>6</td>
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<td>0.2</td>
<td>0.05</td>
<td>0.3</td>
<td>0.2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3.5, 3.6(a), 3.6(b)</td>
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<td>4</td>
<td>/</td>
<td>0.2</td>
<td>0.05</td>
<td>0.3</td>
<td>0.2</td>
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</tr>
<tr>
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<td>0.05</td>
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</tr>
<tr>
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<td>/</td>
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<tr>
<td>3.7(a),3.7(b) C</td>
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<td>4</td>
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<td>0.05</td>
<td>0.3</td>
<td>0.2</td>
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</tbody>
</table>

The main difference from the results of Fujita et al. (1999) is that the agglomeration always is a partial agglomeration instead of a full agglomeration. In the remainder of this chapter, both points are derived, the agglomeration pattern is described and consequences for labor market disparities are discussed.

### 3.6.1. Break Point

The break point describes the situation where a change in transport or congestion costs leads to the symmetric equilibrium changing from unstable to stable (or vice versa). To illustrate this point, consider the following: if a marginal deviation from symmetry (i.e. a marginal increase/decrease in $\lambda$) leads to a larger expected lifetime utility of the unemployed in the marginally larger region, then the symmetry is unstable and an agglomeration arises endogenously. Hence the derivative of the difference in utility, $dM$, with respect to $\lambda$ is larger than zero. In contrast, if this derivative is smaller than zero, the symmetry is stable. The break point lies exactly at the symmetrical equilibrium where the derivative of the differences in utilities of the unemployed is zero ($dM = 0$). A formal definition of the break point is attached in the appendix.

This definition is used to identify all combinations of $\tau$ and $h$ where a break point exists. Assume the congestion cost parameter $h$ is given: Figure 3.3(a) then illustrates the behavior of the symmetry for changes in $\tau$. The basic arguments are in line with Fujita et al. (1999) (see Chapter 2), but two break points now occur.

If one focuses instead on the congestion costs $h$ and assumes fixed transport costs $\tau$, there is only one break point. Figure 3.3(b) illustrates the behavior of the
3.6. Stability

Figure 3.3.: Break Point

(a) Migration at Symmetry for Different $\tau$

(b) Migration at Symmetry for Different $h$
symmetry for changes in \( h \). Figure 3.5 combines the information gathered so far: for all transport costs \( \tau \) and congestion costs \( h \), the break point line illustrates where the break points lie. Outside the field defined by this curve and the line \( h = 1 \), symmetry is stable – and accordingly symmetry is unstable inside this field.

### 3.6.2. Sustain Point

In the same way as the break point, the sustain point describes the situation where changes in transport or congestion costs result in a situation in which the agglomeration changes from being unstable to being stable (or vice versa). However, since it must be a partial agglomeration instead of a full agglomeration, one cannot simply compare the expected life-time utilities of the full agglomeration and the empty periphery, as in Fujita et al. (1999). Instead, this chapter applies a procedure similar to the break point analysis. To illustrate this point, consider the following: if a marginal deviation from agglomeration (i.e. a marginal decrease in \( \lambda \)) leads to a larger expected lifetime utility among the unemployed in the periphery, then the agglomeration is unstable and collapses. Then the derivative of the difference in utility (\( dM \)) with respect to \( \lambda \) is larger than zero (assuming that \( r \) is the agglomeration and thus \( \lambda > 0.5 \)). In contrast, if this derivative is smaller than zero, the agglomeration is stable. The sustain point then lies exactly at the partial agglomeration where the derivative of the differences in the expected lifetime utilities of the unemployed is zero. Consider Figure 3.2: in situation C there is a local maximum at \( \lambda > 0.5 \) and to the right of this maximum there is a stable agglomeration. The sustain point is then the situation where this maximum is tangent to the line \( M = 0 \).

It is apparent that, in contrast to the break point, the situation is now more complex, since \( \lambda \) is not given in advance (by \( \lambda = 0.5 \)), but is instead endogenous. The sustain point is defined by the situation where the derivative of the difference in utilities \( dM \) with respect to \( \lambda \) is zero and where at the same time the difference in utilities \( M \) is also zero. These two conditions are always fulfilled at the break point. However, these two conditions are also fulfilled for \( \lambda \neq 0.5 \) for some constellations of \( \tau \) and \( h \) (the interpretation of this will be discussed in more detail in the subsequent section). A mathematical definition of this point is attached in the appendix.

To understand the behavior of the system around the sustain point, it is helpful to consider the case of \( h = 1 \). When \( h = 1 \), no congestion costs exist, so that any agglomeration is a full agglomeration (i.e. \( \lambda = 0 \) or \( \lambda = 1 \)). In this case it is sufficient to monitor the difference in utility (\( M \)) for different \( \tau \), which is done in Figure 3.4. In Figure 3.4 a well-known feature is apparent: the relative advantage of the agglomeration over the periphery is zero for zero transport costs, then first
3.6. Stability

Figure 3.4.: Migration at Full Agglomeration for Different $\tau$

increases with $\tau$ but later decreases with $\tau$ once a critical value for $\tau$ is reached (see Fujita et al. (1999) and Chapter 2).

Since the conditions for the sustain point are known, one can calculate all combinations of $\tau$ and $h$ where there is a sustain point and arrange them on a map. This is done in Figure 3.5. Inside the field defined by the sustain point line and the line $h = 1$, the agglomeration is stable and, accordingly, it is unstable outside.

3.6.3. Agglomeration Pattern

Combining the information on the break and sustain points delivers an illustration of the behavior of the system: see Figure 3.5. For any level of $h$, one can depict, as in Figure 3.5, the levels of $\tau$ at which there are sustain and break points.

From Figure 3.5 it becomes obvious that, when $\tau$ is large and decreases, there is a level of $h$ at which the sustain and break points coincide. To understand what happens here one has to go back to Figure 3.2. Qualitatively there are three different situations. In situation A, only the symmetry is stable. In Figure 3.5 this is the region outside the fields marked by the two curves and the $h = 1$ line. In situation B only the agglomeration is stable. This is the region inside the break point line and the $h = 1$ line in Figure 3.5. Finally, in situation C the symmetry and the
agglomerations are stable. This is the field marked by the sustain point line and the 
$h = 1$ line minus the field marked by the break point line and the $h = 1$ line.

In situation C there is a local maximum in Figure 3.5, which is above the 
$M = 0$ line and thus enables both the agglomeration and the symmetry to be 
stable. This situation arises when $h$ is small and $\tau$ is large (but not too large). 
At this level of transport costs (and congestion costs), the agglomeration forces are 
strong enough to reinforce the agglomeration only when $\lambda$ is large (or small) enough. 
When $\lambda$ is close to 0.5, then the agglomeration forces are not strong enough and 
symmetry is stable. At the margin, this maximum is tangent to the $M = 0$ line, 
representing the sustain point. Imagine now that the transport costs decrease. To 
remain on the sustain point line, the congestion costs need to increase (since, for 
decreasing transport costs, the agglomeration forces increase). However, this means 
that the sustain point in Figure 3.2, which is the maximum of the curve of situation 
C as a tangent to the $M = 0$ line, moves towards the symmetrical equilibrium at 
$\lambda = 0.5$. This means that the sustain point approaches the break point, and finally 
the sustain point becomes the break point at the margin.
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To understand why this happens recall Figures 3.3(a) and 3.4. When there are no transport costs \( (\tau = 1) \), then an increase in the transport costs destabilizes the symmetry (Figure 3.3(a)) and at the same time stabilizes the agglomeration (since agglomeration forces increase, Figure 3.4). The slope of the M-curve in Figure 3.2 is then monotonic for zero congestion costs. The stability of the system now depends only on congestion costs. An increase in congestion costs leads to a monotonic increase in the disadvantages of the agglomeration (instead of a non-monotonic decrease as in the case of transport costs). Therefore the slope of the M-curve in Figure 3.2 remains monotonic, but the sign of the slope depends on the congestion costs. Since the slope is monotonic, only symmetry or agglomeration can be stable.

However, when transport costs increase further, the agglomeration advantages decrease in Figure 3.3(a), but agglomeration remains stable for even larger values of \( \tau \) in Figure 3.4. That is, the agglomeration forces are no longer monotonically related to transportation costs for sufficiently large levels of \( \tau \). In this case the strength of the agglomeration forces depends on the level of \( \lambda \): the agglomeration forces are only strong enough to reinforce agglomeration when the agglomeration is large enough. Then the sustain point is different from the break point and the sustain and break point lines in Figure 3.5 divide.

3.6.4. Bifurcations

By introducing unemployment and congestion costs into the model of Fujita et al. (1999), the agglomeration pattern changes considerably, and conclusions for regional labor market disparities can be drawn since unemployment disparities arise. This section deals with the implications of the model for regional labor market disparities by using bifurcation diagrams.

With Figure 3.5 in mind, one can qualitatively distinguish three different agglomeration patterns for different levels of the congestion costs parameter \( h \). (1) For low congestion costs an agglomeration pattern arises where agglomeration and symmetry might simultaneously be stable. (2) For intermediate congestion costs, either agglomeration or symmetry is stable, but they are not simultaneously stable. (3) Finally, for high congestion costs symmetry is always stable and agglomeration always unstable. The third case is trivial. Hence, the first and second cases are of special interest here. Both cases are visualized as bifurcation diagrams for the share of manufacturing employees and for the difference in unemployment rates of the regions, in Figures 3.6(a) and 3.6(b).

The model hence covers several bifurcation types, depending on the level of congestion costs. A similar result has already been shown by Pflüger and Südekum (2011) for the transition between tomahawk- and pitchfork-bifurcation types. In
3. Congestion Externalities

their model this is due to the use of a constant elasticity of substitution function for
the upper tier utility function in the core-periphery model, whereas in the present
case it rests on the congestion costs.

In the first example there are low congestion costs (here: $h = 1.04$). When
transport costs are high, then only symmetry is stable and there are no differences
between the regions. However, when transport costs start to decline, a catastrophic
agglomeration pattern arises: for a certain range of $\tau$, both agglomeration and
symmetry are stable. Whether symmetry or agglomeration arises depends on the
initial distribution of manufacturing employees. The agglomeration is marked by
a smaller unemployment rate. Further decreases in transportation costs lead to an
even lower unemployment rate in the agglomeration compared to the periphery, and,
at a certain level of $\tau$, symmetry becomes unstable. Agglomeration is then the only
stable equilibrium. This means that, for intermediate levels of transportation costs,
the centripetal forces described previously lead endogenously to agglomeration and
result in unemployment disparities. When transportation costs decline further, the
centripetal forces decline. Nevertheless, this does not lead to a catastrophic change
in the agglomeration pattern, but instead the agglomeration becomes smaller until
the regions are the same size and symmetry results. This is because the break and
sustain points coincide. At the same time the unemployment rates converge.

In the second example there are intermediate congestion costs (here: $h = 1.12$). When transport costs are high, then only symmetry is stable and there
are no differences between the regions. However, when transport costs decline,
symmetry becomes unstable and agglomeration results. This process is smooth, i.e.
one of the regions becomes successively larger when transport costs decrease. This is
accompanied by a decrease in the unemployment rate in the agglomeration relative
to the unemployment rate in the periphery. There is no catastrophic change from
symmetry to agglomeration since the break and sustain points coincide. In a similar
fashion, if the transport costs decline further this leads to a decline in the centrifugal
forces, and the agglomeration again approaches symmetry in a smooth process, in
terms of both manufacturing employees and unemployment rates.

3.7. Labor Market Frictions and Disparities

The present model shows how regional labor market disparities arise endogenously
through agglomeration in the presence of labor market frictions. However, these
labor market frictions influence the extent and presence of regional labor market
disparities through their interaction with the agglomeration forces. The subsequent
section deals with this interaction.
3.7. Labor Market Frictions and Disparities

Figure 3.6.: Bifurcations
3. Congestion Externalities

Due to the shape of the wage curve and the characteristics of the agglomeration forces, increasing labor market frictions accompany increasing labor market disparities: the agglomeration forces are expressed by the break-even point, represented by the real wage in equation 3.16. In the agglomeration this real wage is higher, implying that firms gain positive profits at real wages that are higher than in the periphery; hence the unemployment rate is lower in the agglomeration, since new firms and jobs are created at even higher wages in the agglomeration compared to the periphery. Furthermore, the absolute slope of the wage curve decreases with increasing unemployment.

Changes in labor market frictions at first only affect the wage curve, since the relevant variables only appear here. Furthermore the break-even point, which is at first unaffected by changes in labor market frictions, defines the real wage. Thus in the first round, changes in labor market frictions affect the regional unemployment rate but not the real wage (i.e. the break-even point). Since the absolute slope of the wage curve decreases with increasing unemployment, the effect of increasing labor market frictions on unemployment (holding constant the wage / break-even point) is greater if the unemployment rate is higher. Therefore the effect of increasing labor market frictions is higher for the periphery (where the unemployment rate is higher) than for the agglomeration, and hence labor market frictions increase (see the appendix for a formal proof). In other words, in the first round increasing labor market frictions lead to an increase in regional labor market disparities.

However, when labor market disparities increase, this leads to an adjustment through migration: labor market disparities increase relative to the congestion costs, so that more people move to the more attractive region, i.e. the agglomeration. Hence, secondary to the shift of the wage curve, increasing labor market frictions intensify the agglomeration forces and further exacerbate labor market disparities. This is illustrated in Figure 3.7(a), where the difference in the unemployment rates of regions \( r \) and \( s \) is plotted against the transport costs \( \tau \) (only the stable agglomeration equilibria are plotted, not the stable symmetry equilibria). In situation A the disutility of work effort \( e \) is 0.2; it is 0.1 in situation B and 0.3 in situation C. The figure highlights that disparities increase when frictions increase. Similar patterns arise when labor market frictions vary in the form of the discount rate of utility \( \rho \), the job destruction rate \( \psi \) or the probability of not detecting shirking \( \gamma \).\(^{14}\)

The figure further implies that the stability characteristics change when the frictions change: the range of transportation costs at which the agglomeration is stable increases with increasing frictions. This is further illustrated by Figure 3.7(b), where all break and sustain points are plotted against the transport costs \( \tau \) and congestion costs \( h \). In situation A the disutility of work effort \( e \) is 0.2, in situation

\(^{14}\)Additional results for these parameters are attached in the appendix.
3.7. Labor Market Frictions and Disparities

Figure 3.7.: Frictions, Disparities, and Stability for Variations of $e$
3. Congestion Externalities

$B$ it is 0.1, and in situation $C$ it is 0.3. The higher $e$ is, meaning the stronger the labor market frictions are, the larger the area is where agglomeration is stable and the smaller the area where symmetry is stable. Similar pattern arise for changes in $\rho$, $\psi$ and $\gamma$.

The above result depends crucially on the shape of the wage curve: only when the (negative) relationship between wages and unemployment is convex (as in this model), does the pattern discussed above hold true. If the relationship is linear, then a shift of the wage curve due to changes in labor market frictions affects the unemployment rates of the regions to the same extend, so that the relative labor market disparities do not change. If the relationship is concave, the agglomeration is more strongly affected by a change in labor market frictions, and the pattern discussed above is reversed. Nevertheless, the empirical evidence strongly suggests that there is a constant unemployment elasticity of wages of about $-0.1$. This means that an increase in the unemployment rate of 10% decreases wages by about 1% (see, for example, Blanchflower and Oswald; 2005). If there is a constant unemployment elasticity of wages this implies that there is a linear relationship between the log wage and log unemployment rate. This, however, means that there is a convex relationship between unemployment and wages. Since the empirical literature suggests a constant negative unemployment elasticity of wages, the relationship between unemployment and wages must be convex so that the relationship between labor market frictions and regional unemployment disparities should be as discussed above.

3.8. Conclusions

Disparities between regional labor markets are a key characteristic in many countries. In the literature on the wage curve it is argued that there is a negative relationship between wages and unemployment at the regional level (Blanchflower and Oswald; 1994). However, this literature cannot explain how disparities in these variables arise endogenously. The NEG in turn explains how disparities between regional economies arise endogenously, but usually assumes full employment. The present model introduces efficiency wages into the NEG in order to explain how disparities between regional labor markets arise endogenously.

The basic idea of the present chapter is that, due to a love of variety, monopolistic competition, increasing returns to scale, and transport costs, firms are able

\[ \ln(w_r) = \alpha + \beta \ln(U_r) \]

Rearranging the terms leads to \[ w_r = e^{\alpha + \beta \ln(U_r)}. \] Then \[ dw_r/dU_r = e^{\alpha + \beta \ln(U_r)} U_r^{-1} \beta < 0 \] and \[ d^2 w_r/dU_r^2 = e^{\alpha + \beta \ln(U_r)} \beta^2 (\beta^2 - \beta) > 0 \text{ for } U_r > 0 \text{ and } \beta < 0, \] which implies convexity. 

\[ ^{15}\text{To see this, consider the linear relationship between log wages and log unemployment,} \]

\[ \ln(w_r) = \alpha + \beta \ln(U_r). \] Rearranging the terms leads to \[ w_r = e^{\alpha + \beta \ln(U_r)}. \] Then \[ dw_r/dU_r = e^{\alpha + \beta \ln(U_r)} U_r^{-1} \beta < 0 \] and \[ d^2 w_r/dU_r^2 = e^{\alpha + \beta \ln(U_r)} \beta^2 (\beta^2 - \beta) > 0 \text{ for } U_r > 0 \text{ and } \beta < 0, \] which implies convexity.
3.8. Conclusions

to pay higher wages in the agglomeration than in the periphery. Due to efficiency wages, higher wages in the agglomeration are associated with lower shirking, so that firms hire more employees and the unemployment rate is lower in the agglomeration. More generally, lower wages in the periphery are associated with higher unemployment than in the agglomeration, since the wage-setting frictions are more binding in the former than in the latter.

Whereas other models using NEG arguments and labor market frictions usually rely on job-matching frictions to explain how regional labor market disparities arise endogenously, this chapter relies on frictions in wage-setting based on efficiency wages. The intention is not to argue that efficiency wages are the only relevant mechanism. Instead it should be highlighted that efficiency wages do matter for regional labor market disparities as well. Empirical evidence, as recently summarized by Peach and Stanley (2009), suggests that efficiency wages are in fact important. The results show how the combination of endogenous agglomeration through NEG arguments and efficiency wages can endogenously generate regional labor market disparities as observed by the wage curve literature. In contrast to most other efficiency wage models, the present chapter shows how this relationship arises endogenously and why it is stable. Further, the results suggest that the level of regional unemployment disparities increases as the level of labor market frictions increases. Hence policy instruments aimed at lowering wage-setting frictions can potentially help to reduce regional unemployment disparities.
4. Monocentric Cities

4.1. Abstract

The literature on the wage curve provides considerable evidence in favor of a negative relationship between unemployment and wages. It is thus often seen as a refutation of the Harris-Todaro model, who point to a positive relationship. This chapter shows that both strands of literature are special cases of a more general approach by combining a New Economic Geography model with monocentric cities and efficiency wages. Whether the relationship is positive or negative depends on the transportation costs between the cities and commuting costs within them. The model helps explain whether and under which conditions the agglomeration of economic activity is associated with higher unemployment and why controls for agglomeration should be included in wage curve regressions.

JEL Classification: R12, R14, R23

Keywords: New Economic Geography, Urban Economics, Efficiency Wages, Unemployment, Disparities, Regional Migration

4.2. Introduction

The wage curve, i.e. the negative relationship between unemployment and wages, is a well-observed fact. More recently, models introducing the labor market into the New Economic Geography (NEG) have been proposed to explain how a wage curve might arise endogenously. In the strand of literature following Harris and Todaro (1970), it is often argued that migration is based on expected income and that in the migration equilibrium there should exist a positive relationship between unemployment and wages. The empirical evidence in favor of the wage curve is therefore often seen as a refutation of the Harris-Todaro model (Freeman; 2009).

This chapter presents a model to show that both strands of literature, the wage curve and the Harris-Todaro model, are special cases of a more general approach. It encompasses an NEG model with monocentric cities and efficiency wages to explain how a wage curve can arise endogenously, while the degree of agglomeration shifts
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the wage curve due to commuting costs. The wage is higher in the agglomeration because of the centripetal forces of the NEG part of the model. However, the unemployment rate is only lower in the agglomeration when the wage surplus over the periphery is large enough to compensate for the higher commuting costs in the agglomeration. The size of the wage surplus depends on the centripetal forces and hence on the transport costs. Whether the relationship between unemployment and wages is positive or negative therefore depends on transportation and commuting costs.

The wage curve is empirically well understood. Blanchflower and Oswald (1994) first presented empirical results for this relationship and numerous studies followed, providing empirical evidence in favor of the wage curve relationship. They further point to several theoretical motivations for the wage curve. Following their analysis, several authors have presented theoretical models to explain the wage curve relationship, such as Campbell and Orszag (1998) using efficiency wages or Sato (2000) using search theory. Blien (2001) presents a survey of such approaches. Nevertheless, these models are usually unable to explain how regional labor market disparities arise endogenously but rather rely on exogenous disparities in productivity, sectoral structure or labor immobility.

In recent years, several authors have introduced the labor market into the NEG. In these models, there typically are two regions, an agglomeration and a periphery, where the wage (unemployment rate) is generally higher (lower) in the agglomeration compared with the periphery. These models explain how the agglomeration of economic activity and disparities in wages and unemployment rates (and thus how the wage curve) arise endogenously.

There exists a broad empirical strand of literature showing that wages are indeed typically higher in agglomerated regions compared with peripheral regions. To illustrate this, Figure 4.1(a) presents box plots of the monthly compensation per employee by region type for German Kreise in 2009.

The relationship between agglomeration and unemployment is, however, less clear. As Elhorst (2003) points out in his survey, empirical evidence of the influence of density on the unemployment rate is mixed at the regional level. On one hand, the wage curve relationship suggests that higher productivity and higher wages in more agglomerated regions are linked to lower unemployment there. On the other hand, the strand of literature following Harris and Todaro (1970) suggests that

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1 See Blanchflower and Oswald (2005) for an overview of existing studies and Nijkamp and Poot (2005) for a meta-analysis.

2 This strand of literature follows the seminal paper by Glaeser and Mare (2001). Heuermann et al. (2010) present an overview of this strand of literature. However, this strand of literature (on the urban wage premium) usually focuses on the technological external effects of agglomeration as the underlying economic mechanism, whereas the present model focuses on pecuniary effects.
4.2. Introduction

(a) Monthly Compensation per Employee

(b) Wage Curves and Region Types

Source: BBSR and BBR (2011), authors own illustration.

Figure 4.1.: Regional Labor Market Disparities in German NUTS 3 Regions
4. Monocentric Cities

when people base their migration decisions on expected incomes, in the migration equilibrium higher wages (due to higher productivity) in the agglomeration must be compensated for by higher unemployment or other factors.\(^3\)

Figure 4.1(b) contains the wage curves for different levels of agglomeration (measured by population density), visualizing both arguments. It becomes obvious that the degree of agglomeration works as a shift parameter, shifting the wage curve outwards. This shift might represent the arguments of Harris and Todaro (1970): a situation of higher wages in the agglomeration compared with the periphery is only stable (i.e. no adjustment through migration) when the wage surplus of the agglomeration is compensated for by higher unemployment or other factors. This is supported by recent empirical studies on the wage curve. For example, Eckey et al. (2008) find that population density is a shift parameter of the wage curve, whereas Baltagi et al. (2010) show that the absolute wage elasticity is higher in rural regions compared with agglomerated regions.

The present chapter therefore builds a theoretical model to show that the wage curve and Harris-Todaro model are both special cases of a more general approach

\(^3\)Partridge and Rickman (1997) argue that more research is necessary to discuss whether the wage curve strand of literature really refutes the Harris-Todaro model.
4.3. Related Literature

The model presented here is linked to two strands of literature: (1) models that combine Urban Economic Theory with the NEG and (2) models that introduce the labor market into the NEG. It is further linked to Zenou and Smith (1995), rather than contradictions. It is based on an NEG model including unemployment, where each region contains a single monocentric city with intra-city commuting and inter-city migration. Commuting is costly and serves as a centrifugal force and as a shift parameter for the wage curve. The model shows that it depends on the level of commuting costs within the cities and on the level of trade costs between the cities whether the unemployment rate is higher or lower in the agglomeration compared with the periphery. The sign of the relationship between unemployment and wages thus depends on transportation and commuting costs.

The basic arguments of this chapter are illustrated in Figure 4.2. Owing to efficiency wages, there is a negative relationship between unemployment and wages in each region. Further wages in the agglomeration are higher compared with the periphery due to centripetal forces. The wage difference between the agglomeration and periphery depends on centripetal forces, which are driven by transport costs. When there are no commuting costs, the incentive to shirk solely depends on wages and unemployment so that the wage curve is identical in both regions. Higher wages in the agglomeration then are accompanied by lower unemployment compared with the periphery. However, when commuting costs are non-negligible, the wage curve of the agglomeration shifts outwards compared with the periphery since there is an additional incentive to shirk, which is more prevalent in the agglomeration. Therefore, the relative unemployment rate between the agglomeration and periphery depends on both the wage differential and the shift of the wage curve. Since wages are always higher in the agglomeration, the relationship between unemployment and wages also depends on the wage differential and shift of the wage curve, where the former is driven by transport costs and the latter by commuting costs. Figure 4.2 is discussed in more detail in Section 4.7.2 to illustrate the results of this chapter.

The remainder of the chapter is organized as follows. Section 4.3 briefly reviews the related literature and the basic model is presented in Section 4.4. Sections 4.5 and 4.6 contain the discussion of the equilibria and their stability. In Section 4.7, the implications of the model for regional labor market disparities are presented. The last Section draws the conclusions.
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who introduce efficiency wages into a two-city model with intra-city commuting and inter-city migration but without endogenous agglomeration.¹

Regarding the first strand of literature, Tabuchi (1998) perhaps offered the first approach combining the NEG, as presented by Krugman (1991), with an urban economic model in the spirit of Alonso (1964). In his model, Tabuchi (1998) compares the influence of inter-city transportation costs on agglomeration advantages in the form of market size with the influence of intra-city commuting costs on the corresponding agglomeration disadvantages. His main result is that economic activity will be dispersed for any set of parameters if inter-city transportation costs become negligible. Murata and Thisse (2005) use a similar approach but derive more results analytically. They show that, contrary to Krugman (1991), agglomeration takes place for high but not for low inter-city transportation costs. They further show that agglomeration is always stable for sufficiently low commuting costs and that there are sets of parameters for which dispersion is always stable irrespective of inter-city transportation costs. Further contributions are delivered by, among others, Tabuchi and Thisse (2006) who focus on the interaction of the preference for variety and increasing returns of production with urban costs or by Cavailîhes et al. (2007) who discuss polycentric cities in the interplay of commuting, communication and transportation costs.

The second strand of literature has emerged in recent years. The assumption of full employment has often been regarded as a drawback of the NEG and hence several authors have developed models that introduce imperfect labor markets into the NEG. Many of these models focus on the international level, because they assume substantial differences between the institutional settings of labor markets or because they neglect migration.² The present model, however, focuses on the regional level where the labor force migrates between regions and there are no differences between the institutional settings of regional labor markets. Most models of this kind introduce frictions in job matching into the NEG, such as those of Epifani and Gancia (2005), Francis (2009) and vom Berge (2011b,a). Models introducing efficiency wages are presented by Francis (2007) and in the preceding two chapters of this thesis.³ Egger and Seidel (2008) use a fair wage approach. These models can explain how the agglomeration of economic activity arises endogenously and why this leads to higher real wages in the agglomeration compared with the periphery.

¹Their model is presented in more detail by Zenou (2009).
²Examples are Peeters and Garretsen (2004) and Pflüger (2004).
⁴Südekum (2005) presents an analytically solvable agglomeration model with efficiency wages that, however, does not contain centrifugal forces.
Further they usually find lower unemployment in the agglomeration compared with the periphery.

Exceptions are presented by vom Berge (2011b,a). In vom Berge (2011b), the unemployment rate might be higher or lower in the agglomeration compared with the periphery, because nominal wages can be lower in the agglomeration so that the replacement ratio is higher there, which causes higher unemployment. Only when transportation costs are very low are centripetal forces strong enough to enable higher nominal wages and lower unemployment in the agglomeration compared with the periphery. However, as only symmetry and full agglomeration are possible outcomes, no unemployed are left in the periphery. Further, higher unemployment in the core is caused by the replacement ratio only and thus this crucially depends on lower nominal wages in the agglomeration, which is counterfactual.8 In vom Berge (2011a), the unemployment rate of low-skilled workers is always higher in the agglomeration because these jobs are more valuable there and the higher unemployment rate compensates for the higher wages, similar to the arguments of the Harris-Todaro model. Nevertheless, only low-skilled workers can become unemployed and they are further immobile between regions so that a major incentive to migrate – escaping unemployment – is neglected.

In the present model, the unemployed are instead allowed to escape their situation by searching for employment in another city and reasons other than the replacement ratio explain why the unemployment rate might be higher in more density populated areas.

As mentioned above, this model is closely linked to Zenou and Smith (1995). They combine efficiency wages with a monocentric city model and extend this to the case of two cities. However, in their model the number of firms in cities and their productivity are assumed to be fixed. Disparities between cities’ labor markets emerge because their levels of productivity are different. The authors discuss unemployment disparities between the cities, namely the unemployment rate might be higher or lower in the larger city than it is in the smaller. The present model, by contrast, does not rely on exogenous differences in the productivity levels between cities, but instead relies on an endogenous formation of industry location. From this perspective, the present model therefore might also be viewed as an extension of the Zenou and Smith (1995) framework by introducing the endogenous location of industries.

8The author is well aware of this point and argues that the unemployment rate is higher in the agglomeration as long as the replacement ratio is higher there, which might also be caused by higher nominal benefits in the core instead of lower nominal wages.
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4.4. Basic Model

The model consists of two regions and two sectors, agriculture and manufacturing. Each region contains a single monocentric city with a central business district (CBD). Workers are immobile between sectors, but manufacturing workers are mobile between regions. Agriculture is located outside cities, whereas manufacturing is located in the city centers. Manufacturing workers thus have to commute to the city centers to work or to search for work if they are unemployed.

4.4.1. Households

Households $j$ receive utility $\mathcal{U}$ from the consumption of manufactured goods $C_M$ and agricultural goods $C_A$. They receive the disutility of work effort $e$. Their utility function is

$$\mathcal{U}_j = C_M^\mu C_A^{1-\mu} - e.$$  \hspace{1cm} (4.1)

Households maximize their utility subject to the budget constraint,

$$p_M C_M + p_A C_A = Y_j,$$  \hspace{1cm} (4.2)

where $p_M$ and $p_A$ are the prices of manufactured and agricultural goods, and $Y_j$ represents household income. Utility maximization yields

$$p_M C_M = \mu Y_j,$$  \hspace{1cm} (4.3)

$$p_A C_A = (1 - \mu) Y_j.$$  \hspace{1cm} (4.4)

$p_A = 1$ is the numeraire, while $C_M$ is a constant-elasticity-of-substitution (CES) bundle of manufactured goods,

$$C_M = \left[ \int_0^n c_i^{\frac{\theta}{\theta-1}} \right]^{\frac{\theta-1}{\theta}},$$  \hspace{1cm} (4.5)

where $\theta$ is the elasticity of substitution between the varieties $c_i$ of the manufactured goods. Shephard’s (1953) Lemma,

$$\min_{\int_0^n p_i c_i di} \text{s.t. } \left[ \int_0^n c_i^{\frac{\theta-1}{\theta-1}} di \right]^{\frac{\theta}{\theta-1}} = C_M,$$  \hspace{1cm} (4.6)

delivers the price index for region $r$ (and $s$ accordingly). $p_i$ represents the prices of varieties of manufactured goods. In the case of two regions where firms are identical.
and there exist iceberg transport costs $\tau$, the manufacturing price index $P_r$ in region $r$ is

$$
P_r = \left[n_r p_r^{1-\theta} + n_s (\tau p_s)^{1-\theta}\right]^\frac{1}{1-\theta},
$$

(4.7)

where $n_r$ and $n_s$ are the number of manufacturing firms, and $p_r$ and $p_s$ are the prices of the varieties of manufactured goods in region $r$ and region $s$. Household $j$’s demand for variety $i$ of the manufactured good is

$$
c_{ij} = \left(\frac{p_i}{p_M}\right)^{-\theta} C_{Mj} = \left(\frac{p_i}{p_M}\right)^{-\theta} \mu \frac{Y_j}{p_M},
$$

(4.8)

Indirect utility is calculated using the income shares,

$$
\Pi_j = KP_r^{-\mu}Y_j - e,
$$

(4.9)

where $K = \mu^\mu (1 - \mu)^{1-\mu}$ and where $p_M$ is replaced by $P_r$ as the model focuses on the two-region case.

### 4.4.2. Cities

To build two monocentric cities with efficiency wages this model relies on Zenou and Smith (1995). However, the commuting costs differ from their framework in the sense that here commuting costs are measured in units of time lost. The proportion of time spent commuting is not available for effective labor supply, and thus commuting costs have the nature of an iceberg (Murata and Thisse; 2005), similar to iceberg transport costs. The monocentric city framework is now presented for region $r$ (the analogous framework applies to region $s$).

Manufacturing is located in the CBDs of the two cities and does not consume any space. Workers locate around the CBD (for simplicity, each city is a line). Assume that the cities are so far away from each other that there is no inter-city commuting. Workers choose their places of residence depending on their status, land rents and commuting costs. Owing to the efficiency wage framework, workers can be employed or unemployed. When they are employed, they can decide whether they shirk or not.

Each employee is equipped with one unit of time. Owing to commuting, he or she can only use a proportion $(1 - \chi d)$ of that time for working, where $0 \leq \chi \leq 1$ are the commuting costs per distance $d$.\footnote{Later, the maximum distance will be set to the world labor supply (which is one) so that the theoretical maximum distance of commuting is one, implying that a worker at the urban fringe, when there is full agglomeration and $\chi = 1$, uses all of her time to commute. Hence here the...}

Employees earn wages $w_r$ lowered by
4. Monocentric Cities

the tax rate $t$ and have to pay land rents $R_r(d)$ depending on their locations (i.e. distance from the CBD). Similar to employees, the unemployed have to commute into the CBD to search for jobs. However, they commute less by the factor $\alpha$. Their commuting costs are measured in terms of lost time/income as well, while they receive unemployment benefit $w_0$. The income of non-shirking employees $NS$, shirking employees $S$ and unemployed 0 then is given by

\[
Y^NS_j = (1 - \chi d_j)(1 - t)w_r - R_r(d_j),
\]

(4.10)

\[
Y^S_j = (1 - \chi d_j)(1 - t)w_r - R_r(d_j),
\]

(4.11)

\[
Y^0_j = (1 - \alpha \chi d_j)w_0 - R_r(d_j).
\]

(4.12)

Making use of the respective income, the indirect utility of non-shirking employees, shirking employees and unemployed is

\[
\Omega^NS_r = KP^{-\mu}_r ((1 - \chi d)(1 - t)w_r - R_r(d)) - e,
\]

(4.13)

\[
\Omega^S_r = \Omega^NS_r + e,
\]

(4.14)

\[
\Omega^0_r = KP^{-\mu}_r ((1 - \alpha \chi d)w_0 - R_r(d)).
\]

(4.15)

Given these utility levels, the location problem is solved by making use of standard arguments (Fujita; 1989). The bid rents for non-shirking employees and the unemployed (in the labor market equilibrium, there are no shirking employees) are given by

\[
R^NS_r(d, \Omega^NS_r) = \max \left[ (1 - \chi d)(1 - t)w_r - (e + \Omega^NS_r)P^\mu_r / K, 0 \right],
\]

(4.16)

\[
R^0_r(d, \Omega^0_r) = \max \left[ (1 - \alpha \chi d)w_0 - \Omega^0_rP^\mu_r / K, 0 \right].
\]

(4.17)

Every household consumes one unit of space, so that the distance to the urban fringe $\bar{d}_r$ is given by the manufacturing labor force $N_r$ in that city (region): $\bar{d}_r = \bar{N}_r$. Further, since $0 < \alpha < 1$ and $w_0 < (1 - t)w_r$, the slopes of the bid rent curves for the unemployed are lower than those for employees, so that the unemployed can only live at the peripheral zones of the cities. As there exists an opportunity rent $\bar{R}$ for land-owners, $R^0_r(\bar{d}_r, \bar{\Omega}^0_r) = \bar{R}$ must hold. In the land use equilibrium, the unique utility level of the unemployed then is

\[
\bar{\Omega}^0_r = KP^\mu_r \left[ (1 - \alpha \chi N_r)w_0 - \bar{R} \right].
\]

(4.18)

The border between the unemployment and employment districts is located at the distance $\hat{b}_r = \hat{L}_r$, where $\hat{L}_r$ is the number of manufacturing employees in

maximum value of $\chi$ is one to ensure that the proportion of time spent commuting is never larger than 100%.
the corresponding region/city. In the land use equilibrium, it must hold that 
\[ R^0_r(\bar{b}_r, \Omega^0_r) = R^NS_r(\bar{b}_r, \Omega^{NS}_r) , \] 
which implies
\[ \Omega^{NS}_r = KP_r^\mu \left[ (1 - \chi L_r)(1 - t)w_r + (1 - \alpha)(N_r - L_r)w_0 - \bar{R} \right] - e. \quad (4.19) \]

4.4.3. Labor Market

The labor market is based on the Shapiro and Stiglitz (1984) efficiency wage framework. That is, workers can decide whether they shirk or not. Workers who shirk face a probability \( 1 - \gamma \) of getting caught shirking and getting fired. There is an exogenous job destruction rate \( \psi \) and an endogenous job generation rate \( \delta_r \). \( \rho \) is the discount rate of utility. The Bellman equations for the expected life-time utilities of non-shirking employees, shirking employees and the unemployed are
\[
\begin{align*}
\rho V^{NS}_r &= \Omega^{NS}_r - \psi(V^{NS}_r - V^0_r), \\
\rho V^S_r &= \Omega^S_r + e - (\psi + 1 - \gamma)(V^S_r - V^0_r), \\
\rho V^0_r &= \Omega^0_r + \delta_r(V^{NS}_r - V^0_r).
\end{align*}
\]

The efficiency wage framework is now expressed for region \( r \) (the analogous framework applies to region \( s \)).

Employers want to prevent shirking and thus they pay wages that are sufficient to prevent shirking at the margin where \( V^{NS}_r = V^S_r \). Using this and plugging the above equations into each other delivers
\[ \Omega^{NS}_r = \Omega^0_r + e \frac{\rho + \psi + \delta_r}{1 - \gamma}. \quad (4.23) \]

Inserting the utility levels from the location decision delivers the wage curve,
\[ w_r = \left[ \frac{P_r^\mu}{K} e \frac{\rho + \psi + \delta_r + 1 - \gamma}{1 - \gamma} + (1 - \alpha)\chi L_r w_0 \right] \frac{1}{(1 - \chi L_r)(1 - t)}, \quad (4.24) \]
where \( \delta_r \) is the endogenous rate of job generation. In equilibrium, the outflow of unemployment \( \delta_r(N_r - L_r) \) must equal the inflow to unemployment \( \psi L_r \), which defines \( \delta_r = \psi L_r / (N_r - L_r) \). This further defines the relationship between the endogenous job generation rate \( \delta_r \) and unemployment rate \( U_r = \psi / (\delta_r + \psi) \).

Manufacturing workers can decide to migrate between the two cities. They base their migration decision on the expected life-time utilities in both regions. Assume that migrants have to search for a new job at their destinations, namely they are unemployed at first. Then, it is sufficient to compare the expected life-time
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utilities of the unemployed to ascertain whether migration occurs (Zenou and Smith; 1995). The expected life-time utility of the unemployed in region $r$ is

$$pV_r^0 = \frac{(\rho + \psi)\Omega_r^0 + \delta_r\Omega_r^{NS}}{\rho + \psi + \delta_r},$$

$$= KP_r^\mu \left( (1 - \alpha)\chi N_r w_0 - \bar{R} \right)$$

$$+ \frac{\delta_r}{\rho + \psi + \delta_r} \left[ KP_r^{-\mu} [(1 - \chi L_r)(1 - t)w_r - (1 - \alpha)\chi L_r w_0] - e \right]. \quad (4.25)$$

The comparison of expected life-time utilities to derive migration behavior in the NEG literature has been criticized. However, Baldwin (2001) shows analytically that the global stability properties of the underlying core-periphery model do not change when forward-looking expectations rather than static expectations (as implied by the simple comparison of expected life-time utilities) are used. Since the key results do not change, the present model rests on static expectations to keep the analysis as traceable as possible.

4.4.4. Goods Market

The goods market is separated into the agricultural and manufacturing markets. The labor force is immobile between sectors but the manufacturing labor force is mobile between regions, whereas the agricultural labor force is not. It is assumed that the productivity and marginal productivity of each agricultural worker is one. It is further assumed that there is perfect competition on the agricultural labor and goods markets so that agricultural wages and prices are normalized to one. These wages and prices serve as a reference for the manufacturing sector (Fujita et al.; 1999).

In manufacturing, the effective labor supply $s(d_j)$ of an individual worker is lowered by commuting time depending on distance $d_j$ (Murata and Thisse; 2005),

$$s(d_j) = 1 - \chi d_j \text{ where } 0 < d_j < L_r. \quad (4.26)$$

Total effective labor supply $S_r$ then is

$$S_r = \int_0^{L_r} s(d_j)dd_j = L_r(1 - \frac{1}{2}\chi L_r). \quad (4.27)$$

Employers pay wages per unit of effective labor supply. Except for the distinction between labor supply and effective labor supply, the manufacturing sector is constructed analogous to Fujita et al. (1999). The manufacturing sector is characterized
4.4. Basic Model

by increasing returns to scale and monopolistic competition. The trade in manufactured goods takes place between the two regions with iceberg transport costs $\tau$. The production function in manufacturing is

$$S_i = \beta + \phi q_i + s_i,$$

(4.28)

where $S_i$ is the effective labor input of firm $i$, $\beta$ is the fixed labor input per firm, $\phi$ is the variable labor input per unit of production $q_i$ and $s_i$ is the labor input needed due to shirking. However, in the labor market equilibrium there is no shirking, so $s_i = 0$. Firms maximize their yields,

$$\pi_i = p_i q_i - w_r (\beta + \phi q_i),$$

(4.29)

with respect to prices $p_i$,

$$\frac{\partial \pi_i}{\partial p_i} = 0 \rightarrow p_i = \frac{\theta}{\theta - 1} w_r \phi = p_r.$$

(4.30)

Hence, the prices of firms within a region do not differ. New firms enter the market until profits decrease to zero,

$$q_i = \frac{\beta(\theta - 1)}{\phi},$$

(4.31)

$$S_i = \beta \theta.$$  

(4.32)

This means that all firms share the same size irrespective of their region of residence. Then, the number of firms per region is

$$n_r = \frac{S_r}{S_i} = \frac{S_r}{\beta \theta}.$$

(4.33)

The usual normalizations $\phi = (\theta - 1)/\theta$ and $\beta = \mu/\theta$ lead to

$$p_r = w_r,$$

(4.34)

$$q_i = \theta \beta = S_i = \mu,$$

(4.35)

$$n_r = S_r/\mu.$$

(4.36)

These and the demand equations for the varieties of manufactured goods are used to calculate the wage rate at which the zero-profit condition holds, i.e. the wage
4. Monocentric Cities

rate up to which new firms enter the market. This is known as the wage equation in the NEG literature,

\[ w_r = \left[ Y_r P_r^{\theta-1} + Y_s P_s^{\theta-1} \right]^{\frac{1}{\theta}}. \]  

(4.37)

Owing to the direct link between the number of firms and employment, the zero-profit condition, or wage equation, implicitly reflects labor demand. When market access increases (i.e. firms can serve a larger market, by increasing income or decreasing transport costs), the break-even point is shifted to a higher wage. New firms thus enter the market, employing more workers.

The manufacturing price index is

\[ P_r = \left[ \frac{1}{\mu} \left( S_r w_r^{1-\theta} + S_s (\tau w_s)^{1-\theta} \right) \right]^{\frac{1}{\tau-\theta}}. \]  

(4.38)

Here, \( Y_r \) and \( Y_s \) stand for the regional income disposable for consumption (i.e. total wage income lowered by space costs). For simplicity, assume \( \bar{R} = 0 \), so that the total wage income in region \( r \) is \( (1-t)w_r S_r \). There are \( N_r - L_r \) unemployed in region \( r \). Their total income is, analogously to the employed, given by \( w_0(N_r - L_r) - \frac{1}{2}w_0(\alpha\chi(N_r^2 - L_r^2)) \), where the second term represents space costs.

Further, assume that the total population is one, of which a proportion \( \mu \) are manufacturing workers and a proportion \( 1-\mu \) are agricultural workers. Agricultural workers are equally distributed among both regions, whereas a proportion \( \lambda \) of manufacturing workers is located in region \( r \) and a proportion \( 1-\lambda \) is located in region \( s \). The total regional income disposable for consumption then is given by

\[ Y_r = (1-t)w_r S_r + w_0(N_r - L_r) - \frac{1}{2}w_0(\alpha\chi(N_r^2 - L_r^2)) + \frac{1-\mu}{2}. \]  

(4.39)

4.5. Equilibria and Migration

For any given level of \( 0 \leq \lambda \leq 1 \), the equilibrium in the short-term (i.e. without migration) is defined by equations 4.24, 4.27, 4.37, 4.38 and 4.39 and by the definition \( \delta_r = \psi L_r/(N_r - L_r) \) for region \( r \) and the corresponding equations for region \( s \) (refer to the appendix for the system of equations). Additionally, the balanced national budget of unemployment insurance is included, which is \( t(w_r S_r + w_s S_s) = \)
4.5. Equilibria and Migration

\[ w_0(N_r + N_s - L_r - L_s) \] No closed form solution exists and the model is solved numerically, as is standard in the NEG.\textsuperscript{10}

Whether a short-term equilibrium is also a long-term equilibrium depends on the migration decisions given by the difference in the expected life-time utilities of the unemployed (equation 4.25), as illustrated in Figure 4.3.

In Figure 4.3, the difference in expected life-time utilities (vertical axis) is plotted against the distribution of manufacturing employees (horizontal axis); the latter represents the degree of agglomeration. When \( \lambda = 0.5 \), both regions share the same size and there are no differences between them (symmetry). When \( \lambda > 0.5 \), region \( r \) is the agglomeration and region \( s \) the periphery (and vice versa for \( \lambda < 0.5 \)). For \( \lambda = 1 \) and \( \lambda = 0 \), there is full agglomeration. Qualitatively, there are thus four situations:

\textsuperscript{10}All simulations of this chapter are based on the parameter constellation A from Table B.1 in the appendix, except for the additional simulations in the appendix.
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- In situation a \((\tau = 1.05, \chi = 0.4)\), the expected life-time utility is always higher in the periphery, so that people immigrate to the periphery and the system returns to symmetry in the long run (only symmetry is stable).

- In situation b \((\tau = 1.75, \chi = 1.0)\), the expected life-time utility is always higher in the agglomeration, so that people leave the periphery and the system becomes full agglomeration of either region \(r\) or region \(s\) (only agglomeration is stable).

- In situation c \((\tau = 3.5, \chi = 1.0)\), the expected life-time utility is higher in the agglomeration, but only up to a certain degree where the line crosses the no-migration line \((V_r^0 = V_s^0)\) at \(\lambda \neq 0.5\). Here, partial agglomeration is stable, and both symmetry and full agglomeration are unstable.

- In situation d \((\tau = 3.0, \chi = 0.2)\), both, full agglomeration and symmetry are stable, but partial agglomeration is unstable. The system thus might move to full agglomeration or symmetry depending on the initial distribution \(\lambda\).

Note that partial agglomeration is only stable when neither full agglomeration nor symmetry is stable. Hence, it is sufficient to discuss the stability of symmetry and full agglomeration in order to describe the dynamics of the model.

4.6. Break and Sustain Points

The stability of symmetry and agglomeration is discussed with reference to the two key parameters of the model, \(\tau\) and \(\chi\). \(\tau\) is the parameter for transportation costs between the two regions and represents the degree of economic integration between them. \(\chi\) is the parameter for commuting costs within the cities and represents the negative congestion externalities of them. Break and sustain points are thus used to describe the dynamics. The break point is the point at which a change in the two key parameters leads to symmetry changing from unstable to stable or vice versa. Analogously, the sustain point is the point at which a change in the two key parameters leads to full agglomeration changing from unstable to stable or vice versa.

To calculate the sustain point all combinations of \(\tau\) and \(\chi\) are derived, where in the case of full agglomeration the expected life-time utilities are equal in the agglomeration and in the periphery. The break point is calculated by searching for all combinations of \(\tau\) and \(\chi\), where in the case of symmetry a marginal deviation from symmetry leads to a zero change in expected life-time utilities.

The break and sustain points are illustrated by thin and thick lines in Figure 4.4, respectively. Hence, left of the left-hand thin line symmetry is stable, whereas
it is unstable to the right of this line and stable again in the lower right corner, defined by the right-hand thin line. Similarly, agglomeration is unstable to the left of the left-hand thick line, stable to its right and unstable to the right of the right-hand thick line. Combining this information, one can distinguish areas where only symmetry, only agglomeration or both are stable. In the upper right-hand corner demarcated by the right-hand thick and thin lines, symmetry and full agglomeration are unstable, so that there is partial agglomeration. The same holds true for the small area in the upper left corner demarcated by the left-hand thick and thin lines.

Note that agglomeration behavior reduces to the model of Fujita et al. (1999) when there are no commuting costs ($\chi = 0$). In this case, there is a sustain point, which lies to the right of the break point, simultaneous break and sustain points at $\tau = 1$ and no partial agglomeration.

The model thus encompasses a multiple bifurcation pattern depending on the parameter constellation. Although most other NEG models include only one bifurcation pattern, there exist examples of other models with multiple patterns, such as that of Pflüger and Südekum (2011).
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4.7. Labor Market Disparities

4.7.1. Numerical Examples

This section focuses on the implications of the model for regional labor market disparities by presenting numerical examples. In Figure 4.5, $\tau$ is set to 3.5 in order to illustrate the degree of agglomeration $\lambda$ and unemployment disparities. This highlights that there is full agglomeration or symmetry for low $\chi$, symmetry for medium $\chi$ and partial agglomeration for large $\chi$, whereas the size of the partial agglomeration increases as $\chi$ increases.

It is interesting to see that in the full agglomeration, the unemployment rate might be higher or lower compared with the periphery depending on $\chi$, whereas in the partial agglomeration the unemployment rate is always higher compared with the periphery. This is true for all combinations of $\tau$ and $\chi$, where there is partial agglomeration.

Additionally, Figure 4.6 illustrates the unemployment disparities for different levels of $\tau$, holding constant $\chi$ at 1.0 or 0.2. In Figure 4.6(a), $\chi$ is 1. Starting at $\tau = 1$, there is a symmetric equilibrium with zero unemployment disparities. However, this symmetry is broken once $\tau$ is larger than 1 and partial agglomeration arises, growing in size as $\tau$ increases. This growth in the partial agglomeration is accompanied by increasing unemployment disparities, whereas the unemployment rate is larger in the agglomeration compared with the periphery. At a particular value of $\tau$ (the sustain point), the partial agglomeration becomes a full agglomeration and the disparities in unemployment rates peak. Further increases in $\tau$ now first lead to a decrease in the unemployment rate of the agglomeration relative to the periphery, before this pattern is reversed once $\tau$ is large enough. Therefore, the unemployment rate is lower in the agglomeration compared with the periphery only for a certain range. The unemployment rate of the agglomeration relative to the periphery reaches another peak at which the full agglomeration is broken and the system changes to a partial agglomeration. Increases in $\tau$ then lead to a decrease in the agglomeration’s unemployment rate relative to the periphery as the agglomeration size shrinks with increasing $\tau$.

A similar pattern holds for $\chi = 0.2$ (Figure 4.6(b)). However, for $\chi = 0.2$ there is no partial agglomeration. Starting at $\tau = 1$, there is symmetry until this is broken once $\tau$ is large enough and the system switches to full agglomeration with the agglomeration’s unemployment rate at first being higher than that of the periphery. Again, the agglomeration’s relative unemployment rate first decreases, but then increases in $\tau$. When $\tau$ is large enough, the agglomeration becomes unstable and the system returns to symmetry.
4.7. Labor Market Disparities

Figure 4.5.: Partial Agglomeration
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Figure 4.6.: Bifurcation Diagram for Unemployment Disparities
These examples illustrate that the unemployment rate is higher in the partial agglomeration than it is in the corresponding periphery, but might be lower or higher in the full agglomeration compared with the corresponding periphery. The next section provides an explanation of why this is the case.

### 4.7.2. Main Results

To compute for which constellations of the parameters $\tau$ and $\chi$ the unemployment rate is higher (lower) in the agglomeration compared with the periphery, Figure 4.7 illustrates all agglomerations where the agglomeration’s unemployment rate is equal to the unemployment rate of the corresponding periphery ($U_r = U_s$). These points are arranged in Figure 4.7 as thick lines, whereas the thin and dashed lines correspond to the break and sustain points as in Figure 4.4. In the area between the thick lines, the agglomeration’s unemployment rate is always lower than it is in the corresponding periphery, whereas the opposite is true outside this field.
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To understand why the unemployment rate might be higher or lower in the agglomeration compared with the periphery one has to consider the wage curve from above,

\[
\begin{align*}
 w_r &= \left[ \frac{P_r}{K} e^{\rho + \psi + \delta_r + 1 - \gamma} + (1 - \alpha)\chi L_r w_0 \right] \frac{1}{(1 - \chi L_r)(1 - t)}. \\
&= (4.40)
\end{align*}
\]

Assume that \( \chi = 0 \). In this case, the wage curve is equal for both regions and commuting costs do not exist. Thus, the difference between the unemployment rates depends only on the wage differential between both regions. The wages in the model depend on the wage equation (equation 4.37), which expresses up to which wage level new firms enter the market. This wage is higher in regions where access to markets is higher, i.e., in the agglomeration. Thus, the unemployment rate is lower in the agglomeration when there are no commuting costs. This is illustrated in Figure 4.2, where initially both the agglomeration \( A \) and the periphery \( P \) are located on the same wage curve. The higher wages in the agglomeration are associated with lower unemployment compared with the periphery.

However, when there are commuting costs (\( \chi > 0 \)), the wage curve of the agglomeration is different from that of the periphery. Since commuting costs are larger in the agglomeration compared with the periphery, individuals in the agglomeration demand additional compensation for these costs. This is represented in the wage curve of the model such that the wage, which is necessary to ensure that employees do not shirk, is higher in the agglomeration compared with the periphery, holding constant the unemployment rate. Likewise, a given wage, resulting from the wage equation, is associated with a higher unemployment rate when commuting costs increase. Hence, the unemployment rate differential between the agglomeration and the periphery depends not only on the wage differential between regions but also on commuting costs.

These arguments are illustrated in Figure 4.2. Owing to the higher commuting costs, the wage curve of the agglomeration is shifted outwards compared with that of the periphery.\(^{11}\) The wage curve shifts outwards since higher commuting costs imply an additional incentive to shirk, which is higher in the agglomeration compared with the periphery since commuting is more pronounced in the former. Depending on the size of \( \chi \), this shift might be small or large. When the shift is small (large), the unemployment rate will remain smaller (become larger) compared with the periphery, holding constant the wage difference. As the wage is always

\(^{11}\)Actually, the wage curve for the periphery also shifts outwards when commuting costs \( \chi \) increase, although this shift is smaller. In Figure 4.2, only the shift for the agglomeration is presented to illustrate the relative shift and to keep the illustration simple.
higher in the agglomeration, the aggregate relationship between unemployment and wages depends on the wage difference and commuting costs. Further, this illustrates that commuting costs are positively linked to the unemployment rate.

The wage differential between regions depends on the strength of the centripetal forces in the NEG part of the model. Those centripetal forces are strongest for intermediate levels of transport costs and small for both high and low levels of transport costs.\textsuperscript{12} Hence, the relative unemployment rate is likely to be lower in the agglomeration for intermediate levels of transport costs and higher in the agglomeration for low and high levels of transport costs. Regarding commuting costs, the relative unemployment rate in the agglomeration is likely to be higher the larger commuting costs are. For commuting costs of zero, the unemployment rate in the agglomeration is always lower than that in the periphery.

This feature is visible in Figure 4.7, which highlights the importance of transport and commuting costs on unemployment rates. The unemployment rate is lower in the agglomeration than it is in the periphery when the wage surplus of the agglomeration over the periphery is large (for intermediate levels of transport costs). For low or high transport costs, the centripetal forces are weak and the unemployment rate instead is higher in the agglomeration. The range of transport costs for which the unemployment rate is lower in the agglomeration compared with the periphery increases as commuting costs decrease. When commuting costs are zero, the unemployment rate will always be lower in the agglomeration than that in the periphery.\textsuperscript{13}

Why is the unemployment rate only lower in the agglomeration than it is in the periphery when there is full agglomeration? Consider the case of partial agglomeration where the unemployment rate is higher than it is in the periphery. The expected life-time utilities in the partial agglomeration must equal those in the periphery to ensure stability. In principle, one could reach a stable partial agglomeration with relatively lower unemployment, when lower unemployment is

\textsuperscript{12}This is a basic feature of the core-periphery model. See Fujita et al. (1999) for a discussion of the underlying reasons.

\textsuperscript{13}In principle, one could calibrate the model using estimates for the parameters to make predictions for the real world. However, the author decided not to do so since the aim of this model is to provide general conclusions on the influence of centripetal and centrifugal forces on unemployment disparities and on the interrelation between the Harris-Todaro model and the wage curve literature. For this reason, the model is rather stylized to keep the analysis traceable, which also means that features that are relevant in reality, such as restrictions to mobility, have been left aside. The appendix provides a large variety of simulations and the reader might choose a constellation to make predictions, although the simulations do not include all features that are important in reality because of the focus of this model.
4. Monocentric Cities

compensated for by lower wages or higher commuting costs. However, within a single region there is a negative relationship between unemployment and wages (which is represented by movements on the wage curve). Further, there is a positive link between the unemployment rate and commuting costs, as discussed above (as represented by shifts in the wage curve). Hence, one cannot reach a stable partial agglomeration where the unemployment rate is lower compared with the periphery. Of course, one can reach an unstable partial agglomeration with relatively lower unemployment. However, since this must be associated with relatively higher wages and/or relatively lower commuting costs, there will be an incentive to immigrate to this partial agglomeration, turning it into a full agglomeration. In fact, the only reason why the unemployment rate can be lower in a stable full agglomeration is that there the relative life-time utilities need not be equal across regions, as stability is assured by the lack of potential migrants in the empty periphery.

The results presented above illustrate how the Harris-Todaro model and wage curve literature can be special cases of a more general model. Harris and Todaro argue that there must be a positive relationship between unemployment and wages in the no-migration equilibrium when migration is based on expected life-time utilities. In the present model, commuting costs are included as a disincentive to migrate. Hence, the relationship between unemployment and wages is altered when overall commuting costs differ across regions (due to population size differences). In contrast to Harris and Todaro, the wage curve literature suggests a negative relationship between unemployment and wages, which is introduced in the present model based on efficiency wages. However, this is augmented by commuting costs in the present model, and the relationship between unemployment and wages in the agglomeration and the periphery depends on these commuting costs. Therefore, both the arguments of Harris and Todaro and the wage curve literature are included in the present model. Whether the arguments of Harris and Todaro or those of the wage curve literature dominate depends on the importance of commuting costs relative to transport costs. More generally, this depends on the size of negative agglomeration externalities (represented by commuting costs) and the size of positive agglomeration externalities (represented by transport costs).

4.8. Conclusions

This chapter presents an NEG model with monocentric cities and efficiency wages to show that the sign of the relationship between unemployment and wages depends on transportation and commuting costs. The model encompasses the wage curve

\footnote{Note that commuting costs refer to overall regional commuting costs and not only to the commuting cost parameter $\chi$.}
and Harris-Todaro model as special cases. Whereas most other models that introduce unemployment into the NEG usually find a lower unemployment rate in the agglomeration compared with the periphery, this model shows under which conditions the unemployment rate might be higher in the agglomeration. Vom Berge (2011b,a) presents two models where the unemployment rate is higher in the agglomeration, too. However, in his models this rests either on lower nominal wages (and thus a higher replacement ratio in the agglomeration) or on the fact that the unemployed are unable to escape their situation through emigration. In the present model, whether the unemployment rate is higher or lower in the agglomeration compared with the periphery depends on commuting and transport costs, while the unemployed are fully mobile between cities.

The results are comparable to Zenou and Smith (1995). Nevertheless, in contrast to their model here the production structure is endogenous. Hence, the labor market disparities in the present model do not depend on an exogenously defined production structure, but rather endogenously emerge simultaneously with the location of industries. The present model shows that the question of whether the unemployment rate is higher or lower in the agglomeration crucially depends on the level of transportation costs, which are a measure of the degree of integration between cities. These define the strength of the centripetal forces. Lower unemployment rates in the agglomeration compared with the periphery only emerge for intermediate levels of transportation costs. When transportation costs are too low or too high, centripetal forces are too weak to generate a wage surplus of the agglomeration that is large enough to compensate for the commuting disadvantages. Then the unemployment rate is higher in the agglomeration. Further, the lower the commuting costs, the larger is the range of transportation costs for which the unemployment rate is lower in the agglomeration compared with the periphery. Therefore commuting costs affect the unemployment rate through their effects on work incentives.

The model presented here therefore shows that the Harris-Todaro model and wage curve are both special cases of a more general model. Whether the relationship between unemployment and wages is positive or negative depends on transportation and commuting costs. The model thus delivers a theoretical foundation for the effects of agglomeration on the wage curve. Such effects have been considered by only few recent empirical wage curve analyses. The results presented here show that the wage curve literature does not refute the Harris-Todaro model and that the empirical applications of the wage curve should include the degree of agglomeration or measures of negative agglomeration externalities, such as commuting costs, to control for shifts in the wage curve.
5. Market Access and Labor Market: Evidence from German Reunification

5.1. Abstract

The New Economic Geography predicts a positive effect of market access on wages, as represented by the wage equation. Several studies provide empirical evidence in favor of the wage equation. However, a key problem is the endogeneity of market access: it is challenging to identify the causal effects of market access on wages, since market access itself depends on wages. Whereas most approaches rely on instrumental variables and strong assumptions on exogeneity, the present analysis relies on German reunification as an exogenous variation of market access in order to identify the effects. Since the market access shock due to reunification was accompanied by a labor supply shock due to migrants and commuters from eastern Germany, the effects on wages, employment and unemployment are analyzed. The results provide evidence in favor of a labor demand shock due to the increase in market access and a labor supply shock due to migrants and commuters from eastern Germany.

JEL Classification: F15, R12, R23

Keywords: New Economic Geography, wage equation, market access, natural experiment, differences-in-differences

5.2. Introduction

The disparities in regional economies are an important concern of national and European economic policy. The New Economic Geography (NEG) provides a theoretical explanation of how such disparities emerge and why they persist. A key prediction from NEG theory is that because of the love of variety, transport costs and increasing returns to scale, firms locate close to large markets. This implies that factor prices are higher in regions where firms have access to larger markets. Hence, a key
result of the NEG is the “wage equation”, which states that wages positively depend on market access.

The empirical side of the NEG is, however, less developed than its theoretical counterpart. Redding (2010) presents a recent review of the empirical NEG literature and especially points to the problems of identification and potential alternative explanations. A key problem of estimating the wage equation is that market access is endogenous in it. It is thus challenging to identify the causal effects of market access on wages and to separate the effects of market access from other determinants of regional development (Redding 2010).

The present analysis therefore relies on a natural experiment to identify the effects of market access. German reunification presents an exogenous increase in market access that varies across regions. These differences across regions are used to estimate the effect of the increase in market access on wages, employment and unemployment in a differences-in-differences (DID) framework. The analysis is not restricted to wages but also includes employment and unemployment since the market access shock due to reunification was accompanied by a labor supply shock triggered by migrants and commuters from eastern Germany, which potentially alleviates the effects of the market access shock on wages. The estimates are based on data for 1.3 million individuals whose employment histories are observed over the period from 1975 to 2004, derived from the IABS data of the Institute for Employment Research (IAB).

The remainder of the chapter is organized as follows. Section 5.3 presents the theoretical background. Section 5.4 provides a brief overview of the related empirical literature, highlighting the identification problems of previous studies. Section 5.5 presents the empirical approach and discusses its suitability in the case of German reunification. Then, the data are introduced in Section 5.6. The results are discussed in Section 5.7 and the conclusions are drawn in Section 5.8.

5.3. Theoretical Background

The idea that market access matters for the location of economic activity goes back to Harris (1954). Harris’s measure of market potential \( MP \) (or market access) of a region \( r \) is the sum of all accessible markets \( M \) divided by their distance \( d \) to that region,

\[
MP_r = \sum_s M_s / d_{rs}. \tag{5.1}
\]
5.3. Theoretical Background

He measures the sizes of accessible markets in terms of sales. However, he does not provide a theoretical foundation for his measure of market access or for how it influences the location of economic activity. This “fairly crude measure of market access” might lead to an overestimation of the role played by market access for the wages of surrounding regions (Hering and Poncet; 2010, p. 145). Nevertheless, Harris’s idea of market access is now a key feature of most NEG models, which provide a sound theoretical foundation of market access and how it affects the location of economic activity.

The most prominent representation of the NEG is the seminal core-periphery model of Fujita et al. (1999). This model is based on monopolistic competition, the love of variety, transport costs and increasing returns to scale in a world of two regions and two sectors (manufacturing and agriculture). Combining these elements leads to the well-known wage equation (Fujita et al.; 1999, p. 64),

\[ w_r = \left( \sum_s Y_s T_{rs}^{1-\theta} P_s^{\theta-1} \right)^{1/\theta}, \]  

(5.2)

where \( w_r \) is the wage in region \( r \), \( Y \) is income, \( T_{rs} \) are the transport costs between region \( r \) and \( s \), \( P \) is the manufacturing price index and \( \theta \) is the elasticity of substitution between varieties of manufactured goods. Hence, the wage in a region depends on the income in all other locations, whereas the influence of the neighbor’s income declines with its distance. However, since income is defined as the sum of labor income (i.e. wages), endogeneity results. Two key approaches exist to estimate the wage equation, one from Hanson (2005) and one from Redding and Venables (2004).

In the original model of Fujita et al. (1999), there are two regions that each contain a manufacturing and an agricultural sector. Nevertheless, the model only allows for the full agglomeration of manufacturing activity in one region, or perfect symmetry in both regions. Helpman (1998) dropped the agricultural market and extended the model to cover a housing market. The resulting model produces less extreme outcomes and partial agglomeration might result. Hanson (2005, p. 6) uses the model of Helpman to derive his wage equation,

\[ \ln(w_r) = \beta + \theta^{-1} \ln \left( \sum_s Y_s^{\theta(\mu-1)+1} H_s^{(\theta-1)(1-\mu)} w_s^{\theta-1} T_{rs}^{\theta-1} \right), \]  

(5.3)

where \( \beta \) is a function of fixed parameters, \( H \) is the stock of housing and \( \mu \) is the share of expenditures for traded goods. Hanson replaces the transport costs by a function \( T_{rs} = e^{-\tau d_{rs}} \), where \( \tau \) are iceberg transport costs for a unit distance and \( d_{rs} \) is the distance between regions \( r \) and \( s \). Then, wages depend on market access,
whereas market access in a region is defined as the sum of income in all regions,\textsuperscript{1} lowered by the distance to the respective regions. Mion (2004) also presents a linearization of Hanson's wage equation.

By contrast, Redding and Venables (2004) use a new trade theory model as the basis for their wage equation. In their equation, wages depend on market and supplier access. They derive market and supplier access from bilateral trade data based on a gravity equation. The approaches of Hanson (2005) and Redding and Venables (2004) thus both include a calculation of market access in order to estimate its influence on prices. This market potential is a function of income $Y$, which itself depends on wages $w$. This is where the endogeneity enters the models. Hanson (2005) and Redding and Venables (2004) use instruments in order to cope with this endogeneity.

In both specifications, the wage equation reflects labor demand by firms, as discussed in the preceding chapters. An increase in market access implies that firms can serve a larger market, so that more firms enter the market, leading to an increase in labor demand. Then, the overall effect of an increase in market access depends on how labor supply is modeled.

The approach of Redding and Venables (2004) is based on the assumption of labor immobility. Further, the approaches of Redding and Venables (2004) and Hanson (2005) are both based on the assumption of fixed (i.e. inelastic) labor supply. These assumptions are not valid in the case of German reunification because with the opening of the border, significant numbers of people from eastern Germany entered the western German labor market as migrants or commuters. Dietz et al. (1992) show that in some regions the share of migrants and commuters as a proportion of regional employment was as much as 20\% by the end of 1991. Hence, labor supply significantly increased in western Germany in the aftermath of German reunification.

Therefore, it is important to consider the effects of elastic labor supply. When labor supply is elastic, the positive effect of market access on wages is alleviated by increasing labor supply. In an imperfect labor market, where there exists a negative relationship between unemployment and wages,\textsuperscript{2} the effect of an increase in market access should lead to increasing wages and employment, but decreasing unemployment because the increase in wages raises labor supply. The previous chapters contain a more detailed analysis of the relation between regional labor markets and NEG forces.

Contrarily, the positive labor supply shock (due to migrants and commuters) should lead to decreasing wages, but increasing employment and unemployment.

\textsuperscript{1}More precisely it is defined as the sum of expenditures for the goods that can be shipped.

\textsuperscript{2}This relationship is frequently confirmed by the wage curve literature. See, for example, Blanchflower and Oswald (1994, 2005).
5.4. Related Literature

detailed discussion of the labor supply shock is presented by Büttner and Rincke (2007) who discuss a specific model for the case of German reunification that consists of three regions: eastern Germany, the border regions to eastern Germany in the west and the hinterland. Since wages are lower in eastern Germany, the drastic reduction of mobility costs due to reunification leads to an increase in labor supply in the border regions at the expense of eastern Germany. Assuming a negative slope for the labor demand function, this increase in labor supply leads to increasing employment and decreasing wages in the border region. Further, assuming a negative relationship between unemployment and wages, as discussed by the wage curve literature, the decline in wages should be accompanied by an increase in unemployment.

5.4. Related Literature

In the empirical NEG literature, two key structural approaches to estimate the wage equation have been proposed by Hanson (2005) and Redding and Venables (2004). Hanson (2005) relies on Helpman’s (1998) modification of the seminal core-periphery model of Fujita et al. (1999). Hanson does not estimate all equations of the model but rather captures its main features in an augmented market potential function. In this equation, nominal wages in a region depend on income, housing prices, wages and transportation costs in all other regions. It is clear that endogeneity arises, since wages appear on both sides of the equation. To cope with this problem Hanson uses spatially aggregated data on the right-hand side of the equation.

Redding and Venables (2004) derive a wage equation from a new trade theory model that has been extended to cover transport frictions and intermediate production goods. Their analysis proceeds in several steps. First, they estimate bilateral transport costs and market and supply capacities based on a gravity equation. They use these estimates to calculate the market access of exporters and the supplier access of importers. Based on these calculations, they estimate a wage equation where the wage depends on market and supplier access. Additionally, they regress the relative manufacturing price index on the estimate of supplier access. However, endogeneity remains an issue in the wage equation. Redding and Venables therefore use time-lagged estimates of market and supplier access in the wage equation to check the robustness of their results.

Many authors who structurally estimate a wage equation follow the approaches of Hanson (2005)\textsuperscript{3} or Redding and Venables (2004)\textsuperscript{4} and apply their analyses to other


countries and contexts, or vary the original approaches. These structural approaches use instruments in order to identify the effects of market access on wages. Hence, these approaches face the problem that the validity of the results ultimately relies on the assumption that the instruments are strictly exogenous. Redding (2010, p. 301) accordingly concludes that “these instruments require demanding identification assumption, which are unlikely to be satisfied in practice”.

A rather new approach is to use micro data in order to reduce the endogeneity problem. Mion and Naticchioni (2005) use linked employer-employee data to distinguish between the influence of market potential and urbanization on individual wages. Hering and Poncet (2010) in turn estimate a wage equation based on micro data for China, whereas Fingelton and Longhi (2011) do so for the United Kingdom. Although the problem of endogeneity is reduced by using micro data, it is not fully resolved. Therefore, Hering and Poncet (2010), for example, rely on instruments in their micro-approach, too, in order to cope with endogeneity.

Another approach to cope with endogeneity is to use exogenous variations of market access to identify causal effects. The division of Germany after the Second World War and its reunification present variations of market access that are unlikely to depend on economic considerations and thus are exogenous. Redding and Sturm (2008) and Bosker et al. (2007) use this variation to test the effect of market access on city sizes. However, owing to a lack of data they are unable to discuss the effects on wages. Others have analyzed the bombing of Japan (Davis and Weinstein; 2002, 2008) or Vietnam (Miguel and Roland; 2011) to discuss NEG arguments. However, they do not test the effects of market access on wages either.

Bröcker and Meier (2010) have already used the reunification of Germany as an exogenous variation of market access to estimate its influence on productivity and employment. They derive an indicator of market access from a theoretical model and use it in their empirical analysis. They find a positive effect of market access in both cases. By contrast, Büttner and Rincke (2007) argue that the reunification of Germany presents a labor supply shock for the direct border regions in western Germany. They apply a DID approach to empirically show the negative effect of the labor supply shock on wages in border regions. Further, they show the positive effects of the labor supply shock on employment and unemployment. The present analysis also applies a DID approach based on German reunification as a natural experiment, but the effects of market access on wages, employment and unemployment are estimated and the interrelation of the labor supply shock with the market access (labor demand) shock is discussed.

The problem is reduced since the individual wage has only a minor influence on the aggregate wage level. However, wages in a region are usually correlated, meaning that the problem remains.
Other related articles include the surveys of integration effects in border regions presented by Niebuhr and Stiller (2004, 2006), a survey of results for the labor market effects of trade by Pflüger et al. (2010) and articles by Moritz (2009a,b, 2011) and Moritz and Gröger (2007), who present results for the labor market effects of European integration in the Bavarian/Czech border region.

For the case of the European integration in the Bavarian/Czech border regions, Moritz (2009a) reports mixed effects on the labor market. There is no structural break in the employment share of border regions in Bavaria, nor in the structural change. Moritz (2009a,b), however, finds that wages of low-skilled male employees increased in border regions due to the integration. Nevertheless, the wage gap between low-skilled and skilled employees increased in the border regions from 1995 to 2001. Moritz and Gröger (2007) also investigate the effects of this integration process on Bavarian border regions and focus on the skill structure. They do not find clear effects on the skill structure. There is weak evidence for wage increases of low-skilled employees, but no effects on skilled and high-skilled employees. Moritz (2011) further investigates the effects of Czech commuters after the fall of the Iron Curtain on the labor market in Bavarian border regions. He does not find far-reaching negative effects of these commuters on the Bavarian labor market. It seems that the integration process between Czech and Bavarian border regions had at most little effects on the Bavarian regional labor markets.

Brülhart et al. (2012) analyze the effects of the integration process between Austria and central and eastern Europe on local labor markets in Austria. They find a rapid positive response of wages and a slower but more pronounced positive response of employment to the integration shock in border municipalities. This implies that the shock was mainly absorbed by quantity (employment) adjustments and only to a lesser extend by price (wage) adjustments. Their results thus confirm that it is important to draw a more encompassing picture of the market under shock, rather than focusing on a single outcome variable only, when discussing the effects of market access shocks.

5.5. Empirical Approach

The basic idea of the present analysis is to treat German reunification as a natural experiment to test the effects of market access on wages, employment and unemployment, based on the arguments of Redding and Sturm (2008). In this setting, German reunification presents the treatment and border regions are regarded as the treatment group. German reunification is suited as a natural experiment since it

6De Pinto and Michaelis (2011), for example, consider the effects of heterogeneous workers in this strand of literature in their theoretical model.
5. Market Access and Labor Market: Evidence from German Reunification

came as a surprise to most observers and it led to a large trade shock.\textsuperscript{7} In the course of reunification, the regions in western Germany gained new trading partners in eastern Germany. This increase in market access was more pronounced for regions close to the former inner-German border since their trading costs to eastern German regions were lower compared with those for remote regions due to the smaller distance. More precisely, the decline in trading costs to eastern Germany induced by reunification was more pronounced for border regions than it was for non-border regions due to the smaller distance to the border. There is no clear argument why the selection process of the regions into the treatment group should be influenced by the variables investigated herein (wages, employment and unemployment), since selection into the treatment group is solely based on the geographical location of the regions. Hence, the treatment can be assumed to be exogenous.\textsuperscript{8}

Based on the theoretical background, a positive labor demand shock of reunification on border regions is expected. Assuming inelastic labor supply, this should lead to higher wages. However, as labor supply is unlikely to be inelastic, the effect on wages should be alleviated by increasing employment and decreasing unemployment. The empirical approach used here to test these hypotheses is the DID framework. In this framework, the effect of a treatment on a treatment group is identified by comparing the relative development of the variable of interest in the treatment group in course of the treatment compared with a control group in the same period. This can be carried out in a fixed effects panel estimation using the specification

\[ y_{rt} = \alpha_r + \beta_1 gru_{rt} + \beta_2 (gru_{rt} \times border_r) + \epsilon_{rt}, \]  

where \( y_{rt} \) denotes the variable of interest and \( \alpha_r \) represents the regional fixed effects that are used to control for preexisting time-constant differences between the regions. The overall effect of time before and after the treatment (here: German reunification) is captured by a time dummy \( gru_{rt} \), which is zero prior to the treatment and one during/after the treatment. The effect of the treatment on the treatment group is represented by the interaction of this time dummy with a dummy for the treatment group \( border_r \), which are the border regions in this case. The key identifying assumption of this approach is that the treatment and control groups would have followed the same trend if the treatment had not occurred. In order

\textsuperscript{7}In particular, Nitsch (2004) shows that the relation of west-to-east German exports is higher than exports from western Germany to foreign countries by a factor of 2.2 and that most of the increase in west-to-east German exports occurred between 1989 and 1992. Hence, the effect was strong and occurred rapidly after reunification.

\textsuperscript{8}German reunification is frequently applied as a natural experiment to test various hypotheses. In the case of the labor market or trade effects, see, for example, Redding and Sturm (2008), Bröcker and Meier (2010) and Büttner and Rincke (2007).
5.5. Empirical Approach

to identify the treatment effect the researcher has to assume that the coefficient $\beta_2$ would be zero in the absence of the treatment. This assumption is of course invalid if the trend in the outcome variable $y_{rt}$ was already different before the treatment. When there are preexisting differences in trends, and the researcher does not control for this, the coefficient $\beta_2$ captures both these preexisting differences in trends as well as the treatment effect.

Based on the above, the present approach argues that reunification increases market access for the border regions so that a positive labor demand shock from reunification on these regions is expected. This increase of market access is the result of the decline in transport costs, caused by reunification. In the previous chapters the effects of transport costs were discussed by varying the transport costs parameter $\tau$, whereas here the reduction of transport costs and its effects on market access are captured by a dummy variable for German reunification as an exogenous variation of transport costs and market access. By comparing the labor market variables in the border regions with those in the control regions, the effects of the increase in market access on wages, employment and unemployment are identified. No indicator is available for the labor force so that the effects of the increase in market access on the distribution of the labor force cannot be discussed. However, the effects on employment and unemployment implicitly contain information on the effect on the distribution of the labor force.

Büttner and Rincke (2007) argue that reunification presents a positive labor supply shock, because significant numbers of migrants and commuters from eastern Germany entered the western German labor market immediately after the opening of the border. This is explicitly illustrated by the figures presented by Dietz et al. (1992) on the regional shares of migrants and commuters from eastern Germany in western German regional employment. In some regions, these shares are as high as 20 % by the end of 1991.

A problem with the present approach, therefore, is that reunification actually presents two shocks, namely a positive labor demand shock and a positive labor supply shock, which makes it difficult to disentangle the two. However, these two shocks have different implications for the development of wages, employment and unemployment. A positive labor demand shock should lead to higher wages, higher employment and lower unemployment, whereas a positive labor supply shock should lead to lower wages, higher employment and higher unemployment. Accordingly, the aggregate developments of wages and unemployment will show which of the labor market shocks dominates. However, when employment is positively affected by reunification, it is unclear whether this is because of the labor demand or the labor supply shock. The figures by Dietz et al. (1992) provide the possibility to partially

\footnote{This distribution of the labor force reflects $\lambda$ in the previous chapters.}
control for the labor supply shock at the regional level, but the measure is imperfect since the figures are only available for the end of 1991. Furthermore, the share of migrants and commuters reflects the labor supply shock, the location decisions of these migrants and commuters and the composition effect of the migrants and commuters on the employees in the region.\textsuperscript{10}

Bertrand et al. (2004) argue that standard panel DID approaches too often reject the null hypothesis of no treatment effect. They show that when there is serial correlation, the standard approach implies a wrong estimation of standard errors, leading to an over-rejection of the null hypothesis. They propose three procedures to correct these standard errors: block bootstrap, an arbitrary variance-covariance matrix or collapsing the data into pre- and post-treatment periods. The first two methods provide reasonable results when \( N \) is large. The third method is also applicable for small \( N \), although the power of this test is small. Here, the second method is used throughout in order to correct the standard errors, as \( N \) is large enough.\textsuperscript{11} More precisely, an arbitrary variance-covariance matrix is estimated where the errors are clustered at the state level (see Bertrand et al.; 2004).

5.6. Data

This analysis relies on the IAB Employment Sample (IABS), which contains the employment histories of 1.3 million individuals in Germany between 1975 and 2004 at the NUTS 3 level. These data are provided by the IAB for scientific purposes as a Scientific Use File. The long period of the data provides the opportunity to use the reunification of Germany as an exogenous variation of market access in order to estimate its effect on labor market indicators over a long period.

An advantage of IABS data is its high reliability, because it is based on official data that are used for the calculation of social security contributions. However, a disadvantage of the data is that wages are reported only below the contribution limit for the social insurance system. The procedure proposed by the IAB is used to impute wages above the limit (Gartner; 2005). In order to improve the quality of the qualification variable the procedure proposed by Fitzenberger et al. (2006) is applied.

The data are organized in employment spells, indicating the start and end date of each employment or unemployment phase. These spells are reorganized into

\textsuperscript{10}The migrants and commuters from eastern Germany were especially medium and highly qualified employees (Dietz et al.; 1992), which affected the composition of the employees in the destination regions.

\textsuperscript{11}Bertrand et al. (2004) consider an \( N \) of 50 as large in their simulations, whereas here \( N \) is 266.
5.6. Data

(a) Neighborhood

Source: Büro für Raumforschung, Raumplanung und Geoinformation (2009), authors own illustration.

(b) Travel Time in Minutes by Car

Source: Büro für Raumforschung, Raumplanung und Geoinformation (2009), authors own illustration.

Figure 5.1.: Definition of the Treatment Group

a panel data set by looking at the employment status of each individual on 30th June each year. This is in accordance with the procedure of the federal employment agency for official statistics on regional employment. IABS data are then used to derive the regional wage level $w_{rt}$ and the regional number of employees $l_{rt}$, where $r$ indicates the region and $t$ indicates the year. Both $w_{rt}$ and $l_{rt}$ are measured in logs. The regional unemployment rate $u_{rt}$ is derived from an official publication of the German employment agency (Bundesagentur für Arbeit; 2005).

Different definitions to differentiate between the treatment and control groups are used. The main definition is based on neighborhood. In the neighborhood setting, regions are defined as being close to the border when they are first- or second-order neighbors to the border. This is illustrated in Figure 5.1(a). To locate these individuals, the NUTS 3 regions of their work-places were identified. IABS data provide the NUTS 3 region of the work-place for each job match. However,
some small regions have been merged with their neighbors into larger regions. The number of regions in the data set is 266.

Further, the distance of each region to eastern Germany is quantified by the travel times between the regions. Travel time is measured by the car travel time in minutes from each centroid of a region to the closest centroid of any eastern German region, derived from a travel time matrix. A centroid reflects the most important administrative center of a region. Figure 5.1(b) shows the distribution of these travel times.

Another feature that has to be taken into account is the special subsidies to the regions at the border to eastern Germany and eastern Europe called Zonenrandförderung. These regions are identified using official publications. New subsidies were granted to firms in these regions until the end of 1991. These features are captured by a dummy for regions subject to the Zonenrandförderung (zrg,) and a time dummy for years before 1992 (subsidy), the period during which these subsidies were granted. Additionally, the regional share of migrants and commuters in total employment from eastern Germany serves as a control for the labor supply shock after reunification. These data are derived from Dietz et al. (1992) who report this share for the end of 1991. They are thus used for all years from 1990 but set to zero for years before 1990 in order to control for the increase in labor supply after reunification.

Table 5.1 contains the descriptive statistics of the data for the full sample, as well as individually for the treatment and control groups. Treatment regions are defined as those regions that are first- or second-order neighbors of eastern Germany (border, = 1); the remaining regions are defined as members of the control group (border, = 0). Table 5.1 refers to the period 1984 to 2000. The descriptive statistics, which are based on the regional aggregates, show some key features of the data. For example, the log wage is lower in the treatment compared with the control group. Further, the share of migrants and commuters from eastern Germany in total regional employment is larger in treatment regions. An important feature is contained in the dummy variable for regions subject to the Zonenrandförderung: Treatment and control groups both contain regions subject to as well as not subject to the Zonenrandförderung. This is because not all second-order neighbors of eastern Germany received those subsidies and because those subsidies were granted to regions at the border to eastern Europe, which covers more regions than just the border regions to eastern Germany.

A prerequisite of the analysis is that the sectoral structure must not diverge too much between the border and non-border regions. In particular, the share of

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13 The regions are depicted from the German Zonal Border Development Act.
### 5.7. Results

This section presents the results of the estimations. The first subsection refers to the effects on wages, the second to unemployment and the third to employment. Based on the insights into the developments of the individual labor market indicators, a picture of the shocks that occurred on the labor market is drawn in the last subsection, including an analysis of the robustness.

<table>
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<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
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<th>Max</th>
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<table>
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<tbody>
<tr>
<td>(a)</td>
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<tr>
<td>(b)</td>
<td>based on all low/medium qualified employees</td>
</tr>
<tr>
<td>(c)</td>
<td>based on all employees</td>
</tr>
</tbody>
</table>

Table 5.1.: Descriptive Statistics

the tradeables sector should be sufficiently large so that the increase of market access, due to reunification, can have an effect on the labor markets in the border regions. Table C.1 in the appendix highlights that the sectoral structure is very similar between border and non-border regions. Thus the sectoral structure does not constrain the analysis.
5. Market Access and Labor Market: Evidence from German Reunification

5.7.1. Wages

A DID approach is applied to show the overall effect of reunification on wages in the border regions. Average regional wages are based on the information on full-time male employees only. The hypothesis, derived from the wage equation, is that reunification led to an increase in market potential, resulting in an increase in wages. However, reunification also lead to an increase in labor supply due to migrants and commuters from eastern Germany, especially in the border regions, which should lead to a decrease in average wages in border regions (see Büttner and Rincke; 2007). The first DID specification is

\[ w_{rt} = \alpha_r + \beta_1 gru_t + \beta_2 (gru_t \times \text{border}_r) + \beta_3 \text{subsidy}_t + \beta_4 (zrg_r \times \text{subsidy}_t) + \beta_5 \text{migr}_{rt} + \epsilon_{rt}, \]  

where \( w_{rt} \) represents average log wages in region \( r \) and at year \( t \). \( gru_t \) is a time dummy for reunification, which is one for the period of reunification, starting in 1990, and zero for the pre-reunification period until 1989. The variable \( \text{border}_r \) is one for regions that are defined as border regions and zero for the remaining regions. Border regions are the treatment group and these are usually defined as first- and second-order neighbors, although below the robustness of the results is shown by changing this definition. The interaction effect \( (gru_t \times \text{border}_r) \) captures the effect of reunification on border regions, that is, the treatment effect. A time dummy \( \text{subsidy}_t \) controls for the subsidies of the Zonenrandförderung, which is one for the period of these subsidies (and zero otherwise). This is interacted with a dummy \( zrg_r \), which is one for the regions of the Zonenrandförderung and zero for the remaining regions. \( \text{migr}_{rt} \) reflects the share of migrants and commuters from eastern Germany in total regional employment. This controls for the overall effect of the labor supply shock on wages. The model is a fixed effects panel model (within transformation), while \( \alpha_r \) contains the individual effects and \( \epsilon_{rt} \) is the error term.

The results are presented in Table 5.2.\(^{14}\) It seems that the overall effect of reunification on wages in border regions was negative, even when controlling for the labor supply shock. This is in contrast to the hypothesis of a positive market access shock. The effect of the labor supply shock, represented by \( \text{migr}_{rt} \), seems to be positive. However, this variable represents the effect of migration and commuting on wages, the location choices of migrants and commuters and the effect of migration on the skill composition of employees.

\(^{14}\)All models are labeled using three elements. The first element refers to the endogenous variable, the second to the equation (specification) number from the text and the last is an alphabetic index of the models.
5.7. Results

<table>
<thead>
<tr>
<th>Variable</th>
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<th>w5.5b</th>
</tr>
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<td>(0.0037)</td>
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<td>coef.</td>
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<td>0.0106***</td>
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<td>s.e.</td>
<td>(0.0040)</td>
<td>(0.0038)</td>
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<td>subsidy_t</td>
<td>coef.</td>
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<td>-0.2226***</td>
</tr>
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<td>s.e.</td>
<td>(0.0019)</td>
<td>(0.0019)</td>
</tr>
<tr>
<td>migr rt</td>
<td>coef.</td>
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<td>5.0166***</td>
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<td>(0.0009)</td>
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<td>5586</td>
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<td>time</td>
<td></td>
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<td>1984-2004</td>
</tr>
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<tr>
<td>time eff.</td>
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<td>no</td>
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<td>rob. s.e. (1)</td>
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<td>yes</td>
<td>yes</td>
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<td>(1) according to Bertrand et al. (2004)</td>
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<td>sign. lev.</td>
<td></td>
<td>*0.1, **0.05, ***0.01</td>
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</tbody>
</table>

Table 5.2.: Specification 5.5 for Wages

Büttner and Rincke (2007) instead use interactions between yearly time dummies and the border region dummy to illustrate the variation in the effect of the labor supply shock on wages over time. Their approach is shown in Table 5.3. The specification of this model is

\[ w_{rt} = \alpha_r + \sum_{t=2}^{T} \phi_{1,t}d_t + \sum_{t=2}^{T} \phi_{2,t}(d_t \times \text{border}_r) \]
\[ + \phi_3(zrg_r \times \text{subsidy}_t) + \phi_4\text{migr}_{rt} + \nu_{rt}, \tag{5.6} \]

where \(d_t\) is a set of dummy variables for each year (with the first year as the base year) and \((d_t \times \text{border}_r)\) is the respective interaction effect for each year dummy with the border region dummy. The remaining variables are as before and the model is estimated as fixed effects where \(\alpha_r\) contains the individual effects and \(\nu_{rt}\) is the error term. In contrast to Büttner and Rincke (2007) first- and second-order neighbors are used as border regions because this analysis focuses on the effect of market access, which potentially works at larger distances. Variations of this definition are presented later to show the robustness of the results. The results of Büttner and Rincke (2007) are confirmed when applying their estimation approach. Starting from 1990, the interactions between the year dummies and border dummy are negative and significant. This points to a negative effect of reunification on wages in border regions and stands in contrast to the hypothesis of a positive effect.
5. Market Access and Labor Market: Evidence from German Reunification

<table>
<thead>
<tr>
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<th>Model</th>
</tr>
</thead>
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</tr>
<tr>
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</tr>
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<td>s.e.</td>
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</tr>
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<tr>
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</tr>
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<td>s.e.</td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>s.e.</td>
</tr>
<tr>
<td>((d_{1992} \times \text{border}))</td>
<td>coef.</td>
</tr>
<tr>
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<td>s.e.</td>
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<tr>
<td>((d_{1993} \times \text{border}))</td>
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</tr>
<tr>
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<td>s.e.</td>
</tr>
<tr>
<td>((d_{1994} \times \text{border}))</td>
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</tr>
<tr>
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<td>s.e.</td>
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<tr>
<td>((d_{1995} \times \text{border}))</td>
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</tr>
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<td>s.e.</td>
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<td>((d_{1996} \times \text{border}))</td>
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</tr>
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<td></td>
<td>s.e.</td>
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<td>((d_{1997} \times \text{border}))</td>
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<td>coef.</td>
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<td>s.e.</td>
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<td>s.e.</td>
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<td>((d_{2000} \times \text{border}))</td>
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</tr>
<tr>
<td></td>
<td>s.e.</td>
</tr>
<tr>
<td>(\text{zrg} \times \text{subsidy})</td>
<td>coef.</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
</tr>
</tbody>
</table>

|               |            |            |            |            |
| indiv. eff.    | yes        | yes        | yes        | yes        |
| time eff.      | yes        | yes        | yes        | yes        |
| rob. s.e. (1)  | yes        | yes        | yes        | yes        |

(1) according to Bertrand et al. (2004)
sign. lev.: *0.1, **0.05, ***0.01

Table 5.3.: Specification 5.6 for Wages
of market access on wages. However, the results are not robust: when changing the time period to the years 1984 to 2000, the interaction effects become negative and significant before reunification. This highlights that the negative interaction effects are not due to reunification. Instead, there is a general negative trend in these interactions because the trend of wages in border regions tended to be worse than that in the remaining regions before reunification. Hence, one cannot conclude from the negative interaction effects that reunification had a negative effect on wages. The common trend hypothesis is violated and thus simply comparing the average levels of wages in the treatment and control regions before and after reunification, as is carried out in the models from Tables 5.2 and 5.3, is misleading. To support this argument, wages in the control and treatment regions before reunification (time period from 1984 to 1989) are regressed on a time trend \( \text{trend}_t \) which is interacted with the border dummy \( (\text{trend}_t \times \text{border}_r) \) in a fixed effects panel model. Table 5.4 presents the results.

\[
  w_{rt} = \alpha_r + \gamma_1 \text{trend}_t + \gamma_2 (\text{trend}_t \times \text{border}_r) + \varepsilon_{rt}. \tag{5.7}
\]

The results from Table 5.4 highlight that the common trend hypothesis is indeed violated. Wage trends in border regions were already worse than those in the remaining regions before reunification, as the coefficient for the interaction effect \( \gamma_2 \) is negative and significant. One therefore cannot conclude from the previous models that reunification had a negative effect on wage levels: this negative effect might just simply reflect the preexisting negative trends in wages. The following DID approach is used to take these differences in trends into account,

\[
  w_{rt} = \alpha_r + \theta_1 \text{trend}_t + \theta_2 (\text{trend}_t \times \text{border}_r) + \theta_3 \text{gru}_t + \theta_4 (\text{gru}_t \times \text{border}_r) + \theta_5 (\text{gru}_t \times \text{trend}_t) + \theta_6 (\text{gru}_t \times \text{border}_r \times \text{trend}_t) + \theta_7 \text{subsidy}_t + \theta_8 (\text{zrg}_r \times \text{subsidy}_t) + \theta_9 \text{migr}_{rt} + \eta_{rt}. \tag{5.8}
\]

The model is estimated as fixed effects. \( \text{gru}_t \times \text{trend}_t \) represents the interaction of the reunification dummy with the trend, i.e. the change in the time trend due to reunification. \( \text{gru}_t \times \text{border}_r \times \text{trend}_t \) represents the interaction of border regions with reunification and the time trend and captures the difference in the change in the time trend due to reunification in border compared with non-border regions. The remaining variables are as above. The results are presented in Table 5.4.

In this setting, neither \( \theta_4 \) nor \( \theta_6 \) are significantly different from zero. When controlling for preexisting differences in trends, the effect of reunification on wages

---

15 The time trend \( \text{trend}_t \) is one for the year 1984, two for the year 1985 and so on.
5. Market Access and Labor Market: Evidence from German Reunification

<table>
<thead>
<tr>
<th>Variable</th>
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<th>w5.8b</th>
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<td>0.0334***</td>
<td>0.0334***</td>
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<td>(0.0009)</td>
<td>(0.0009)</td>
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<td>(grurt × trendt)</td>
<td>coef.</td>
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<td>(0.0004)</td>
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(1) according to Bertrand et al. (2004)

Table 5.4.: Specifications 5.7 and 5.8 for Wages

vanishes. Note that the effect of migrants and commuters on wages \((\theta_9)\) is positive and significant, although only at the 10% level. However, this coefficient reflects the labor supply shock, the location decisions of migrants and commuters and the composition effect of employees’ qualifications. The results are robust against the exclusion of the migration variable. Therefore, there is no significant aggregate effect of reunification on the wages of full-time male employees.

In a next step, the above regressions are repeated based on wage data for all low and medium qualified employees. As in Büttner and Rincke (2007), high qualified are excluded, since for a significant proportion of them wages are censored at the social security system contribution limit. The results do not change qualitatively, except for specification 5.8. Here, there is a significant negative effect of reunification on wages and a much stronger positive and significant effect of migration on wages. However, the former effect vanishes when restricting the coefficient for migration to zero \((\theta_9 \equiv 0)\). This confirms that the aggregate effect of reunification, including the labor supply shock as well as the labor demand shock (due to the increase in market access), is zero.

16The results are in the appendix.
5.7. Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th></th>
<th></th>
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<tr>
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<td>(0.0045)</td>
</tr>
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<td>(zrg_t × subsidy_t)</td>
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<td>0.0082**</td>
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<td>(0.0040)</td>
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<td>-0.0254***</td>
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<td>(0.0008)</td>
<td>(0.0008)</td>
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<td>*0.1, **0.05, ***0.01</td>
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Table 5.5.: Specification 5.5 for Unemployment

5.7.2. Unemployment

As the aggregate effect of the labor demand shock (due to the increase in market access) and the labor supply shock (due to migrants and commuters from eastern Germany) on regional wages after reunification is zero, the analysis proceeds with the effects on unemployment. As a first approach, specification 5.5 is estimated, although wages \( w_{rt} \) are replaced by the unemployment rate \( u_{rt} \) as the endogenous variable. In the basic specification where migration \( migr_{rt} \) is included, there seems to be a positive and significant effect of reunification on the unemployment rate. However, this effect becomes insignificant when standard errors, as suggested by Bertrand et al. (2004), are used. Nevertheless, the positive effect of migration on the unemployment rate remains. It seems that there was indeed a positive labor supply shock (see Table 5.5).

Specification 5.6 is applied to the unemployment rate \( u_{rt} \) to illustrate the time variation of this effect. These results seem to confirm the results from model u5.5a: starting in 1990, the interactions between the year dummies and border dummy are positive and many of them are significantly so, when excluding migration from the specification (\( \phi_4 \equiv 0 \)). In the model where \( \phi_4 \) is not restricted to zero, the effect of the labor supply shock on the unemployment rate is fully captured by the migration variable \( migr_{rt} \) and no more reflected in the year border interactions, as these interactions become insignificant. However, by adjusting the time period, the results for the year border interaction coefficients again change substantially. It still
### Table 5.6.: Specification 5.6 for Unemployment

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<th>(u5.6b)</th>
<th>(u5.6c)</th>
<th>(u5.6d)</th>
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<td>-0.0021*</td>
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<td>(0.0012)</td>
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<td>(0.0018)</td>
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</tr>
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<td>coef.</td>
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<td>(0.0063)</td>
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<td>(0.0063)</td>
<td>(0.0063)</td>
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<td>0.0131**</td>
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<td>0.1018**</td>
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<td>0.0930***</td>
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<td>0.1030***</td>
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<td>(0.0013)</td>
<td>(0.0013)</td>
<td>(0.0014)</td>
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NT: 3990 3990 4522 4522  
Indiv eff.: yes yes yes yes 
Time eff.: yes yes yes yes 
Rob. s.e. (1) yes yes yes yes 
Sign. lev.: *0.1, **0.05, ***0.01

5. Market Access and Labor Market: Evidence from German Reunification

It seems that the unemployment rate increased in border regions due to reunification when \(\phi_4\) is restricted to zero, although this is hard to distinguish from a potentially different time trend in the border regions compared with the remaining regions (see Table 5.6).
Therefore, specification 5.7 is estimated for the unemployment rate as the endogenous variable to test for diverging trends before reunification. The results show that the time trend in the unemployment rate was different in border regions before reunification (see Table 5.7). To control for these differences in trends between border and non-border regions, specification 5.8 is estimated for the unemployment rate as the endogenous variable. The results confirm that the labor supply shock due to migration had a positive effect on the unemployment rate. However, interestingly, now there is a negative effect of reunification on the unemployment rate in border regions. This shows that the increase in market access due to reunification and the respective labor demand shock significantly reduced the unemployment rate in border regions, when controlling for the labor supply shock. However, this effect is not permanent, as reunification simultaneously led to an increase in the general trend of the unemployment rate in border regions compared with non-border regions (see Table 5.7).

5.7.3. Employment

So far, the results point to a simultaneous positive labor supply and positive labor demand shock, the former due to migration and commuting from eastern Germany and the latter due to the increase in market access. In order to get a full picture of the labor market the analysis proceeds with the effects on employment.

Again, specification 5.5 is first estimated for (log) total employment \( l_{rt} \) as the endogenous variable. Repeating the forthcoming models based on data for full-time male employees qualitatively does not lead to different results.\(^{17}\) The results for all employees show a positive significant effect of migration on employment, indicating that the immigrating and in-commuting labor force from eastern Germany found new employment in border regions. Contrarily, the effect of reunification on employment in border regions (\( \beta_2 \)) is negative and significant. The latter is contra-intuitive to the interpretation of reunification as a simultaneous positive labor supply and positive labor demand shock. However, no significant effect of reunification remains when excluding migration (\( \beta_5 \equiv 0 \)), which indicates that the aggregate effect of the labor supply and demand shock is zero (see Table 5.8).

In order to improve the picture of the effects of reunification, specification 5.6 is estimated for employment as the endogenous variable (see Table 5.9). When controlling for migration, there seems to be a negative effect of reunification on employment in border regions in 1990 and 1991, although this effect vanishes when \( \phi_4 \) is restricted to zero, so that the interaction effects capture both the labor supply and the labor demand shock. When \( \phi_4 \equiv 0 \), there is weak evidence for a positive overall

\(^{17}\)These additional results are in the appendix.
5. Market Access and Labor Market: Evidence from German Reunification

<table>
<thead>
<tr>
<th>Variable</th>
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<th>(u5.8a)</th>
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<td>-0.0043***</td>
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<td>-0.0012***</td>
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<td>(0.0005)</td>
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<td>s.e.</td>
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<td>coef.</td>
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<td>(0.0015)</td>
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<td></td>
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<tr>
<td><strong>time</strong></td>
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<tr>
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<tr>
<td><strong>time eff.</strong></td>
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<tr>
<td><strong>rob. s.e. (1)</strong></td>
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</table>

(1) according to Bertrand et al. (2004)

Table 5.7.: Specifications 5.7 and 5.8 for Unemployment

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<th>15.5b</th>
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<td>coef.</td>
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<td>(0.0131)</td>
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<td>coef.</td>
<td>-0.0009</td>
<td>-0.0127</td>
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<tr>
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<td>(0.0132)</td>
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<td>7.0352***</td>
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(1) according to Bertrand et al. (2004)

Table 5.8.: Specification 5.5 for Employment
5.7. Results

The results presented above point to a simultaneous positive labor supply shock and positive labor demand shock due to reunification. In order to check the robustness of these results, a placebo test is performed and the definition of the treatment group is varied for specification 5.8 for wages, unemployment rate and employment as the endogenous variable. The results tables are in the appendix. In the placebo setting, treatment status is randomly assigned to the regions. Thus, the interaction of the treatment group with the reunification dummy \( \theta_1 \), and the interaction of the treatment group with the reunification dummy and the time trend \( \theta_6 \), should not significantly diverge from zero. Indeed, they do not significantly diverge from zero, which confirms that the results are not spurious.

Further, the definition of treatment (=border region) status is varied by using only first-order neighbors or only regions within a distance of two hours travel time to eastern Germany as border regions. The key results qualitatively do not differ from the above results, pointing to the robustness of the findings. Hence, the results are robust and indicate that there was no effect of reunification on wages, except for
5. Market Access and Labor Market: Evidence from German Reunification

<table>
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<tr>
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<th>15.6c</th>
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</tr>
<tr>
<td>( (d_{1999} \times \text{border}) )</td>
<td>coef.</td>
<td>-0.0569**</td>
<td>-0.0243</td>
<td>-0.0515**</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0223)</td>
<td>(0.0205)</td>
<td>(0.0247)</td>
<td>(0.0227)</td>
</tr>
<tr>
<td>( (z_{rg} \times \text{subsidy}) )</td>
<td>coef.</td>
<td>-0.0071</td>
<td>-0.0194</td>
<td>-0.0070</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0156)</td>
<td>(0.0151)</td>
<td>(0.0170)</td>
<td>(0.0163)</td>
</tr>
<tr>
<td>( m_{\text{igr} r t} )</td>
<td>coef.</td>
<td>0.6911***</td>
<td>0.7538***</td>
<td>0.70128***</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.1920)</td>
<td>(0.2100)</td>
<td>(0.0046)</td>
<td>(0.0047)</td>
</tr>
<tr>
<td>constant</td>
<td>coef.</td>
<td>7.0419***</td>
<td>7.0439***</td>
<td>7.0128***</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0046)</td>
<td>(0.0047)</td>
<td>(0.0048)</td>
<td>(0.0050)</td>
</tr>
</tbody>
</table>

| NT | 3991 | 3991 | 4522 | 4522 |
| indiv. eff. | yes | yes | yes | yes |
| time eff. | yes | yes | yes | yes |
| rob. s.e. (1) | yes | yes | yes | yes |

Table 5.9.: Specification 5.6 for Employment
the effect of migrants and commuters from eastern Germany. However, the latter effect is hard to interpret since it covers the labor supply shock, the location decisions of the migrants and commuters and the composition effect on employees. Further, there was a temporary reduction in unemployment due to reunification, although this effect vanishes over time. Finally, migration and commuting from eastern Germany led to an increase in employment in border regions. The migration variable fully captures the positive effect of reunification on employment, although the general trend of employment in border regions relative to non-border regions declined after reunification.

Additionally, the time period is varied to the years until 1995 for specification 5.8 for wages, unemployment and employment to check the robustness of the results. This is done, because starting 1995, trade agreements with central and eastern European countries were made so that there was an additional market access shock which, however, was weaker than the reunification shock. The shock was weaker because the distance of the border regions of the present sample to the central and eastern European countries is larger than to eastern Germany and because the political and economic integration process was much stronger between the two

<table>
<thead>
<tr>
<th>Variable</th>
<th>15.8a</th>
<th>15.8b</th>
</tr>
</thead>
<tbody>
<tr>
<td>trend_t</td>
<td>0.0125***</td>
<td>0.0125***</td>
</tr>
<tr>
<td>s.e. 0.0007</td>
<td>0.0007</td>
<td></td>
</tr>
<tr>
<td>(trend_t × border_r)</td>
<td>0.0005</td>
<td>0.0005</td>
</tr>
<tr>
<td>s.e. (0.0016)</td>
<td>(0.0016)</td>
<td></td>
</tr>
<tr>
<td>gru_t</td>
<td>0.1064***</td>
<td>0.1346***</td>
</tr>
<tr>
<td>s.e. (0.0098)</td>
<td>(0.0049)</td>
<td></td>
</tr>
<tr>
<td>(gru_t × border_r)</td>
<td>0.0026</td>
<td>0.0485***</td>
</tr>
<tr>
<td>s.e. (0.0168)</td>
<td>(0.0105)</td>
<td></td>
</tr>
<tr>
<td>(gru_t × trend_t)</td>
<td>-0.0135***</td>
<td>-0.0134***</td>
</tr>
<tr>
<td>s.e. (0.0008)</td>
<td>(0.0008)</td>
<td></td>
</tr>
<tr>
<td>(gru_t × border_r × trend_t)</td>
<td>-0.0038**</td>
<td>-0.0045**</td>
</tr>
<tr>
<td>s.e. (0.0018)</td>
<td>(0.0018)</td>
<td></td>
</tr>
<tr>
<td>migr_t</td>
<td>0.7346***</td>
<td></td>
</tr>
<tr>
<td>s.e. (0.2095)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(zrg_r × subsidy_t)</td>
<td>-0.0136</td>
<td>-0.0254*</td>
</tr>
<tr>
<td>s.e. (0.0136)</td>
<td>(0.0133)</td>
<td></td>
</tr>
<tr>
<td>subsidy_t</td>
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<td>0.0032</td>
</tr>
<tr>
<td>s.e. (0.0030)</td>
<td>(0.0030)</td>
<td></td>
</tr>
<tr>
<td>NT</td>
<td>4522</td>
<td>4522</td>
</tr>
<tr>
<td>indiv. eff.</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>time eff.</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>rob. s.e. (1)</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

Table 5.10.: Specification 5.8 for Employment
German states than the integration process between western Germany and central and eastern Europe. The results are presented in Table C.5 in the appendix. They do not change qualitatively for wages and unemployment and hence are robust. However, the employment effects of reunification on border regions are insignificant in the shorter time period which indicates that the employment adjustment process took place much slower than the adjustment processes of wages and unemployment; a similar result has been presented by Brülhart et al. (2012) for the case of Austria.

Therefore, the results are in favor of a simultaneous positive labor demand and labor supply shock. A labor demand shock leads to increasing wages, decreasing unemployment and increasing employment. Contrarily, a labor supply shock leads to decreasing wages, increasing unemployment and increasing employment. The results show that on aggregate wages did not change, whereas employment increased and unemployment decreased in the short run. Hence, the increase in labor demand was absorbed by the increase in labor supply due to the immigration and in-commuting from eastern Germany, so that no effect on wages remained. However, the positive effects on employment and negative effects on unemployment are only temporary. This points to only a temporary labor demand shock. The labor demand shock, induced by an increase in market access, might be temporary, as in the aftermath of reunification the former socialist eastern German economy collapsed, leading to emigration and a decline in income. This emigration and decline in income potentially (partly) reduced the former increase in market access in border regions.

The results presented above confirm the positive labor supply shock found by Büttner and Rincke (2007), although controls for the relevant violations of the common trend hypothesis are included. In contrast to them, the results presented here also show evidence in favor of a positive labor demand shock, as induced by the increase in market access, although this effect seems to be temporary.

In their survey of integration effects in border regions, Niebuhr and Stiller (2004) conclude that no clear evidence exists on whether border regions benefit or lose out from the integration. The results presented above suggest that this might be caused by the fact that opening borders results in more than one shock. In the case of German reunification, the effects of the increase in market access on wages are alleviated by labor supply adjustments and the labor supply shock. This shows that interpreting the results of an integration process as a single shock on a single variable might be misleading. Historical events such as German reunification remain attractive as natural experiments, but the multitude of shocks should be taken into consideration to identify the effects of interest.
5.8. Conclusions

The wage equation, a core element of the NEG, predicts a positive effect of market access on wages. However, market access itself depends on wages, meaning that endogeneity is a key issue in empirical applications to the wage equation. Whereas most studies rely on instruments to cope with this endogeneity, the present analysis relies on German reunification as an exogenous variation of market access. Owing to the opening of the border, former border regions gained new trading partners in eastern Germany, leading to an increase in market access. This is reflected in a labor demand shock. However, this labor demand shock was accompanied by a labor supply shock since significant numbers of eastern Germans entered the western German labor market as migrants or commuters.

This analysis estimates the effects of these shocks on wages, unemployment and employment in the aftermath of reunification in order to draw a picture of the reaction of the labor market to these shocks. The results show that there was no aggregate effect on wages, whereas unemployment temporarily decreased and employment temporarily increased in border regions relative to non-border regions. This is in line with the interpretation of reunification as a simultaneous positive labor demand and labor supply shock. The expansion of labor demand in border regions, because of their enlarged market access led to upward pressure on wages and employment, but downward pressure on unemployment. Contrariwise, the labor supply shock put downward pressure on wages, but upward pressure on employment and unemployment in border regions. In the case of German reunification, the aggregate effect on wages was zero, whereas employment temporarily expanded and unemployment temporarily declined. The results of the employment regressions further suggest that the expansion of labor demand was absorbed by the increase in labor supply, which explains why the aggregate effect on wages was zero.

Additionally, this analysis provides an example why the aggregate effects of integration processes on border regions are often ambitious, as for example found by Niebuhr and Stiller (2004): integration processes can imply multiple shocks, meaning that the effects on a single outcome variable might be hard to identify. By drawing a more encompassing picture of the market under shocks, researchers might disentangle shocks from one another.
6. Conclusions

6.1. The Contribution of this Thesis

This thesis is concerned with two central questions:

- How do disparities between regional labor markets arise?
- Why are these disparities so persistent?

The thesis builds on the New Economic Geography (NEG) to analyze how disparities between regional economies arise endogenously, and introduces wage-setting frictions based on efficiency wages to discuss how this is accompanied by and interrelated with regional labor market disparities. Chapters 2 to 4 introduce theoretical models to discuss this interrelationship, and Chapter 5 presents empirical results for the relevance of NEG arguments for regional labor market disparities.

Chapter 2 introduces the basic theoretical framework of this thesis. It combines the core-periphery model of Fujita et al. (1999) with the efficiency wage framework of Shapiro and Stiglitz (1984). Francis (2007) has independently presented a comparable approach, combining the same elements. The model in Chapter 2 is intended as the basic framework for this thesis. It shows how and under what conditions economic activity endogenously agglomerates in the core through the interplay of increasing returns to scale, monopolistic competition, transport costs and migration.

The basic arguments of the model are that firms have an incentive to locate close to large markets, whereas workers have an incentive to locate at places where the labor market conditions are better and the real wage is higher. This implies that firms move to places where there are more people, and that people move to places where there are more firms, which leads to the endogenous agglomeration of people, firms, and economic activity. Due to wage-setting frictions, this process is accompanied by lower unemployment in the core than in the periphery.

However, since the model relies on the core-periphery model of Fujita et al. (1999) and no additional centrifugal forces exist, there is either perfect symmetry in both regions or full agglomeration in one region. The labor market disparities are then arbitrary since they are measured between a full agglomeration and an empty periphery. Hence they are measured by comparing the wage and unemployment
6. Conclusions

rate in the agglomeration to the wage and unemployment rate that would prevail in the periphery should a single worker emigrate to the periphery. The model is therefore only intended as a basic framework, whereas Chapters 3 and 4 build on this framework to discuss regional labor market disparities.

Chapter 3 introduces congestion externalities into the basic framework. These externalities prevent a full agglomeration of economic activity in the agglomeration, so that either symmetry or partial agglomeration results. The key idea proposed in the model is that, due to the centripetal and centrifugal forces from the basic framework, economic activity agglomerates in the core. Firms in the agglomerated core can serve a larger market, so that they are able to pay higher wages. Due to efficiency wages, higher wages in the agglomeration are associated with lower shirking, so that firms hire more workers and the unemployment rate is lower in the agglomeration than in the (non-empty) periphery.

The partial agglomeration is stable when people do not have any incentive to migrate. In the model from Chapter 2 this was impossible, since the higher wages in the agglomeration are associated with lower unemployment there, so that the expected life-time utility was always higher in the agglomeration, assuming that the centripetal forces were strong enough. In the model from Chapter 3, agglomeration is accompanied by congestion externalities. Since more people and more firms are concentrated within a single region, congestion such as traffic jams, higher housing prices or pollution provide incentives to leave the core. Then the higher congestion externalities in the core must be compensated through higher wages and lower unemployment if the agglomeration is to be stable. Through this interdependency, only partial agglomerations emerge, and disparities between non-empty regional labor markets can arise. The results from the model show that it is not only the centripetal and centrifugal forces (resulting from the NEG part of the model) which are important for regional labor market disparities. Instead, the degree of wage-setting frictions also affects the level of disparities. When wage-setting frictions increase, this leads to an increase in labor market disparities, which further reinforces the disparities between the regional economies.

Whereas most other models combining the NEG with labor market frictions rely on job-matching frictions, the model from Chapter 3 relies on frictions in wage-setting based on efficiency wages. The intention is not to argue that efficiency wages are the only mechanism at work. Rather, the relevance of wage-setting frictions for regional labor market disparities should be highlighted. The empirical literature suggests that efficiency wages are indeed relevant. Furthermore, the model adds to the literature by showing the interrelationship of labor market frictions with the agglomeration process, with the disparities between the regional economies, and with the disparities between the regional labor markets.
Chapter 4 introduces monocentric cities into the basic framework from Chapter 2. The monocentric cities framework is an explicit way to model congestion externalities in the regions. The regions are constructed as cities with a central business district (CBD). People commute to the CBD of their region to work or to search for work. Commuting consumes time, which motivates the congestion externalities, because commuting time increases as the city grows. People also migrate from one region to another depending on their expected life-time utilities. Again, through the centripetal and centrifugal forces of the NEG part of the model, wages are higher in the agglomeration due to higher market access. However, the unemployment rate now might be higher or lower in the agglomeration than in the periphery, depending on the relative strength of the centripetal and centrifugal forces, and the commuting costs.

The model adds to the literature as it presents a link between the Harris and Todaro (1970) model and the wage curve literature. The literature following the Harris-Todaro model suggests that there is a positive link between unemployment and wages in the migration equilibrium. This is because in the migration equilibrium, higher wages in the agglomeration must be compensated for by higher unemployment, since otherwise migration would occur and the system would not be in equilibrium. On the contrary, the empirically dominated wage curve literature finds a negative correlation between unemployment and wages. Therefore the wage curve literature is often seen as a refutation of the Harris-Todaro model.

The model from Chapter 4 presents a link between the two literatures by showing the conditions under which higher wages in the agglomeration are associated with higher or lower unemployment. The key argument is that the wage curve of a region shifts when the commuting costs change, because commuting alters the incentive to shirk which lies at the core of the wage curve relationship, due to efficiency wages. Whether the unemployment rate is higher or lower in the agglomeration than in the periphery then depends on the strength of the centripetal and centrifugal forces, represented by the wage differential between the regions, and on the size of the commuting externalities.

The model further adds to the literature by highlighting the relevance of control variables for the degree of agglomeration or for the strength of congestion externalities, as represented by commuting costs, in empirical wage curve analyses. Such control variables have been included in only a few empirical applications of the wage curve. Additionally the model adds to the literature by showing the conditions under which the agglomeration of economic activity can be associated with higher unemployment in the agglomeration than in the periphery, whereas most other models combining labor market frictions with the NEG usually just include lower unemployment in the agglomeration.
6. Conclusions

Finally, Chapter 5 presents empirical evidence in favor of the arguments presented in the theory. The empirical analysis focuses on the effect of market access, as the core element of the NEG models used here, on the regional labor markets. The effect of market access on regional economies has usually been estimated in the literature through the wage equation. The wage equation is the key element of the core-periphery model, which is used here as well. It predicts a positive effect of market access on wages. However, as market access itself depends on wages, endogeneity results. Most of the approaches in the literature rely on instruments to identify the effects of market access on wages. Here, instead, German reunification is used as an exogenous variation of market access to identify its effect on wages. The effect of the market access shock on wages basically reflects a labor demand shock. However, this labor demand shock was accompanied by a labor supply shock during German reunification, due to the significant numbers of migrants and commuters from Eastern Germany.

Chapter 5 takes the simultaneity of shocks into account by estimating the effects on the whole labor market. Focusing on wages, unemployment, and employment, the results show a picture of the overall effects on the labor market. This renders it possible to separate the labor demand and labor supply shocks from each other. The results then show that German reunification led to a positive labor demand shock and to a positive labor supply shock. The labor demand shock is due to the increase in market access, highlighting the relevance of the NEG arguments for regional labor markets. The labor supply shock is due to the migrants and commuters from Eastern Germany.

The results of Chapter 5 add to the literature by showing the effect of market access on regional labor markets. They rely on an exogenous variation of market access, whereas most other approaches rely on instruments to cope with the endogeneity. They add to an article by Büttner and Rincke (2007), who analyze the labor supply shock of the reunification. Büttner and Rincke use a Differences-in-Differences approach to estimate the effects, although the results from Chapter 5 show that for some of the endogenous variables the underlying common trend hypothesis is violated. The analysis in Chapter 5 controls for these violations, and finds that the labor supply shock is still visible, although it is accompanied by a labor demand shock, as described above.

6.2. Policy Implications

The NEG has been predominantly theoretical for many years, since its introduction through the core-periphery model by Krugman (1991). Empirical work on the NEG, however, is still less developed than the theoretical work, and this was, for
6.2. Policy Implications

example, stressed by Redding (2010) in his recent survey on NEG empirics. Policy implications of the NEG were also largely lacking until the publication of the excellent textbook by Baldwin et al. (2003). Baldwin et al. (2003) present the first comprehensive treatise of NEG policy implications. A more recent summary of how to draw policy implications from the NEG, especially from NEG empirics, has been presented by Combes (2011). Combes presents a somewhat pessimistic, but at the same time forward-looking picture of the policy implications of the NEG:

In the end, we know little and so many dimensions are ignored from current analysis that little advice can be given to policy-makers. But the glass is also half-full. (Combes; 2011, p. 590)

The glass is indeed at least not empty because Baldwin et al. (2003) have already presented the policy implications of the NEG for trade policy, tax policy and regional policy. Since the publication of their book, the empirical NEG literature has grown, and the more recent survey of Combes (2011) can rely on a noticeable body of empirical results. Combes hence concludes that – despite the size of the research gap that needs to be filled – NEG empirics already delivers a wide range of policy implications.

The policy implications of this thesis should therefore be interpreted against the background of a body of NEG literature whose policy implications are still incomplete and developing. The policy implications of this thesis – which is largely based on the NEG, and the primary objective of which is to extend the NEG literature to imperfectly functioning labor markets – must necessarily remain limited, as well.

The key message of this thesis is that the agglomeration of economic activity matters for regional labor market disparities. This has been discussed in the theory of Chapters 2 to 4. Chapter 5 presents empirical results for the relevance of these arguments. Actually, the results from Chapter 5 only point to a short-term effect of market access on labor demand. However, this might be due to the fact that the increase in market access was due to there being potential new trading partners in Eastern Germany, where the economic situation significantly worsened during the post-unification period, so that the initial gain in market access potentially soon declined.

Hence regional labor market policy can learn by taking into account the results of the NEG literature. The policy implications presented here therefore rely on the policy implications of the NEG, summarized by Combes (2011), and they extend Combes’ implications to regional labor markets based on the results from this thesis.

A key result of NEG empirics, and the empirics of the economics of agglomerations in general, is the positive effect of density on productivity. This result also
holds when controlling for endogeneity or the composition of the labor force. However, little is known about how policy makers can set incentives to increase density. Moreover, the estimation of the effects of density on productivity implicitly assumes that the congestion externalities remain constant (Combes; 2011). This finding of Combes is especially relevant in the current case, as is obvious from the discussion on the relevance of congestion costs and commuting costs in Chapters 3 and 4. When it is not clear from an empirical point of view how to set incentives to immigrate (and in particular, when the size of the effects are unknown), or how immigration affects congestion externalities, little can be said about how policy makers can increase density and how this might affect welfare.

The models from Chapters 3 and 4 imply that a reduction in congestion externalities and in commuting costs sets incentives to migrate to the agglomeration, which will result in higher productivity and better labor market outcomes in the agglomeration. However, the models also imply that this comes at costs to the periphery. Furthermore, a full analysis of the overall welfare effects is lacking both in the theoretical literature and in the empirical literature. Whether the economy gains as a whole from such policies therefore remains unclear.

The models presented here can only give advice to policy makers about the mechanisms at work, but cannot give advice on how overall welfare is affected. Even the size of the effects of the mechanisms is only known for the effects of density on productivity, but not for the effects of migration incentives. Chapter 5 presents evidence about the size of the effects of market access on labor market outcomes, although the analysis refers to the specific situation of German reunification, and more research is necessary to analyze whether the effects are similar in less extraordinary situations.

A further key result of NEG empirics is the positive effect of market access on wages and productivity. Chapter 5 adds to these results by using German reunification as an exogenous variation of market access to cope with the endogeneity issues, and further extends the results of previous studies to a broader assessment of the effects on the labor market. The basic result from Chapter 5 is that market access positively affects labor demand. Hence increasing market access positively affects wages and employment, and it further reduces unemployment.

However, the question remains of how policy makers can increase market access. There are basically two options, the first being an increase in density in nearby regions, and the second being a reduction in transport costs. The first is plagued by the same simultaneity problems as discussed above. The second, reducing trans-

\[1\] A reduction in congestion externalities could be achieved, for example, through an improvement in the transport infrastructure, a reduction in environmental externalities, or an increase in the housing supply.
6.2. Policy Implications

Port costs, seems to be less problematic. Policy makers can reduce transport costs through infrastructure investments, for example. However, the financing of such investments is not part of the models. Further, the reduction of transport costs affects all regions and the location choices of all agents, whereas in empirical applications the impact of a reduction in transport costs or of an increase in market access is evaluated ceteris paribus (Combes; 2011).

The results of Chapter 5 are somewhat more general as they take the effects of labor supply into account and therefore at least partly cover location choices. Nevertheless, in order to derive policy implications one would need to estimate the location choices of all agents at the same time as the effects of market access on productivity, wages, or labor market outcomes in general (Combes; 2011). Therefore it again remains unclear whether policy makers should try to increase market access, because the overall welfare effects are unclear. The results presented in the literature, as well as the results presented here, only deliver estimates for individual effects, although the present thesis provides a broader view of labor market effects. The results from Chapter 5 show that the increase in market access had a positive effect on labor demand, although this was only a short-term effect. Policy makers therefore might be tempted to affect market access positively through decreasing transport costs. However, this affects the location decisions of all agents in the agglomeration and in the periphery, and simultaneity issues arise, as highlighted in Chapters 2 to 4. No general conclusion is possible on how such a policy affects overall welfare.

The basic conclusion from the discussion of the policy implications of this thesis is therefore that the results from the NEG literature are important for regional labor market disparities, and that a full assessment of the welfare effects of regional policies is still lacking. Regional labor market policy can learn from the NEG literature. The results presented here can help to understand the underlying mechanisms, but for a full assessment of specific regional labor market policies one needs an assessment of the equity-efficiency trade off. In particular, policy makers need to take into account the effects of their policies not only in the region where the policy is implemented, but also in the surrounding regions, as well as the dynamic effects through location decisions and their respective effects on the objective variables.

Combes (2011) argues that, so far as the policy implications of the NEG are concerned, the glass is half full. The present thesis shows that some of this half full glass can be used for regional labor market policy. There is still plenty of room for further research in this field.
6. Conclusions

6.3. Areas for Further Research

From the discussion about policy implications it becomes clear where future research is necessary: more empirical results are needed to get estimates about the sizes of the mechanisms at work. This thesis provides a discussion of how the NEG can be extended to the labor market in order to discuss how disparities between regional labor markets arise and why they are persistent. Empirical results are also provided. Still, many questions remain unresolved, and there is a huge amount of work to be done in order to give more detailed advice to policy makers about how specific policies affect regional labor markets. In particular, more studies are needed to estimate the overall welfare effects of specific policies, taking into account the numerous simultaneity issues including the location decisions of all agents.

Against the background of the current thesis, a fruitful approach might be to estimate a simultaneous spatial system of two equations, the wage equation and the wage curve. The wage curve represents labor market frictions in terms of efficiency wages, whereas the wage equation represents labor demand derived from the NEG framework. This system is spatially interdependent through the wage equation which states that wages respectively productivity in a region depend on wages and employment in all other regions. Kelejian and Prucha (2004) derived a spatial simultaneous equation estimator, which might be applicable to such an approach. Nevertheless, the researcher would need to reduce the NEG part of the model to a single wage equation for each region. Although there are examples in the literature of how to reduce NEG models to a single equation framework, as discussed in Chapter 5, these are restricted to the case of perfectly functioning labor markets with zero unemployment. One would therefore need to derive a single wage equation in a much more complex model with imperfect labor markets. Furthermore, the reduction of the NEG part of such a model usually relies on the exclusion of certain equilibrium conditions so that the empirical model includes the assumption that some adjustment processes are absent. Then, however, the empirical results again do not represent the overall effects of a policy.

The models presented in this thesis can be further applied to other aspects of regional labor market policy. For example, in the literature it is sometimes argued that the social insurance system works as a regional redistribution policy. Contributions to pension insurance and unemployment insurance are linked to income, so that they are higher in economically leading regions. Expenditures in the unemployment insurance system are, instead, especially high in regions that face a depressed labor market situation. In Germany, for example, the volume of redistribution on the federal level due to the pension and unemployment insurance systems is larger than the volume of redistribution due to the German Länder fiscal equalization scheme (Länderfinanzausgleich) between the federation and the federal states.
6.3. Areas for Further Research

(Koller et al.; 2003). Hence, social insurance systems play an important role for regional redistribution in Germany. Several studies deal with this aspect and calculate the financial volume of redistribution due to social insurance systems in Germany and other countries.²

The social insurance system is actually already implemented in the model in Chapter 4. By adjusting the social insurance system in this model one could analyze the effects of this redistribution on regional labor market disparities. Intuitively, one would question from the model whether the periphery, as the economically backward region, gains from redistribution through the social insurance system. This is because one has to take into account the effects of the social insurance system on the regional work incentives in the periphery. As the break-even point for firms is lower in the periphery, they are less likely to pay wages above the reservation wage,³ so that unemployment is more strongly affected by the social insurance system in the periphery than in the agglomeration. The social insurance system might then increase regional labor market disparities rather than reduce them.

To sum up, there is still plenty of room for further research on the interrelationship between the NEG and labor market frictions. Concerning policy implications in particular, more empirical results on the overall effects of policies are needed to provide better advice to policy makers about how they can influence regional labor market disparities.

²In Germany, the IAB estimated the financial volume of regional redistribution due to the social insurance systems (Blos; 2006). Bruckmeier and Schwengler (2010) deliver further results. Disney (1984) presents results for the unemployment insurance system of the United Kingdom, and Stoffelsma and Oosterhaven (1989) analyze the regional financial flows of social insurance systems in the Netherlands. Hansen and Jensen-Butler (1996) deliver empirical results for the regional economic impact of financial redistribution through the social insurance systems in Denmark.

³In terms of efficiency wage models, the likelihood of firms paying wages high enough to prevent shirking is lower in the periphery.
A. Appendix to Chapter 3

A.1. Definition of the Break Point

To calculate the break point, \( \lambda \) is set to 0.5 and the fact that all endogenous variables are equal in both regions is utilized. Furthermore, a positive change in one variable in a region is equal to a negative change in the same variable in the other region. Therefore the system can be expressed in units of region \( r \), and the index for regions is dropped. Consequently, the break point is expressed by the system of equations A.1 to A.13,

\[
P = \left[ \frac{1 + \tau^{1-\theta}}{\mu} \left( Lw^{1-\theta} \right) \right]^{1/(1-\theta)}, \quad (A.1)
\]

\[
w = \left[ (1 + \tau^{1-\theta})YP^{\theta-1} \right]^{1/\theta}, \quad (A.2)
\]

\[Y = wL + LA, \quad (A.3)
\]

\[w = \frac{P^\mu e}{K} \left( \rho + \psi + \delta + 1 - \gamma \right), \quad (A.4)
\]

\[\delta = \frac{\psi L}{\mu \lambda - L}, \quad (A.5)
\]

\[H = h^{1 - \frac{\lambda}{\mu}}, \quad (A.6)
\]

\[
dP = \frac{P^\theta (1 - \tau^{1-\theta})}{\mu} \left[ \frac{w^{1-\theta}}{1 - \theta} dL + Lw^{-\theta} dw \right], \quad (A.7)
\]

\[
dw = \frac{w^{1-\theta} P^{\theta-1} (1 - \tau^{1-\theta})}{\theta} \left[ dY + (\theta - 1)Y \frac{dP}{P} \right], \quad (A.8)
\]

\[dY = wdL + Ldw, \quad (A.9)
\]

\[dw = \mu w P dP + \frac{P^\mu e}{K} \frac{1}{1 - \gamma} d\delta \quad (A.10
\]
A. Appendix to Chapter 3

\[
d\delta = \frac{\mu \psi}{(\mu \lambda - L)^2} (\lambda dL - L d\lambda), \quad (A.11)
\]

\[
d\frac{M}{2} = 0 = \frac{\delta}{\rho + \psi + \delta} \left[ w \frac{K}{P^{1+\mu}} \right] dH + \frac{HK}{P^{1+\mu}} d\delta + \frac{\rho + \psi}{(\rho + \psi + \delta)^2} \frac{H}{P^{1+\mu}} d\delta,
\]

\[
dH = -\frac{1}{(1 - \lambda)^2} H \ln(h) d\lambda. \quad (A.13)
\]

A.2. Definition of the Sustain Point

The sustain point is defined by the equilibrium conditions 3.6, 3.13, 3.16 and the definition of income \( Y_r = w_r L_r + (1 - \mu)/2 \) for region \( r \) (and for region \( s \) in the same way), the definition of the congestion costs 3.2 and 3.3, the no-migration condition 3.17, and the derivative of the system with respect to \( \lambda \). Only the derivative for region \( r \) is presented here, but the equations for region \( s \) are calculated in the same way.

\[
dP_r = \frac{P^{1-\theta} r}{\mu} \left[ \frac{w_r^{1-\theta}}{1-\theta} dL_r + \frac{L_r}{w_r} d\omega_r + \frac{(w_s \tau)^{1-\theta}}{1-\theta} dL_s + \frac{L_s^{1-\theta}}{w_s} d\omega_s \right], \quad (A.14)
\]

\[
dw_r = \left( \frac{w_r}{P_r} \right)^{1-\theta} \frac{1}{\theta} \left[ dY_r + (\theta - 1) \frac{Y_r}{P_r} dP_r \right] + \left( \frac{w_s}{P_s} \right)^{1-\theta} \frac{\tau^{1-\theta}}{\theta} \left[ dY_s + (\theta - 1) \frac{Y_s}{P_s} dP_s \right], \quad (A.15)
\]

\[
dY_r = w_r dL_r + L_r d\omega_r, \quad (A.16)
\]

\[
d\omega_r = \mu w_r dP_r + \frac{P^{1+\mu} r}{K} \frac{e}{1 - \gamma} d\delta_r, \quad (A.17)
\]

\[
dH_r = -\frac{1}{(1 - \lambda)^2} \ln(h) H_r d\lambda, \quad (A.18)
\]

\[
d\delta_r = \frac{\mu \psi}{(\mu \lambda - L_r)^2} (\lambda dL_r - L_r d\lambda), \quad (A.19)
\]
A.3. Frictions and Disparities

Labor market frictions are characterized by the parameters $e$, $\rho$, $\gamma$ and $\psi$. When these parameters increase, frictions increase. These parameters are only included in the wage curve, but they do not appear in the equations for the goods market equilibrium, so they influence the goods market only indirectly through their effects on the wage curve. The wage at which firms reach their break-even point, results from the goods market. Until this point is reached, new firms enter the market. Therefore unemployment adjusts, until the break-even point (and its corresponding wage) is reached. Therefore the primary influence of labor market frictions is only on the unemployment rate, whereas the break-even point, and its corresponding wage, changes in reaction to the changes in the unemployment rate. Thus the real wage is fixed if one looks only at the wage curve. The same is true for migration. Thus the wage curve is reformulated as

$$\frac{v(w_r)}{H_r} = e \left( 1 + \frac{\rho + \psi}{1 - \gamma} \right). \quad (A.21)$$

The same holds true for region $s$. It is further known from the arguments above that

$$d \left( \frac{v(w_r)}{H_r} \right) = 0 \text{ and } d \left( \frac{v(w_s)}{H_s} \right) = 0. \quad (A.22)$$

Then changes in the labor market frictions lead to changes in the unemployment rate which are larger for regions where the unemployment rate is higher,

$$dU_r = \left( \frac{U_r^2 \rho}{e \psi} + \frac{U_r}{e} + \frac{U_r^2 (1 - \gamma)}{e \psi} \right) de, \quad (A.23)$$

$$dU_r = \frac{d\rho}{\psi} U_r^2, \quad (A.24)$$
A. Appendix to Chapter 3

\[ dU_r = \frac{d\psi}{\psi} U_r, \]  \hspace{5cm} (A.25)

\[ dU_r = d\gamma \left( \frac{\rho U_r^2}{\psi (1 - \gamma)} + \frac{U_r}{1 - \gamma} \right). \]  \hspace{5cm} (A.26)

Hence, the primary effect of increasing frictions (which occur through the wage curve) is to exaggerate disparities. The increasing disparities then spur migration from the periphery to the agglomeration, which further exaggerates disparities through its effect on the goods market.

A.4. Additional Simulations for Frictions

More simulation results for variations of the labor market parameters are presented below. These are based on the parameter constellations of Figure 3.5 (see Table 3.1). The numbers for the variations of the individual labor market parameters are indicated in the figures. In the case of the figures for the unemployment disparities, the congestion parameter \( h \) is 1.04.
A.4. Additional Simulations for Frictions

(a) Frictions and Disparities

(b) Frictions and Stability

Figure A.1.: Frictions, Disparities, and Stability for Variations of $\psi$
A. Appendix to Chapter 3

Figure A.2.: Frictions, Disparities, and Stability for Variations of $\gamma$
A.4. Additional Simulations for Frictions

(a) Frictions and Disparities

(b) Frictions and Stability

Figure A.3.: Frictions, Disparities, and Stability for Variations of $\rho$
B. Appendix to Chapter 4

B.1. Short-term Equilibrium

The equations for the short-term equilibrium are now presented for region \( r \). Analogous expressions hold for region \( s \). In the forthcoming equations, \( N_r = \mu \lambda \) and \( N_s = \mu (1 - \lambda) \), as described in Section 4.4.4,

\[
P_r = \left[ \frac{1}{\mu} (S_r w_r^{1-\theta} + S_s (\tau w_s)^{1-\theta}) \right]^{\frac{1}{1-\theta}},
\]
(B.1)

\[
w_r = \left[ Y_r P_r^{\theta-1} + Y_s P_s^{\theta-1} \right]^{\frac{1}{\theta}},
\]
(B.2)

\[
Y_r = (1-t) w_r S_r + w_0 (N_r - L_r) - \frac{1}{2} \alpha \chi w_0 (N_r^2 - L_r^2) + \frac{1-\mu}{2},
\]
(B.3)

\[
\delta_r = \psi \frac{L_r}{N_r - L_r},
\]
(B.4)

\[
S_r = L_r (1 - 0.5 \chi L_r),
\]
(B.5)

\[
w_r = \left( \frac{P_r^\mu}{K} e \rho + \psi + \delta_r + 1 - \gamma + (1 - \alpha) \chi L_r w_0 \right) \frac{1}{(1 - \chi L_r)(1 - t)},
\]
(B.6)

\[
\rho V_r^0 = KP_r^{-\mu} (1 - \alpha) \chi N_r w_0
\]

\[
+ \frac{\delta_r}{\rho + \psi + \delta_r} \left[ KP_r^{-\mu} ((1 - \chi L_r)(1 - t) w_r - (1 - \alpha) \chi L_r w_0) - e \right],
\]
(B.7)

\[
t(w_r S_r + w_s S_s) = w_0 (N_r + N_s - L_r - L_s).
\]
(B.8)
B. Appendix to Chapter 4

B.2. Sustain Point

Based on the short-term equilibrium above, it is easy to derive the sustain point. The sustain point is the point at which $\lambda = 1$, so that $N_r = \mu$, $N_s = 0$, $L_s = 0$, $S_s = 0$ and $V_r^0 = V_s^0$, as described in Section 4.6. In the simulations of appendix B.4, the restriction $V_r^0 = V_s^0$ is not included, but instead $V_r^0 - V_s^0$ is calculated in the $(\tau, \chi)$-space.

\[
P_r = \left[ \frac{1}{\mu} S_r w_r^{1-\theta} \right]^{\frac{1}{1-\theta}},
\]  \hspace{1cm} (B.9)

\[
P_s = \left[ \frac{1}{\mu} S_s (\tau w_r)\right]^{\frac{1}{1-\theta}},
\]  \hspace{1cm} (B.10)

\[
w_r = \left[ Y_r P_r^{\theta-1} + Y_s P_s^{\theta-1} \tau^{1-\theta} \right]^{\frac{1}{\theta}},
\]  \hspace{1cm} (B.11)

\[
w_s = \left[ Y_s P_s^{\theta-1} + Y_r P_r^{\theta-1} \tau^{1-\theta} \right]^{\frac{1}{\theta}},
\]  \hspace{1cm} (B.12)

\[
Y_r = (1-t)w_r S_r + w_0(N_r - L_r) - 0.5\alpha\chi w_0(N_r^2 - L_r^2) + \frac{1-\mu}{2},
\]  \hspace{1cm} (B.13)

\[
Y_s = \frac{1-\mu}{2},
\]  \hspace{1cm} (B.14)

\[
\delta_r = \frac{\psi L_r}{N_r - L_r},
\]  \hspace{1cm} (B.15)

\[
S_r = L_r(1 - 0.5\chi L_r),
\]  \hspace{1cm} (B.16)

\[
w_r = \left[ (1-\alpha)\chi L_r w_0 + \frac{P_r}{K} \rho + \psi + \delta_r + 1 - \gamma \right] \frac{1}{(1-\chi L_r)(1-t)},
\]  \hspace{1cm} (B.17)

\[
w_s = \left[ (1-\alpha)\chi L_s w_0 + \frac{P_s}{K} \rho + \psi + \delta_s + 1 - \gamma \right] \frac{1}{(1-\chi L_s)(1-t)},
\]  \hspace{1cm} (B.18)

\[
\rho V_r^0 = K P_r^{-\mu}(1-\alpha)\chi N_r w_0 + \frac{\delta_r}{\rho + \psi + \delta_r} \left[ K P_r^{-\mu} ((1-\chi L_r)(1-t)w_r - (1-\alpha)\chi L_r w_0) - \epsilon \right],
\]  \hspace{1cm} (B.19)

\[
\rho V_s^0 = K P_s^{-\mu}(1-\alpha)\chi N_s w_0 + \frac{\delta_s}{\rho + \psi + \delta_s} \left[ K P_s^{-\mu} ((1-\chi L_s)(1-t)w_s - (1-\alpha)\chi L_s w_0) - \epsilon \right],
\]  \hspace{1cm} (B.20)

\[
t(w_r S_r + w_s S_s) = w_0(N_r + N_s - L_r - L_s).
\]  \hspace{1cm} (B.21)
B.3. Break Point

The break point is the point at which the symmetry is stable at the margin, i.e. where the regional system is in symmetry ($\lambda = 0.5$) and people neither gain nor lose utility by emigrating. It is thus defined by the situation where the derivative of the difference in expected life-time utilities between the two regions with respect to $\lambda$ is exactly zero ($dV_r^0 - dV_s^0 = 0$). Since the regional system is in symmetry at the break point, one can exploit this symmetry by dropping the indexes $r$ and $s$ for the regions. This is because the levels of the variables are equal in both regions, and thus the change in the variables share the same absolute value but differ in the sign as long as one considers a marginal deviation from symmetry, such as by calculating the derivative with respect to $\lambda$. Subsequently, the indexes are dropped and all variables are expressed in units of region $r$. Since $N_r = \mu \lambda$, it is obvious that $dN_r = \mu d\lambda$ and since $\partial t/\partial \lambda = 0$, $dt$ is excluded.

\[ P = \left[ \frac{1}{\mu} Sw^{1-\theta}(1 + \tau^{1-\theta}) \right]^{\frac{1}{1-\theta}}, \]  \hfill (B.22)

\[ w = \left[ YP^{\theta - 1}(1 + \tau^{1-\theta}) \right]^\frac{1}{\theta}, \]  \hfill (B.23)

\[ Y = (1 - t)wS + w_0(N - L) - 0.5\alpha \chi w_0(N^2 - L^2) + \frac{1 - \mu}{2}, \]  \hfill (B.24)

\[ w = \left[ \frac{P^\mu}{K} e^\frac{\rho + \psi + \delta + 1 - \gamma}{1 - \gamma} + (1 - \alpha)\chi Lw_0 \right] \frac{1}{(1 - \chi L)(1 - t)}, \]  \hfill (B.25)

\[ \delta = \frac{\psi L}{N - L}, \]  \hfill (B.26)

\[ \rho V^0 = K P^{-\mu}(1 - \alpha)\chi N w_0 \]  
\[ + \frac{\delta}{\rho + \psi + \delta} \left[ K P^{-\mu} ((1 - \chi L)(1 - t)w - (1 - \alpha)\chi Lw_0) - e \right], \]  \hfill (B.27)

\[ S = L(1 - 0.5\chi L), \]  \hfill (B.28)

\[ t = w_0 \frac{N - L}{wS}, \]  \hfill (B.29)
B. Appendix to Chapter 4

(B.30) \[ dP = \frac{1}{\mu} (1 - \tau^{1-\theta}) P^{\theta} \left( \frac{w^{1-\theta}}{1 - \theta} dS + S w^{-\theta} dw \right) , \]

(B.31) \[ dw = \frac{1}{\theta} (1 - \tau^{1-\theta}) P^{\theta-1} w^{1-\theta} \left( dY + Y(\theta - 1) \frac{dP}{P} \right) , \]

(B.32) \[ dY = (1 - t)(Sdw + wdS) + w_0(dN - dL) - w_0 \alpha \chi(NdN - LdL) , \]

(B.33) \[ dw = \left( w - \frac{(1 - \alpha)w_0 \chi L}{(1 - \chi L)(1 - t)} \right) \mu \frac{P^{\mu}}{P} + \frac{P^{\mu}}{K(1 - \chi L)(1 - t)} d\delta \]

\[ + \frac{(1 - \alpha)\chi w_0}{(1 - \chi L)(1 - t)} dL + w \left( \frac{\chi dL}{1 - \chi L} - \frac{dt}{1 - t} \right) , \]

(B.34) \[ d\delta = \frac{\psi}{(N - L)^2} (NdL - LdN) , \]

(B.35) \[ \rho dV^0 = KP^{-\mu}(1 - \alpha) \chi w_0 \left( dN - \mu N \frac{dP}{P} \right) - e \frac{\rho + \psi}{(\rho + \psi + \delta)^2} d\delta \]

\[ + \frac{1}{\rho + \psi + \delta} KP^{-\mu} ((1 - \chi L)(1 - t)w - (1 - \alpha)\chi Lw_0) \left( \frac{\rho + \psi}{\rho + \psi + \delta} d\delta - \mu \frac{dP}{P} \right) \]

\[ + \frac{\delta}{\rho + \psi + \delta} KP^{-\mu} ((1 - \chi L)(1 - t)dw - \chi(1 - t)wdL - (1 - \alpha)\chi w_0 dL) \]

\[ dS = dL - \chi LdL . \]

B.4. Additional Simulations

This appendix provides additional simulations of the model for the break points, sustain points and unemployment disparities. The simulations for the break points illustrate the derivative of the difference in expected life-time utilities in both regions with respect to \( \lambda \) in the case of symmetry (\( \lambda = 0.5 \)). When this derivative is larger (smaller) than zero, symmetry is unstable (stable). The points at which this derivative is exactly zero are the break points. In each of the forthcoming figures, this derivative is presented for a total of 16,281 points on the grid (1 \( \leq \tau \leq 5 \), 0 \( \leq \chi \leq 1 \)). Owing to symmetry, it is sufficient to calculate only the derivative of expected life-time utilities in region \( r \), because the derivative of the difference in expected life-time utilities is simply double the former derivative.

The results for the sustain points are provided by calculating the difference in expected life-time utilities in the case of full agglomeration (\( \lambda = 1 \)) on the same grid for \( \tau \) and \( \chi \). When this difference is larger (smaller) than zero, full agglomeration is stable (unstable). All points at which this difference is zero are termed sustain
points. For each of the full agglomerations, the difference in unemployment rates is also presented.

The parameter constellations are summarized in Table B.1. They have to fulfill the so-called no-black-hole condition \((\theta - 1)/\theta \geq \mu\). This condition constrains the strength of the centripetal forces in the model and ensures that they are not so strong that they would lead to a collapse of the economy into a single point (see Fujita et al. (1999, p.58-59) for a detailed discussion).

Example A (Figure B.1) replicates the simulations from Figures 4.4 and 4.7, although the method of illustration is different here, as all equilibria on the grid are calculated, not only the break and sustain points. The forthcoming examples show variations of this baseline specification, first by changing \(\theta\) and \(\mu\), and later by changing the labor market parameters. The parameters \(\theta\) and \(\mu\) are at the core of the model since they have a crucial impact on the strength of the centripetal forces. The higher \(\mu\) and the lower \(\theta\), the stronger the centripetal forces are and the larger (smaller) the area is, where full agglomeration (symmetry) is stable. When the centripetal forces are weak, the space in which agglomerations are stable reduces to a small area where \(\chi\) is small and \(\tau\) is intermediate. Further, the area in which the unemployment rate is lower in the agglomeration compared with the periphery is always a subset of the area in which the full agglomeration is stable. However, example E (Figure B.5) shows that when \(\theta\) and \(\mu\) get closer to the no-black-hole condition, the relationship between \(\chi\) and unemployment disparities becomes non-linear. This is because the effect of commuting on the attractiveness of a region depends not only on the size of the region, but also on the wages in that region, and thus on the strengths of the centripetal forces. When wage disparities are very large, the loss of income due to commuting might be significant, which affects the unemployment rate through the effect of commuting costs on shirking incentives.
## B. Appendix to Chapter 4

### Table B.1.: Parameter Constellations

<table>
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<tr>
<th>Simulation</th>
<th>$\mu$</th>
<th>$\theta$</th>
<th>$\psi$</th>
<th>$\gamma$</th>
<th>$\rho$</th>
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<th>$w_0$</th>
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<td>0.1</td>
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<td>0.3</td>
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B.4. Additional Simulations

Derivation of expected lifetime utilities

Difference in expected lifetime utilities

(a) Break Point

(b) Sustain Point

Difference in Unemployment Rates

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.1.: Simulation A
B. Appendix to Chapter 4

Derivation of expected lifetime utilities

\[ \tau \]

\[ \chi \]

\[ 0.2 \]

\[ 0.4 \]

\[ 0.6 \]

\[ 0.8 \]

\[ 2 \ 3 \ 4 \]

\[ -3 \]

\[ -2 \]

\[ -1 \]

\[ -1 \]

\[ 0 \]

\[ 1 \]

\[ -5 \]

\[ -4 \]

\[ -3 \]

\[ -2 \]

\[ -1 \]

\[ 0 \]

\[ 1 \]

\[ 2 \]

(a) Break Point

(b) Sustain Point

Difference in expected lifetime utilities

\[ \tau \]

\[ \chi \]

\[ 0.2 \]

\[ 0.4 \]

\[ 0.6 \]

\[ 0.8 \]

\[ 2 \ 3 \ 4 \]

\[ -4 \]

\[ -3 \]

\[ -2 \]

\[ -1 \]

\[ -1 \]

\[ 0 \]

\[ 1 \]

\[ -6 \]

\[ -5 \]

\[ -4 \]

\[ -3 \]

\[ -2 \]

\[ -1 \]

\[ 0 \]

\[ 1 \]

\[ 2 \]

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.2.: Simulation B
B.4. Additional Simulations

(a) Break Point

(b) Sustain Point

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.3.: Simulation C
B. Appendix to Chapter 4

(a) Break Point

(b) Sustain Point

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.4.: Simulation D
B.4. Additional Simulations

Derivation of expected lifetime utilities

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Difference in expected lifetime utilities

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(a) Break Point

(b) Sustain Point

Difference in Unemployment Rates

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(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.5.: Simulation E
B. Appendix to Chapter 4

Derivation of expected life time utilities

\( \tau \)  \( \chi \)
0.2 0.4 0.6 0.8

\( \tau \)  \( \chi \)
2 3 4

\( \tau \)  \( \chi \)

-5 -4 -3 -2 -1 0 -7 -6 -5 -4 -3 -2 -1 0 1 2

(a) Break Point

(b) Sustain Point

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.6.: Simulation F
B.4. Additional Simulations

Derivation of expected life time utilities

(a) Break Point

Difference in expected life time utilities

(b) Sustain Point

Difference in Unemployment Rates

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.7.: Simulation G
B. Appendix to Chapter 4

Derivation of expected life time utilities

\begin{align*}
\tau & \quad \chi \\
0.2 & \\
0.4 & \\
0.6 & \\
0.8 & \\
2 & 3 & 4 \\
0.0 & 0.0 & 0.5 & 0.5 & 1.0 & 1.5 \\
-1.0 & -0.5 & 0.0 & 0.5 & 1.0 & 1.5 & 2.0 & 2.5
\end{align*}

(a) Break Point

Difference in expected life time utilities

\begin{align*}
\tau & \quad \chi \\
0.2 & \\
0.4 & \\
0.6 & \\
0.8 & \\
2 & 3 & 4 \\
-0.5 & 0.0 & 0.0 & 0.5 & 0.5 & 1.0 & 1.0 & 1.5 \\
-1.5 & -1.0 & -0.5 & 0.0 & 0.5 & 1.0 & 1.5 & 2.0 & 2.5
\end{align*}

(b) Sustain Point

Difference in Unemployment Rates

\begin{align*}
\tau & \quad \chi \\
0.2 & \\
0.4 & \\
0.6 & \\
0.8 & \\
2 & 3 & 4 \\
-0.6 & -0.4 & -0.4 & -0.2 & -0.2 & 0.0 & 0.0 & 0.2 & 0.2 & 0.4 & -0.8 & -0.6 & -0.4 & -0.2 & 0.0 & 0.2 & 0.4 & 0.6
\end{align*}

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.8.: Simulation H
B.4. Additional Simulations

Derivation of expected life time utilities

(a) Break Point

(b) Sustain Point

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.9.: Simulation I
B. Appendix to Chapter 4

Derivation of expected life time utilities

Difference in expected life time utilities

(a) Break Point

(b) Sustain Point

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.10.: Simulation J
B.4. Additional Simulations

Derivation of expected life time utilities

\( \tau \)
\( \chi \)
0.2
0.4
0.6
0.8
2 3 4

(a) Break Point

Difference in expected life time utilities

(b) Sustain Point

Difference in Unemployment Rates

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.11.: Simulation K
B. Appendix to Chapter 4

Derivation of expected life time utilities

![Graph of Derivation of expected life time utilities]

(a) Break Point

Difference in expected life time utilities

![Graph of Difference in expected life time utilities]

(b) Sustain Point

Difference in Unemployment Rates

![Graph of Difference in Unemployment Rates]

(c) Unemployment Disparities

See Table B.1 for the Parameter Constellation.

Figure B.12.: Simulation L
### C. Appendix to Chapter 5

#### C.1. Descriptive Statistics

<table>
<thead>
<tr>
<th>Sector</th>
<th>border_r</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, energy, mining</td>
<td>2.85</td>
<td>2.76</td>
</tr>
<tr>
<td>Raw material production</td>
<td>8.05</td>
<td>7.77</td>
</tr>
<tr>
<td>Steel/light metal production, machine building</td>
<td>10.75</td>
<td>10.81</td>
</tr>
<tr>
<td>Construction of vehicles and equipment</td>
<td>10.06</td>
<td>9.6</td>
</tr>
<tr>
<td>Consumer goods industry</td>
<td>7.18</td>
<td>7.32</td>
</tr>
<tr>
<td>Food, drink and tobacco industry</td>
<td>3.43</td>
<td>3.15</td>
</tr>
<tr>
<td>Main construction trade</td>
<td>4.5</td>
<td>4.49</td>
</tr>
<tr>
<td>Finishing trade</td>
<td>2.78</td>
<td>2.8</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>5.69</td>
<td>5.72</td>
</tr>
<tr>
<td>Retail trade</td>
<td>7.92</td>
<td>7.98</td>
</tr>
<tr>
<td>Transport and communication</td>
<td>4.71</td>
<td>4.91</td>
</tr>
<tr>
<td>Business related services</td>
<td>9.19</td>
<td>9.26</td>
</tr>
<tr>
<td>Household related services</td>
<td>4.32</td>
<td>4.37</td>
</tr>
<tr>
<td>Health and education</td>
<td>8.19</td>
<td>8.37</td>
</tr>
<tr>
<td>Associations, organizations</td>
<td>4.08</td>
<td>4.09</td>
</tr>
<tr>
<td>Administrative units, social insurance</td>
<td>6.59</td>
<td>6.6</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table C.1.: Employment Shares of Sectors
C. Appendix to Chapter 5

C.2. Robustness Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>m5.8b</th>
<th>w5.8c</th>
<th>l5.8c</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>trend</strong>_t</td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.0046***</td>
<td>0.0331***</td>
<td>0.0128***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0004)</td>
<td>(0.0005)</td>
<td>(0.0009)</td>
</tr>
<tr>
<td><strong>(trend_t × border_r)</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0002</td>
<td>-0.0000</td>
<td>-0.0004</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0005)</td>
<td>(0.0006)</td>
<td>(0.0012)</td>
</tr>
<tr>
<td><strong>gru_t</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.0726***</td>
<td>0.1175***</td>
<td>0.1454***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0034)</td>
<td>(0.0044)</td>
<td>(0.0067)</td>
</tr>
<tr>
<td><strong>(gru_t × border_r)</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0003</td>
<td>-0.0075</td>
<td>-0.0062</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0037)</td>
<td>(0.0048)</td>
<td>(0.0089)</td>
</tr>
<tr>
<td><strong>(gru_t × trend_t)</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0072***</td>
<td>-0.0110***</td>
<td>-0.0144***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0004)</td>
<td>(0.0005)</td>
<td>(0.0010)</td>
</tr>
<tr>
<td><strong>(gru_t × border_r × trend_t)</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.0001</td>
<td>0.0009</td>
<td>0.0006</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0005)</td>
<td>(0.0007)</td>
<td>(0.0013)</td>
</tr>
<tr>
<td><strong>migrt</strong>_t</td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.1137***</td>
<td>-0.0428</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0346)</td>
<td>(0.0511)</td>
<td></td>
</tr>
<tr>
<td><strong>(zrg × subsidy_t)</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0070*</td>
<td>0.0137***</td>
<td>-0.0188</td>
</tr>
<tr>
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<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0038)</td>
<td>(0.0038)</td>
<td>(0.0116)</td>
</tr>
<tr>
<td><strong>subsidy_t</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.0114***</td>
<td>-0.0550***</td>
<td>0.0021</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0009)</td>
<td>(0.0014)</td>
<td>(0.0029)</td>
</tr>
<tr>
<td><strong>constant</strong></td>
<td>coef.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.1209***</td>
<td>4.7329***</td>
<td>6.9944***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0015)</td>
<td>(0.0026)</td>
<td>(0.0046)</td>
</tr>
</tbody>
</table>

|                |      |       |       |
| NT             | 4522 | 4522 | 4522 |
| indiv. eff.    | yes  | yes  | yes  |
| time eff.      | no   | no   | no   |
| rob. s.e. (1)  | yes  | yes  | yes  |

(1) according to Bertrand et al. (2004)

sign. lev.: *0.1, **0.05, ***0.01

Table C.2.: Placebo Tests
C.2. Robustness Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th>wS.Sc</th>
<th>wS.Sd</th>
<th>tS.Sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>$trend_t$</td>
<td>coef.</td>
<td>-0.0044***</td>
<td>0.0331***</td>
<td>0.0126***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td>(0.0006)</td>
</tr>
<tr>
<td>$(trend_t \times border_r)$</td>
<td>coef.</td>
<td>-0.0015**</td>
<td>-0.0013</td>
<td>-0.0002</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0007)</td>
<td>(0.0014)</td>
<td>(0.0021)</td>
</tr>
<tr>
<td>$gru_t$</td>
<td>coef.</td>
<td>-0.0679***</td>
<td>0.1062***</td>
<td>0.1392***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0029)</td>
<td>(0.0047)</td>
<td>(0.0047)</td>
</tr>
<tr>
<td>$(gru_t \times border_r)$</td>
<td>coef.</td>
<td>-0.0154*</td>
<td>-0.0103</td>
<td>0.0481***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0082)</td>
<td>(0.0128)</td>
<td>(0.0113)</td>
</tr>
<tr>
<td>$(gru_t \times trend_t)$</td>
<td>coef.</td>
<td>0.0069***</td>
<td>-0.0105***</td>
<td>-0.0139***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0003)</td>
<td>(0.0004)</td>
<td>(0.0007)</td>
</tr>
<tr>
<td>$(gru_t \times trend_t \times trend_t)$</td>
<td>coef.</td>
<td>0.0036***</td>
<td>-0.007</td>
<td>-0.0033</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0007)</td>
<td>(0.0011)</td>
<td>(0.0024)</td>
</tr>
<tr>
<td>$migvt$</td>
<td>coef.</td>
<td>0.0390</td>
<td>0.1263</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0573)</td>
<td>(0.0992)</td>
<td></td>
</tr>
<tr>
<td>$(zrg_r \times subsidyt)$</td>
<td>coef.</td>
<td>0.0100**</td>
<td>0.0104***</td>
<td>-0.0196</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0040)</td>
<td>(0.0040)</td>
<td>(0.0129)</td>
</tr>
<tr>
<td>$subsidyt$</td>
<td>coef.</td>
<td>-0.0119***</td>
<td>-0.0545***</td>
<td>0.0022</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0009)</td>
<td>(0.0015)</td>
<td>(0.0029)</td>
</tr>
<tr>
<td>$constant$</td>
<td>coef.</td>
<td>0.1209***</td>
<td>4.7329***</td>
<td>6.9941***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0015)</td>
<td>(0.0025)</td>
<td>(0.0046)</td>
</tr>
<tr>
<td>NT</td>
<td></td>
<td>4522</td>
<td>4522</td>
<td>4522</td>
</tr>
<tr>
<td>indiv. eff.</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>time eff.</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>rob. s.e. (1)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

(1) according to Bertrand et al. (2004)
sign. lev.: *0.1, **0.05, ***0.01

Table C.3.: Only 1st Order Neighbors
C. Appendix to Chapter 5

<table>
<thead>
<tr>
<th>Variable</th>
<th>m.8d</th>
<th>w.8e</th>
<th>l.8e</th>
</tr>
</thead>
<tbody>
<tr>
<td>trend_t</td>
<td>coef. (-0.0044^{***})</td>
<td>0.0331^{***}</td>
<td>0.0122^{***}</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td>(0.0007)</td>
</tr>
<tr>
<td>(trend_t \times border_r)</td>
<td>coef. (-0.0008^*)</td>
<td>-0.0004</td>
<td>0.0019</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0005)</td>
<td>(0.0006)</td>
<td>(0.0015)</td>
</tr>
<tr>
<td>gru_t</td>
<td>coef. (-0.0689^{***})</td>
<td>0.1135^{***}</td>
<td>0.1352^{***}</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0024)</td>
<td>(0.0037)</td>
<td>(0.0051)</td>
</tr>
<tr>
<td>(gru_t \times border_r)</td>
<td>coef. (-0.0102^{**})</td>
<td>-0.0014</td>
<td>0.0368^{***}</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0044)</td>
<td>(0.0062)</td>
<td>(0.0099)</td>
</tr>
<tr>
<td>(gru_t \times trend_t)</td>
<td>coef. (-0.0067^{***})</td>
<td>-0.0106^{***}</td>
<td>-0.0135^{***}</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0003)</td>
<td>(0.0004)</td>
<td>(0.0008)</td>
</tr>
<tr>
<td>(gru_t \times border_r \times trend_t)</td>
<td>coef. (-0.0021^{***})</td>
<td>0.0003</td>
<td>-0.0033^{**}</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0006)</td>
<td>(0.0009)</td>
<td>(0.0016)</td>
</tr>
<tr>
<td>migr_t</td>
<td>coef. 0.0814^{**}</td>
<td>-0.0333</td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0390)</td>
<td>(0.0632)</td>
<td></td>
</tr>
<tr>
<td>(zrg_r \times subsidy_t)</td>
<td>coef. 0.0115^{***}</td>
<td>0.0132^{***}</td>
<td>-0.0142</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0041)</td>
<td>(0.0046)</td>
<td>(0.0124)</td>
</tr>
<tr>
<td>subsidy_t</td>
<td>coef. -0.0121^{***}</td>
<td>-0.0549^{***}</td>
<td>0.0014</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0010)</td>
<td>(0.0015)</td>
<td>(0.0029)</td>
</tr>
<tr>
<td>constant</td>
<td>coef. 0.1209^{***}</td>
<td>4.7329^{***}</td>
<td>6.9944^{***}</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0015)</td>
<td>(0.0026)</td>
<td>(0.0046)</td>
</tr>
<tr>
<td>NT</td>
<td>4522</td>
<td>4522</td>
<td>4522</td>
</tr>
<tr>
<td>indiv. eff.</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>time eff.</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>rob. s.e. (1)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

(1) according to Bertrand et al. (2004)

sign. lev.: *0.1, **0.05, ***0.01

Table C.4.: Border Regions Based on Travel Time
### C.2. Robustness Tests

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th>w5 Se</th>
<th>w6 N</th>
<th>l5 M</th>
</tr>
</thead>
<tbody>
<tr>
<td>trend</td>
<td>coef.</td>
<td>-0.0043***</td>
<td>0.0334***</td>
<td>0.0125***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td>(0.0007)</td>
</tr>
<tr>
<td>(trend × border)</td>
<td>coef.</td>
<td>-0.0012**</td>
<td>-0.0021**</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0005)</td>
<td>(0.0009)</td>
<td>(0.0016)</td>
</tr>
<tr>
<td>gru</td>
<td>coef.</td>
<td>-0.0995***</td>
<td>0.0538***</td>
<td>0.2071***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0024)</td>
<td>(0.0035)</td>
<td>(0.0075)</td>
</tr>
<tr>
<td>(gru × border)</td>
<td>coef.</td>
<td>-0.0160**</td>
<td>-0.0121</td>
<td>0.0062</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0073)</td>
<td>(0.0097)</td>
<td>(0.0187)</td>
</tr>
<tr>
<td>(gru × trend)</td>
<td>coef.</td>
<td>0.0109***</td>
<td>-0.0027***</td>
<td>-0.0239***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0003)</td>
<td>(0.0005)</td>
<td>(0.0011)</td>
</tr>
<tr>
<td>(gru × border × trend)</td>
<td>coef.</td>
<td>0.0026**</td>
<td>0.0009</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0010)</td>
<td>(0.0014)</td>
<td>(0.0028)</td>
</tr>
<tr>
<td>migr</td>
<td>coef.</td>
<td>0.0858**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0414)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(zrg × subsidy)</td>
<td>coef.</td>
<td>0.0108**</td>
<td>-0.0012</td>
<td>-0.0165</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0042)</td>
<td>(0.0026)</td>
<td>(0.0102)</td>
</tr>
<tr>
<td>subsidy</td>
<td>coef.</td>
<td>0.0030***</td>
<td>-0.0327***</td>
<td>-0.0310***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0010)</td>
<td>(0.0013)</td>
<td>(0.0025)</td>
</tr>
<tr>
<td>constant</td>
<td>coef.</td>
<td>0.1059***</td>
<td>4.7130***</td>
<td>7.0270***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0015)</td>
<td>(0.0019)</td>
<td>(0.0040)</td>
</tr>
<tr>
<td>NT</td>
<td></td>
<td>3192</td>
<td>3192</td>
<td>3192</td>
</tr>
<tr>
<td>indiv. eff.</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>time eff.</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>rob. s.e. (1)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

(1) according to Bertrand et al. (2004)

sign. lev.: *0.1, **0.05, ***0.001

Table C.5.: Shorter Time Period
C. Appendix to Chapter 5

C.3. Wage Regressions for Medium and Low Qualified

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th>w5.5a (2)</th>
<th>w5.5b (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$gru_t$</td>
<td>coef.</td>
<td>0.1613***</td>
<td>0.1741***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0034)</td>
<td>(0.0013)</td>
</tr>
<tr>
<td>($gru_t \times border_r$)</td>
<td>coef.</td>
<td>-0.0272***</td>
<td>-0.0121***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0053)</td>
<td>(0.0035)</td>
</tr>
<tr>
<td>($zrg_r \times subsidy_t$)</td>
<td>coef.</td>
<td>0.0047</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0005)</td>
<td>(0.0031)</td>
</tr>
<tr>
<td>$subsidy_t$</td>
<td>coef.</td>
<td>-0.2001***</td>
<td>-0.1994***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0013)</td>
<td>(0.0013)</td>
</tr>
<tr>
<td>$migr_{it}$</td>
<td>coef.</td>
<td>0.2956***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0784)</td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>coef.</td>
<td>4.7368***</td>
<td>4.7368***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0009)</td>
<td>(0.0009)</td>
</tr>
</tbody>
</table>

| NT           | 5586           | 5586      |
| time         | 1984-2004      | 1984-2004 |
| indiv. eff.  | yes            | yes       |
| time eff.    | no             | no        |
| rob. s.e. (1)| yes            | yes       |

(1) according to Bertrand et al. (2004)
(2) based on low/medium qualified employees
sign. lev.: *0.1, **0.05, ***0.01

Table C.6.: Specification 5.5 for Wages (Low/Medium Qualified)
C.3. Wage Regressions for Medium and Low Qualified

<table>
<thead>
<tr>
<th>Variable</th>
<th>w5.6a (2)</th>
<th>w5.6b (2)</th>
<th>w5.6c (2)</th>
<th>w5.6d (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_{1985} \times border_r$</td>
<td>-0.0029</td>
<td>-0.0029</td>
<td>(0.0024)</td>
<td>(0.0024)</td>
</tr>
<tr>
<td>$d_{1986} \times border_r$</td>
<td>-0.0030</td>
<td>-0.0030</td>
<td>(0.0029)</td>
<td>(0.0029)</td>
</tr>
<tr>
<td>$d_{1987} \times border_r$</td>
<td>-0.0022</td>
<td>-0.0022</td>
<td>(0.0016)</td>
<td>(0.0016)</td>
</tr>
<tr>
<td>$d_{1988} \times border_r$</td>
<td>0.0015</td>
<td>0.0015</td>
<td>(0.0027)</td>
<td>(0.0027)</td>
</tr>
<tr>
<td>$d_{1989} \times border_r$</td>
<td>-0.0056*</td>
<td>-0.0056*</td>
<td>(0.0033)</td>
<td>(0.0033)</td>
</tr>
<tr>
<td>$d_{1990} \times border_r$</td>
<td>-0.0207***</td>
<td>-0.0207***</td>
<td>(0.0048)</td>
<td>(0.0048)</td>
</tr>
<tr>
<td>$d_{1991} \times border_r$</td>
<td>-0.0232***</td>
<td>-0.0232***</td>
<td>(0.0051)</td>
<td>(0.0051)</td>
</tr>
<tr>
<td>$d_{1992} \times border_r$</td>
<td>-0.0220***</td>
<td>-0.0220***</td>
<td>(0.0049)</td>
<td>(0.0049)</td>
</tr>
<tr>
<td>$d_{1993} \times border_r$</td>
<td>-0.0222***</td>
<td>-0.0222***</td>
<td>(0.0053)</td>
<td>(0.0053)</td>
</tr>
<tr>
<td>$d_{1994} \times border_r$</td>
<td>-0.0259***</td>
<td>-0.0259***</td>
<td>(0.0063)</td>
<td>(0.0063)</td>
</tr>
<tr>
<td>$d_{1995} \times border_r$</td>
<td>-0.0244***</td>
<td>-0.0244***</td>
<td>(0.0064)</td>
<td>(0.0064)</td>
</tr>
<tr>
<td>$d_{1996} \times border_r$</td>
<td>-0.0236***</td>
<td>-0.0236***</td>
<td>(0.0061)</td>
<td>(0.0061)</td>
</tr>
<tr>
<td>$d_{1997} \times border_r$</td>
<td>-0.0245***</td>
<td>-0.0245***</td>
<td>(0.0063)</td>
<td>(0.0063)</td>
</tr>
<tr>
<td>$d_{1998} \times border_r$</td>
<td>-0.0236***</td>
<td>-0.0236***</td>
<td>(0.0060)</td>
<td>(0.0060)</td>
</tr>
<tr>
<td>$d_{1999} \times border_r$</td>
<td>-0.0239***</td>
<td>-0.0239***</td>
<td>(0.0055)</td>
<td>(0.0055)</td>
</tr>
<tr>
<td>$d_{2000} \times border_r$</td>
<td>-0.0282***</td>
<td>-0.0282***</td>
<td>(0.0063)</td>
<td>(0.0063)</td>
</tr>
<tr>
<td>$zrg \times subsidy_t$</td>
<td>0.0008</td>
<td>-0.0036</td>
<td>(0.0039)</td>
<td>(0.0039)</td>
</tr>
<tr>
<td>migr</td>
<td>0.2470***</td>
<td>0.2704***</td>
<td>(0.0653)</td>
<td>(0.0653)</td>
</tr>
<tr>
<td>constant</td>
<td>4.5209***</td>
<td>4.5216***</td>
<td>4.5451***</td>
<td>4.5600***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NT</th>
<th>3990</th>
<th>3990</th>
<th>4522</th>
<th>4522</th>
</tr>
</thead>
<tbody>
<tr>
<td>indiv. eff.</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>time eff.</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>rob. s.e. (1)</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

(1) according to Bertrand et al. (2004)
(2) based on low/medium qualified employees

sign. lev.: *0.1, **0.05, ***0.01

Table C.7.: Specification 5.6 for Wages (Low/Medium Qualified)
### C. Appendix to Chapter 5

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th>w5.7 (2)</th>
<th>w5.8a (2)</th>
<th>w5.8b (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>trend&lt;sub&gt;t&lt;/sub&gt;</td>
<td>coef.</td>
<td>0.0328***</td>
<td>0.0328***</td>
<td>0.0328***</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0002)</td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td></td>
</tr>
<tr>
<td>(trend&lt;sub&gt;t&lt;/sub&gt; × border&lt;sub&gt;r&lt;/sub&gt;)</td>
<td>coef.</td>
<td>-0.0012***</td>
<td>-0.0012</td>
<td>-0.0012</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0005)</td>
<td>(0.0008)</td>
<td>(0.0008)</td>
<td></td>
</tr>
<tr>
<td>gru&lt;sub&gt;t&lt;/sub&gt;</td>
<td>coef.</td>
<td>0.1475***</td>
<td>0.1578***</td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0036)</td>
<td>(0.0023)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gru&lt;sub&gt;t&lt;/sub&gt; × border&lt;sub&gt;r&lt;/sub&gt;)</td>
<td>coef.</td>
<td>-0.0204***</td>
<td>-0.0037</td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0066)</td>
<td>(0.0057)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gru&lt;sub&gt;t&lt;/sub&gt; × trend&lt;sub&gt;t&lt;/sub&gt;)</td>
<td>coef.</td>
<td>-0.0156***</td>
<td>-0.0156***</td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0003)</td>
<td>(0.0008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(gru&lt;sub&gt;t&lt;/sub&gt; × border&lt;sub&gt;r&lt;/sub&gt; × trend&lt;sub&gt;t&lt;/sub&gt;)</td>
<td>coef.</td>
<td>0.0004</td>
<td>0.0002</td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0009)</td>
<td>(0.0009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>migr&lt;sub&gt;r&lt;/sub&gt;</td>
<td>coef.</td>
<td>0.2682***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0715)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(zrg × subsidy)</td>
<td>coef.</td>
<td>0.0016</td>
<td>-0.0027</td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0035)</td>
<td>(0.0032)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsidy</td>
<td>coef.</td>
<td>-0.0768***</td>
<td>-0.0761***</td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0011)</td>
<td>(0.0011)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>coef.</td>
<td>4.4233***</td>
<td>4.4998***</td>
<td>4.4998***</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0007)</td>
<td>(0.0021)</td>
<td>(0.0021)</td>
<td></td>
</tr>
</tbody>
</table>

| NT | 1596 | 4522 | 4522 |
| indiv. eff. | yes | yes | yes |
| time eff. | no | no | no |
| rob. s.e. (1) | no | yes | yes |

(1) according to Bertrand et al. (2004)
(2) based on low/medium qualified employees
sign. lev.: *0.1, **0.05, ***0.01

Table C.8.: Specifications 5.7 and 5.8 for Wages (Low/Medium Qualified)
### C.4. Employment Regressions for Male Full Time Employees

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th>15.5a (2)</th>
<th>15.5b (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gru_t</td>
<td>coef.</td>
<td>0.0356***</td>
<td>0.0833***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0126)</td>
<td>(0.0041)</td>
</tr>
<tr>
<td>(gru_t × border_t)</td>
<td>coef.</td>
<td>-0.0654***</td>
<td>-0.0042</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0222)</td>
<td>(0.0168)</td>
</tr>
<tr>
<td>(zrg × subsidy_t)</td>
<td>coef.</td>
<td>-0.0039</td>
<td>-0.0209</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0164)</td>
<td>(0.0162)</td>
</tr>
<tr>
<td>subsidy_t</td>
<td>coef.</td>
<td>0.0462***</td>
<td>0.0490***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0059)</td>
<td>(0.0060)</td>
</tr>
<tr>
<td>migr_t</td>
<td>coef.</td>
<td>1.1924***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.2930)</td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>coef.</td>
<td>6.4348***</td>
<td>6.4348***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0023)</td>
<td>(0.0021)</td>
</tr>
</tbody>
</table>

| NT                 | 5586        | 5586         |
| time               | 1984-2004   | 1984-2004    |
| indiv. eff.        | yes         | yes          |
| time eff.          | no          | no           |
| rob. s.e. (1)      | yes         | yes          |

(1) according to Bertrand et al. (2004)
(2) based on male full time employees

sign. lev.: *0.1, **0.05, ***0.01

Table C.9.: Specification 5.5 for Employment (Male Full Time Employees)
<table>
<thead>
<tr>
<th>Variable</th>
<th>15.6a (2)</th>
<th>15.6b (2)</th>
<th>15.6c (2)</th>
<th>15.6d (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( (d_{1986} \times \text{border}_r) ) coef.</td>
<td>0.0045</td>
<td>0.0045</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0074)</td>
<td>(0.0074)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( (d_{1987} \times \text{border}_r) ) coef.</td>
<td>0.0033</td>
<td>0.0033</td>
<td>0.0089</td>
<td>0.0089</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0045)</td>
<td>(0.0045)</td>
<td>(0.0076)</td>
<td>(0.0076)</td>
</tr>
<tr>
<td>( (d_{1988} \times \text{border}_r) ) coef.</td>
<td>-0.0054</td>
<td>-0.0054</td>
<td>0.0032</td>
<td>0.0032</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0055)</td>
<td>(0.0055)</td>
<td>(0.0088)</td>
<td>(0.0088)</td>
</tr>
<tr>
<td>( (d_{1989} \times \text{border}_r) ) coef.</td>
<td>-0.0023</td>
<td>-0.0023</td>
<td>0.0063</td>
<td>0.0063</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0071)</td>
<td>(0.0071)</td>
<td>(0.0110)</td>
<td>(0.0110)</td>
</tr>
<tr>
<td>( (d_{1990} \times \text{border}_r) ) coef.</td>
<td>-0.0492</td>
<td>-0.0492</td>
<td>0.0282**</td>
<td>0.0282**</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0160)</td>
<td>(0.0160)</td>
<td>(0.0119)</td>
<td>(0.0119)</td>
</tr>
<tr>
<td>( (d_{1991} \times \text{border}_r) ) coef.</td>
<td>-0.0391**</td>
<td>0.0197*</td>
<td>-0.0359*</td>
<td>0.0282**</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0172)</td>
<td>(0.0115)</td>
<td>(0.0187)</td>
<td>(0.0125)</td>
</tr>
<tr>
<td>( (d_{1992} \times \text{border}_r) ) coef.</td>
<td>-0.0382</td>
<td>0.0077</td>
<td>-0.0332</td>
<td>0.0152</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0219)</td>
<td>(0.0184)</td>
<td>(0.0236)</td>
<td>(0.0200)</td>
</tr>
<tr>
<td>( (d_{1993} \times \text{border}_r) ) coef.</td>
<td>-0.0405</td>
<td>0.0054</td>
<td>-0.0354</td>
<td>0.0129</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0229)</td>
<td>(0.0195)</td>
<td>(0.0243)</td>
<td>(0.0207)</td>
</tr>
<tr>
<td>( (d_{1994} \times \text{border}_r) ) coef.</td>
<td>-0.0386</td>
<td>0.0073</td>
<td>-0.0336</td>
<td>0.0148</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0240)</td>
<td>(0.0207)</td>
<td>(0.0264)</td>
<td>(0.0230)</td>
</tr>
<tr>
<td>( (d_{1995} \times \text{border}_r) ) coef.</td>
<td>-0.0336</td>
<td>0.0123</td>
<td>-0.0286</td>
<td>0.0198</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0250)</td>
<td>(0.0222)</td>
<td>(0.0275)</td>
<td>(0.0246)</td>
</tr>
<tr>
<td>( (d_{1996} \times \text{border}_r) ) coef.</td>
<td>-0.0381</td>
<td>0.0079</td>
<td>-0.0330</td>
<td>0.0153</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0248)</td>
<td>(0.0222)</td>
<td>(0.0271)</td>
<td>(0.0244)</td>
</tr>
<tr>
<td>( (d_{1997} \times \text{border}_r) ) coef.</td>
<td>-0.0510*</td>
<td>-0.0051</td>
<td>-0.0460</td>
<td>0.0024</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0270)</td>
<td>(0.0244)</td>
<td>(0.0293)</td>
<td>(0.0266)</td>
</tr>
<tr>
<td>( (d_{1998} \times \text{border}_r) ) coef.</td>
<td>-0.0568*</td>
<td>-0.0109</td>
<td>-0.0517*</td>
<td>-0.0304</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0263)</td>
<td>(0.0242)</td>
<td>(0.0285)</td>
<td>(0.0263)</td>
</tr>
<tr>
<td>( (d_{1999} \times \text{border}_r) ) coef.</td>
<td>-0.0508</td>
<td>-0.0139</td>
<td>-0.0547*</td>
<td>-0.0064</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0272)</td>
<td>(0.0253)</td>
<td>(0.0299)</td>
<td>(0.0280)</td>
</tr>
<tr>
<td>( (d_{2000} \times \text{border}_r) ) coef.</td>
<td>-0.0748***</td>
<td>-0.0289</td>
<td>-0.0698***</td>
<td>-0.0214</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0278)</td>
<td>(0.0260)</td>
<td>(0.0306)</td>
<td>(0.0287)</td>
</tr>
<tr>
<td>( (zrg_r \times \text{subsidy}_t) ) coef.</td>
<td>-0.0110</td>
<td>-0.0283</td>
<td>-0.0085</td>
<td>-0.0298</td>
</tr>
<tr>
<td>s.e.</td>
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<td>(0.0178)</td>
<td>(0.0207)</td>
<td>(0.0198)</td>
</tr>
<tr>
<td>( \text{migr}_{rt} ) coef.</td>
<td>0.9728***</td>
<td>1.0610***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.2570)</td>
<td>(0.2585)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \text{constant} ) coef.</td>
<td>6.4789***</td>
<td>6.4817***</td>
<td>6.4595***</td>
<td>6.4629***</td>
</tr>
<tr>
<td>s.e.</td>
<td>(0.0057)</td>
<td>(0.0059)</td>
<td>(0.0060)</td>
<td>(0.0061)</td>
</tr>
</tbody>
</table>

| NT                        | 3990      | 3990      | 4522      | 4522      |
| indiv. eff.               | yes       | yes       | yes       | yes       |
| time eff.                 | yes       | yes       | yes       | yes       |
| rob. s.e. (1)             | yes       | yes       | yes       | yes       |

(1) according to Bertrand et al. (2004)
(2) based on male full time employees
sign. lev.: *0.1, **0.05, ***0.01

Table C.10.: Specification 5.6 for Employment (Male Full Time Employees)
C.4. Employment Regressions for Male Full Time Employees

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model</th>
<th>5.8a (2)</th>
<th>5.8b (2)</th>
</tr>
</thead>
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<tr>
<td>trend_t</td>
<td>coef.</td>
<td>0.0102***</td>
<td>0.0102***</td>
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<tr>
<td></td>
<td>s.e.</td>
<td>(0.0008)</td>
<td>(0.0008)</td>
</tr>
<tr>
<td>(trend_t × border_r)</td>
<td>coef.</td>
<td>0.0008</td>
<td>0.0008</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0019)</td>
<td>(0.0019)</td>
</tr>
<tr>
<td>gru_t</td>
<td>coef.</td>
<td>0.1291***</td>
<td>0.1690***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0120)</td>
<td>(0.0058)</td>
</tr>
<tr>
<td>(gru_t × border_r)</td>
<td>coef.</td>
<td>-0.0137</td>
<td>0.0514***</td>
</tr>
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<td></td>
<td>s.e.</td>
<td>(0.0208)</td>
<td>(0.0138)</td>
</tr>
<tr>
<td>(gru_t × trend_t)</td>
<td>coef.</td>
<td>-0.0176***</td>
<td>-0.0174***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0009)</td>
<td>(0.0009)</td>
</tr>
<tr>
<td>(gru_t × border_r × trend_t)</td>
<td>coef.</td>
<td>-0.0036*</td>
<td>-0.0046**</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0020)</td>
<td>(0.0020)</td>
</tr>
<tr>
<td>migr_t</td>
<td>coef.</td>
<td>1.0436***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.2586)</td>
<td></td>
</tr>
<tr>
<td>(zrg × subsidy_t)</td>
<td>coef.</td>
<td>-0.0144</td>
<td>-0.0312*</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0168)</td>
<td>(0.0163)</td>
</tr>
<tr>
<td>subsidy_t</td>
<td>coef.</td>
<td>-0.0085**</td>
<td>-0.0058</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0036)</td>
<td>(0.0036)</td>
</tr>
<tr>
<td>constant</td>
<td>coef.</td>
<td>6.4550***</td>
<td>6.4550***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>(0.0056)</td>
<td>(0.0056)</td>
</tr>
<tr>
<td>NT</td>
<td></td>
<td>4522</td>
<td>4522</td>
</tr>
<tr>
<td>individ. eff.</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>time eff.</td>
<td>no</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>rob. s.e. (1)</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

(1) according to Bertrand et al. (2004)
(2) based on male full time employees
sign. lev.: *0.1, **0.05, ***0.01

Table C.11.: Specification 5.8 for Employment (Male Full Time Employees)
Bibliography


Bibliography


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Bibliography


Legal Sources


German Zonal Border Development Act (Gesetz zur Förderung des Zonenrandgebiets) from 5 August 1971, as last amended by German Tax Adjustment Law (Steuerbereinigungsgesetz) 1986 from 19 December 1985 (Federal Law Gazette I p. 2436), in German.


Zusammenfassung

Zur Relevanz regionaler Arbeitsmarktdisparitäten

Die Reduktion von Disparitäten regionaler Ökonomien ist ein zentraler Aspekt der Wirtschaftspolitik. In der Europäischen Union werden beispielsweise die harmonische Entwicklung und der regionale Zusammenhalt als explizite Ziele im Vertrag über die Arbeitsweise der Europäischen Union (VAEU) formuliert:

Die Union entwickelt und verfolgt weiterhin ihre Politik zur Stärkung ihres wirtschaftlichen, sozialen und territorialen Zusammenhalts, um eine harmonische Entwicklung der Union als Ganzes zu fördern.

Die Union setzt sich insbesondere zum Ziel, die Unterschiede im Entwicklungsstand der verschiedenen Regionen und den Rückstand der am stärksten benachteiligten Gebiete zu verringern. (Art. 174 VAEU)


Das Konvergenzziel ist auf die Unterstützung von Regionen ausgerichtet, welche in Bezug auf Einkommen und Beschäftigung zurückliegen und soll diesen durch Wachstumsförderung den Anschluss an die weiter entwickelten Regionen ermöglichen. Die übrigen Regionen, welche nicht unter das Konvergenzziel fallen, werden im Rahmen des Ziels der regionalen Wettbewerbsfähigkeit und Beschäftigung unterstützt. Diese Politik zielt auf die Unterstützung der regionalen Wettbewerbsfähigkeit und Beschäftigung durch Innovation, Forschung und Entwicklung, Umweltschutz und Unternehmensgründungen ab (Karl; 2012).
Zusammenfassung

Auch in Deutschland fokussiert die Regionalpolitik auf die Unterstützung wirtschaftlich zurückliegender Regionen, um einen Aufholprozess zu erreichen. Dieses Ziel ergibt sich aus dem Grundgesetz, aus welchem die „Herstellung gleichwertiger Lebensverhältnisse“ hervorgeht (Art. 72 II GG). Durch die Europäischen Verträge ist die Regionalpolitik der Mitgliedsstaaten eng mit der Europäischen Regionalpolitik verbunden. Die Beihilfenkontrolle der Europäischen Wettbewerbspolitik beschränkt die Hilfen der Staaten auf solche Regionen, in denen das Einkommen unterhalb und die Arbeitslosigkeit oberhalb definierter Grenzwerte liegen (Karl; 2012).


Die Wahl der Zielregionen in der aktuellen Förderperiode der GRW ergibt sich auf Basis von vier gewichteten Indikatoren: der durchschnittlichen Arbeitslosenquote zwischen 2002 und 2005 (50 %), dem Durchschnittslohn im Jahr 2003 (40 %), einer Erwerbstätigenprognose für die Jahre 2004 bis 2011 (5 %) und einem Infrastrukturindikator (5 %) (Deutscher Bundestag; 2009). Dieses Vorgehen zur Wahl der Zielregionen hebt die Bedeutung der regionalen Arbeitsmarktsituation für die Regionalpolitik hervor.

Regionale Arbeitsmarktdisparitäten sind damit ein Kernpunkt der Regionalpolitik. Dies wird insbesondere in Deutschland deutlich, wo die Regionalpolitik sich an der „Herstellung gleichwertiger Lebensverhältnisse“ orientiert, welche eng mit der regionalen Arbeitsmarktsituation verbunden sind. Die regionale Arbeitsmarktsituation formt die Möglichkeiten der regionalen Bevölkerung, Beschäftigung zu finden und ihren Lebensunterhalt zu verdienen. So zeigen Büttner und Ebertz (2009), dass die regionalen Arbeitsmarktsituationen in Deutschland in der Tat ein zentraler Faktor für die regionalen Lebensbedingungen sind. Dies erklärt auch, weshalb die Regionalpolitik insbesondere in Deutschland so stark auf die regionalen Arbeitsmarktsituationen fokussiert. Die vorliegende Arbeit konzentriert sich aus diesem Grund auf die regionalen Arbeitsmarktdisparitäten als zentraler Indikator für die regionalen Lebensbedingungen.
Ausmaß und Persistenz regionaler Arbeitsmarktdisparitäten

Während die Regionalpolitik Deutschlands und der Europäischen Union auf die Konvergenz der wirtschaftlichen Situation und Lebensbedingungen zwischen den Regionen abzielt, zeigen die Indikatoren für die regionalen Arbeitsmarktbedingungen weiterhin erhebliche Disparitäten. So ist in Deutschland etwa die Arbeitslosigkeit in ostdeutschen Kreisen deutlich stärker ausgeprägt als in westdeutschen Kreisen. Auch ein Nord-Süd-Gefälle hinsichtlich der Arbeitslosenquoten lässt sich feststellen, wobei dieses geringer ausfällt als jenes von Ost nach West. Die Arbeitslosenquote reicht von 1,1 % in Eichstätt bis 15,9 % in der Uckermark (Zahlen von Juni 2012 auf Kreisebene). Dies bedeutet, dass die Region mit der höchsten Arbeitslosenquote um den Faktor 15 oberhalb der Arbeitslosenquote des Kreises mit der geringsten Arbeitslosigkeit liegt (siehe Abbildung 1.1).

Solche Disparitäten sind nicht auf Deutschland beschränkt, sie sind auch in der Europäischen Union vorzufinden. So reicht etwa die Spanne der Arbeitslosenquoten in der Europäischen Union (NUTS-2-Ebene1, Zahlen von 2011) von 2,1 % in Salzburg (Österreich) bis 27,8 % in Andalusien (Spanien). Allerdings werden diese Zahlen natürlich stark durch die derzeitige Krise beeinflusst (siehe Abbildung 1.2).


1NUTS bezeichnet die Systematik der Gebietseinheiten für die Statistik von Eurostat. Es handelt sich um ein hierarchisches System zur regionalen Klassifikation, welches in drei Ebenen unterteilt wird. Ebene 1 ist die höchste Ebene und beinhaltet „soziökonomische Großregionen”, Ebene 2 umfasst „Basisregionen für regionalpolitische Maßnahmen” und Ebene 3 enthält „kleine Regionen für spezifische Diagnosen”. Die dritte Ebene entspricht in Deutschland weitestgehend den Kreisen und kreisfreien Städten (Eurostat; 2012b).

Zusammenfassung

sung an Schocks in Europa vor allem durch die Partizipation erfolgt, wohingegen in den USA die Migration als Anpassungsmechanismus dominiert. Die Arbeitslosenquote spielt dagegen für den Anpassungsprozess nur eine untergeordnete Rolle, was darauf hindeutet, dass Disparitäten regionaler natürlicher Arbeitslosenquoten vorliegen. Außerdem weisen ihre Ergebnisse auf die Persistenz der regionalen Arbeitsmarktdisparitäten hin.

Beim Vergleich der regionalen Arbeitslosenquoten in Deutschland im Zeitablauf lässt sich feststellen, dass die Disparitäten äußerst persistent sind. Regionen, welche zu einem gewissen Zeitpunkt überdurchschnittliche Arbeitslosenquoten aufweisen, weisen auch in den Folgejahren überdurchschnittliche Arbeitslosenquoten auf. Die Rangfolge der Regionen hinsichtlich der Arbeitslosenquoten variiert kaum im Zeitablauf (siehe dazu auch Abbildung 1.3).


nen konvergieren zu einem höheren Einkommensniveau als periphere Regionen was bedeutet, dass die Disparitäten der regionalen Einkommen persistent sind.


**Ansatz dieser Arbeit**

Vor diesem Hintergrund beschäftigt sich diese Arbeit mit zwei zentralen Fragen:

- Wie bilden sich Disparitäten zwischen regionalen Arbeitsmärkten heraus?
- Weshalb sind diese Disparitäten so persistent?


Der Leitgedanke dieser Arbeit ist daher, Arbeitsmarktfriktionen in die NÖG zu integrieren, um zu diskutieren, wie Disparitäten regionaler Arbeitsmärkte entstehen, und weshalb sie so persistent sind.

Die zuvor dargestellten deskriptiven Statistiken deuten bereits darauf hin, welche Relevanz die Argumente der NÖG in diesem Zusammenhang besitzen. Die NÖG erklärt, wie sich Personen, Unternehmen und ökonomische Aktivität endogen im Zentrum ballen, während die Peripherie zurückfällt. Aus der kurzen Darstellung der deskriptiven Statistiken wird ersichtlich, dass sich Personen und das Pro-Kopf-Einkommen im Zentrum Europas anhäufen, und dass die Arbeitslosigkeit dort im Durchschnitt geringer ist, als in weiter vom Zentrum entfernten Regionen. Im Rah-
Zusammenfassung

In dieser Arbeit werden Lohnsetzungsfriktionen, basierend auf Effizienzlöhnen, in die NÖG integriert, wohingegen sich die meisten anderen Artikel zur Integration von Arbeitsmarktfraktionen in die NÖG auf Such- und Matching-Friktionen konzentrieren. Die einzelnen Kapitel dieser Arbeit liefern dabei individuell eine Motivation der jeweils verwendeten Theorie-Elemente.

Zusammenfassung der wesentlichen Ergebnisse

Kapitel 2 bis 4 dieser Arbeit beinhalten die Theorie, auf Basis derer die Beziehungen zwischen den Arbeitsmarktfraktionen und der NÖG diskutiert werden, um die Disparitäten regionaler Arbeitsmärkte und deren Persistenz zu erklären. Kapitel 5 präsentiert empirische Ergebnisse zur Relevanz der NÖG-Argumente für regionale Arbeitsmarktdisparitäten.


Da das Modell auf dem Zentrum-Peripherie-Modell von Fujita et al. (1999) beruht und keine weiteren zentrifugalen Kräfte integriert werden, kann sich das System nur in der vollständigen Symmetrie oder der vollständigen Agglomeration befinden. Die Arbeitsmarktdisparitäten sind dann arbiträr, weil sie zwischen einer
Summary in German

vollständigen Agglomeration und der entleerten Peripherie gemessen werden. Sie werden also gemessen, indem der Lohn und die Arbeitslosenquote in der Agglomeration mit dem Lohn und der Arbeitslosenquote verglichen werden, welche ein einzelner Arbeitnehmer erfahren würde, wenn er in die leere Peripherie auswandern würde. Entsprechend dient das Modell lediglich als Ausgangspunkt, auf den in den Kapiteln 3 und 4 aufgebaut wird, um die Disparitäten regionaler Arbeitsmärkte zu diskutieren.

Kapitel 3 erweitert diesen Rahmen um negative Verdichtungsexternalitäten. Diese Externalitäten verhindern eine vollständige Agglomeration aller ökonomischer Aktivität in einer Region, so dass entweder die Symmetrie, oder die partielle Agglomeration daraus resultiert. Der Leitgedanke, welcher in dem Modell vorgetragen wird ist, dass sich die ökonomische Aktivität aufgrund der zentripetalen und zentrifugalen Kräfte des Grundmodells im Zentrum ballt. Firmen im Zentrum können einen größeren Markt bedienen, so dass deren Möglichkeiten, höhere Löhne zu zahlen, besser sind. Aufgrund der Effizienzlöhne sind die potentiell höheren Löhne in der Agglomeration mit höheren Arbeitsanreizen verbunden, so dass die Arbeitslosigkeit im Zusammenhang der Effizienzlöhne im Zentrum geringer ausfällt als in der Peripherie.

Die partielle Agglomeration ist stabil, wenn keine Anreize zur Migration bestehen. Im Grundmodell aus Kapitel 2 ist dies unmöglich, da höhere Löhne in der Agglomeration mit geringerer Arbeitslosigkeit verbunden sind, so dass der erwartete Lebenszeitnutzen in der Agglomeration immer höher ausfallen muss als in der Peripherie, vorausgesetzt dass die zentripetalen Kräfte stark genug sind. Im Modell aus Kapitel 3 hingegen ist die Agglomeration der ökonomischen Aktivität mit negativen Verdichtungsexternalitäten verbunden. Da sich mehr Personen und Firmen im Zentrum ballen, kommt es zu negativen Verdichtungsexternalitäten in Form von Staus, hohen Miet-/Immobilienpreisen oder Umweltverschmutzung, welche Anreize dazu bieten, das Zentrum zu verlassen. Die höheren Verdichtungsexternalitäten im Zentrum müssen dann durch höhere Löhne und geringere Arbeitslosigkeit kompensiert werden, um zu erreichen, dass keine Emigrationsanreize bestehen, so dass die partielle Agglomeration stabil ist. Durch dieses Zusammenspiel kommt es nur zu partieller Agglomeration und die Arbeitsmarktdisparitäten können zwischen nicht-entleernten Regionen gemessen werden. Aus dem Modell geht hervor, dass nicht nur die zentripetalen und zentrifugalen Kräfte des NÖG-Teils des Modells für die Disparitäten regionaler Arbeitsmärkte bestimmend sind, sondern dass darüber hinaus der Grad der Arbeitsmarktfraktionen Rückwirkungen auf diese Disparitäten hat. Wenn die Arbeitsmarktfraktionen zunehmen, dann führt dies zu einem Anstieg der Arbeitsmarktdisparitäten, welcher wiederum die Disparitäten der regionalen Ökononien verstärkt.
Zusammenfassung

Während sich die meisten anderen Modelle, welche Arbeitsmarktfriktionen in die NÖG einführen, auf Matching-Friktionen konzentrieren, basiert das Modell in Kapitel 3 auf Lohnsetzungsfriktionen in Form von Effizienzlöhnen. Damit soll nicht ausgedrückt werden, dass Effizienzlöhne der einzig relevante Mechanismus seien; stattdessen soll die Relevanz von Effizienzlöhnen für regionale Arbeitsmarktdisparitäten hervorgehoben werden. Empirische Studien zeigen, dass Effizienzlöhne in der Tat relevant sind. Das Modell aus Kapitel 3 erweitert die bestehende Literatur zusätzlich dadurch, dass die Interdependenz der Arbeitsmarktfriktionen mit dem Agglomerationsprozess, den Disparitäten der regionalen Ökonomien, und den Disparitäten der regionalen Arbeitsmärkte aufgezeigt und erläutert wird.


Das Modell aus Kapitel 4 zeigt eine Verbindung zwischen den beiden Literatursträngen, indem erarbeitet wird, unter welchen Umständen die höheren Löhne in der Agglomeration mit höherer oder geringerer Arbeitslosigkeit verbunden sind. Das zentrale Argument ist, dass die Lohnkurve (wage curve) einer Region durch Änderungen der Pendlerkosten verschoben wird. Diese Verschiebung erfolgt, da die Pendlerkosten die Arbeitsanreize beeinflussen, welche ein zentrales Element der durch
Effizienzlöhne begründeten Lohnkurve darstellen. Es hängt dann von der Stärke der zentripetalen und zentrifugalen Kräfte, repräsentiert durch die Lohndifferenzen zwischen den Regionen, und dem Ausmaß der Pendlerkosten ab, ob die Arbeitslosenquote in der Agglomeration höher oder geringer als in der Peripherie ausfällt.

Zusätzlich trägt das Modell zur Literatur bei, indem es die Relevanz von Kontrollvariablen hinsichtlich des Agglomerationsgrades, repräsentiert durch die Pendlerkosten, für empirische Analysen zur Lohnkurve hervorhebt. Solche Kontrollvariablen wurden bisher nur von wenigen empirischen Lohnkurvenanalysen berücksichtigt. Außerdem trägt das Modell dadurch zur Literatur bei, dass es zeigt, unter welchen Umständen die Agglomeration ökonomischer Aktivität mit höherer Arbeitslosigkeit in der Agglomeration als in der Peripherie verbunden ist, wohingegen die meisten bisherigen Modelle, welche Arbeitsmarktfriktionen in die NÖG integrieren, üblicherweise ausschließlich geringere Arbeitslosigkeit in der Agglomeration behandelten.


Zusammenfassung


Politikimplikationen


Schlussendlich wissen wir wenig und so viele Dimensionen werden in der derzeitigen Analyse außer Acht gelassen, dass nur wenige Ratschläge an Politiker gegeben werden können. Andererseits ist das Glas auch halb voll. (Combes 2011, S. 590; Übersetzung des Autors)

Die Politikimplikationen dieser Arbeit sollen daher vor dem Hintergrund einer NÖG-Literatur interpretiert werden, deren Politikimplikationen noch unvollständig und im Entwicklungsstadium sind. Die Politikimplikationen dieser Arbeit, welche zu großen Teilen auf der NÖG basiert und deren primäres Ziel es ist, die NÖG-Literatur um imperfekte Arbeitsmärkte zu erweitern, müssen vor diesem Hintergrund zwangsläufig ebenso unvollständig bleiben.

Die zentrale Aussage dieser Arbeit ist, dass die Agglomeration ökonomischer Aktivität für die Disparitäten regionaler Arbeitsmärkte relevant ist. Dies wird durch die Kapitel 2 bis 4 diskutiert. Kapitel 5 präsentiert empirische Ergebnisse, welche die Relevanz dieser Argumente stützt. Tatsächlich zeigen die Ergebnisse aus Kapitel 5 lediglich einen kurzfristigen Effekt des Marktzugangs auf regionale Arbeitsmärkte. Allerdings kann dies auch dadurch geschuldet sein, dass sich der Zugewinn an Marktzugang im Zuge der Wiedervereinigung im Zeitablauf dadurch abgeschwächt hat, dass sich die wirtschaftliche Situation Ostdeutschlands nach der Wiedervereinigung verschlechtert hat und so den ursprünglichen Zugewinn an Marktzugang potentiell schrittweise wieder verringert hat.


Zusammenfassung

Die Modelle aus Kapitel 3 und 4 implizieren, dass eine Reduktion der Verdichtungsexternalitäten und der Pendlerkosten Anreize zur Einwanderung in die Agglomeration setzt, was mit höherer Produktivität und einer besseren Arbeitsmarktsituation in der Agglomeration einhergeht. Allerdings implizieren die Modelle auch, dass dies Kosten für die Peripherie nach sich zieht. Zudem fehlt eine vollständige Analyse der aggregierten Wohlfahrteffekte sowohl in der bestehenden Empirie wie auch der Theorie. Ob die Ökonomie daher von solchen Politikmaßnahmen insgesamt profitiert, bleibt unklar.

Die hier präsentierten Modelle können somit nur Beiträge dazu liefern, welche Mechanismen wirken; eine vollständige Wohlfahrtsanalyse bieten sie nicht. Auch die Größenordnung der Effekte dieser Mechanismen ist nur für den Effekt der Bevölkerungsdichte auf die Produktivität bekannt, aber nicht, wie diese Effekte mit Migrationsanreizen zusammenwirken. Kapitel 5 beinhaltet Evidenz hinsichtlich der Effekte des Marktzugangs auf Arbeitsmarkteindikatoren. Allerdings bezieht sich die Analyse auf die spezifische Situation während der Deutschen Wiedervereinigung und weitere Studien sind notwendig, um zu erforschen, ob ähnliche Größenordnungen der Effekte auch in weniger spezifischen Situationen auftreten.


\[4\text{Eine Reduktion der Verdichtungsexternalitäten kann beispielsweise durch eine Verbesserung der Verkehrstransportinfrastruktur, der Verringerung von Umweltexternalitäten, oder ein größeres Wohnungs-/Immobilienangebot erreicht werden.}\]

Die zentrale Schlussfolgerung aus den Politikimplikationen dieser Arbeit ist somit, dass die Erkenntnisse aus der NÖG-Literatur wichtige Informationen für die Disparitäten regionaler Arbeitsmärkte liefern. Eine vollständige Bewertung der aggregierten Wohlfahrtseffekte von Regionalpolitik liegt aber nicht vor. Regionale Arbeitsmarktpolitik kann dennoch von der NÖG-Literatur lernen. Die hier vorgestellten Ergebnisse helfen, die zugrundeliegenden Mechanismen zu verstehen. Für eine vollständige Bewertung spezifischer regionaler Arbeitsmarktpolitiken wäre dagegen eine Bewertung der Abwägung zwischen Gleichheit und Effizienz notwendig. Vor allem sollten sich Politiker nicht nur auf die Effekte von Maßnahmen konzentrieren, welche sich auf die Region beziehen, in welcher die Maßnahme umgesetzt wird, sondern ebenso die umliegenden Regionen berücksichtigen, wie auch die dynamischen Effekte im Zuge der Ansiedlungsentscheidungen und deren Folgewirkungen für die Zielvariablen.