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Regional Unemployment and New Economic Geography

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Regional Unemployment and New Economic Geography

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March 7, 2011

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 disparities of these variables between regions endogenously arise. In contrast, the New Economic Geography analyzes how disparities of regional goods markets endogenously arise, but usually ignores unemployment. Therefore, this paper discusses regional unemployment disparities by introducing efficiency wages into the New Economic Geography. This model shows how disparities of regional goods and labor markets endogenously arise through the interplay of increasing returns to scale, transport costs and migration.

JEL Classification: J64, R12, R23

Keywords: regional unemployment, new economic geography, core-periphery, wage curve, labor migration

1 Introduction

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

In the literature, different approaches for modeling regional labor markets exist. Blanchard and Katz present the perhaps most comprehensive model for explaining disparities between regional labor markets (Elhorst; 2003). Blanchard and Katz (1992) regionalize a wage-/price-setting model. They discuss how regional labor markets adjust to shocks in labor demand via 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 on the regional level, the wage curve has to be similar for all regions as well. Under this assumption disparities of regional labor markets are predominantly the result of differences in labor demand between the regions. Regional labor demand in turn is derived from regional production. However, Blanchard and Katz (1992) do not endogenously explain why labor demand and production differ between regions. Instead, the authors discuss the impacts of shocks in labor demand on regional labor markets. They do not discuss how disparities endogenously arise.

Overman and Puga (2002) empirically show that disparities of 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 for these disparities. The New Economic Geography analyzes how disparities of regional goods markets endogenously arise. Models of the New Economic Geography are traced back to the basic core-periphery model by Krugman (1991). Krugman (1991) models centrifugal and centripetal forces and discusses how regional disparities of goods markets endogenously arise 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 combining New Economic Geography models with theories of unemployment to explain disparities of regional labor markets. Only individual approaches modeling frictions of regional labor markets within the framework of the New Economic Geography exist, such as the model of Epifani and Gancia (2005). Nevertheless, these authors concentrate on frictions in job matching, whereas wages are assumed to be flexible.

In this paper disparities of regional labor markets are discussed in the framework of the New Economic Geography. The core-periphery model of Krugman (1991) forms the basis for the modeling of disparities of regional goods markets, and its labor market is adjusted. Therefore the 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 manufacturing goods are traded freely between the regions. However, iceberg transport costs exist for manufacturing goods. While in the Krugman model employment in a region is determined by the labor force (due to full employment), in the present model unemployment is allowed to be larger than zero. Employment is therefore not only endogenous in the long run due to migration (as in the Krugman model), but as well 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 on the regional level.[1] Blien (2001) for example argues that they are in particular suitable to model a wage curve for German regions.

The efficiency wage model of Shapiro and Stiglitz (1984) is based on the utilities of unemployed, shirking and non-shirking employed. 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 the regions: Unemployed compare their lifetime utilities between both regions and decide to migrate if their utility in the neighboring region is higher than in their home region.

The rest of the paper is organized as follows: In chapter 2 an overview of the related literature is delivered. The basic model is presented in chapter 3. Subsequently the equilibrium is discussed with a special focus on migration. Chapter 5 is about on the stability of the equilibria. Results are interpreted and discussed in chapter 6 and conclusions are drawn in the final chapter.

[1] Cahuc and Zylberberg (2004) deliver a summary of the empirical relevance of the wage curve approach.

2 Related Literature

Different approaches exist that integrate the labor market into the New Economic Geography. Several models discuss labor market rigidities within the New Economic Geography or related models for the comparison of national states. However, due to their focus on the international level these models assume immobile labor. For example, Méjean and Patureau (2010) discuss the influence of minimum wages on location decisions of firms. Strauss-Kahn (2005) studies — in the framework of the New Economic Geography — how fixed wages and heterogeneous labor leads to vertical specialization an further increases disparities of high and low skilled labor. Picard and Toulemonde (2006) present a core-periphery model with labor unions bargaining over wages. Higher wages can increase purchasing power in a country under certain circumstances and an effect on the domestic market might result, stimulating agglomeration. However, the authors ignore unemployment. Monford and Ottaviano (2002) discuss a New Economic Geography model in which agglomerative forces result from the labor market. Chen and Zhao (2009) chose a 2-country 2-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 of these models assume immobile labor between the regions and therefore concentrate on the international level.

Peeters and Garretsen (2000) model heterogeneous labor and rigid wages within the New Economic Geography. They analyze the impact of globalization (in 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 both countries. Furthermore, they discuss institutional differences between the labor markets. Therefore, their approach is adequate for discussing disparities between national states, but it is less suitable for analyzing disparities of regional labor markets within a national state since labor market institutions vary only marginally on the regional level.[2]

This paper instead 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 New Economic Geography. Rigidities exist in regional labor markets based on job matching, leading to equilibrium unemployment. Through

[2]Three further models should be mentioned here: Haaland and Wooton (2007) model the location decision of multinational companies when there is wage bargaining with labor unions. Pflüger (2004) discusses the location decision when there is monopolistic competition and when differences exist in the social insurance and tax systems. Dewit et al. (2003) analyze the location decision of oligopolistic companies when dismissal costs differ between countries (by use of game theory).

the goods market, based on the New Economic Geography, agglomeration might result (for medium and low transport costs). If agglomeration occurs, this affects regional labor markets leading to lower unemployment in the agglomeration compared to the periphery. In the short term migration decreases unemployment disparities, since unemployed leave the lagging region. However, in the long term migration intensifies unemployment disparities through 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 New Economic Geography.

Südekum (2005) models a wage curve based on efficiency wages within the framework of a goods market which is characterized by monopolistic competition and increasing returns to scale. However, the author concentrates exclusively on agglomerative forces and prevents full agglomeration only by assuming a home bias for migration. He views his model as a first step to include unemployment into the New Economic Geography but does not refer to his model as a New Economic Geography model due to the omission of centrifugal forces. The model of Südekum (2005) is based on an earlier model of Matusz (1996).[4]

Thus, Südekum (2005) already took the first step of introducing efficiency wages into a model of monopolistic competition. However, Suedekum only includes centripetal but no centrifugal forces. Against this background the present paper introduces efficiency wages into a full New Economic Geography model and discusses the impacts of agglomeration on regional labor markets.

Egger and Seidel (2008) deliver a comparable approach. They integrate a “fair wage” approach into the New Economic Geography. The work effort of low qualified is influenced by the fairness of their wages. This leads to a link between wages and unemployment. However, only low qualified may become unemployed. Furthermore, low qualified are (in contrast to high qualified) inter-regionally immobile. In addition, the wage of low qualified is fixed to one in both regions. Thus a wage curve exists only in the sense that the unemployment of low qualified is linked to the wage of high qualified. The model presented here instead shows a link between wage and unemployment of *the same* labor market group and unemployed are allowed to migrate between the regions.

[3]Francis (2009) extends the Epifani and Gancia (2005) model so as to endogenise the job destruction rate.

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

3 Basic Model

The present paper develops a New Economic Geography model with labor market rigidities based on efficiency wages (and thus a wage curve). The model is constructed to discuss how disparities of regional labor markets endogenously arise. The New Economic Geography part of this model is depicted from Fujita et al. (1999). Their household model is extended to disutility of work effort which is basic 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.

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, goods and labor market. Manufacturing instead is characterized by monopolistic competition on the goods market and efficiency wages on the labor market. Labor is inter-sectoral immobile but labor in manufacturing is interregional mobile. Labor in agriculture is interregional immobile.

3.1 Households

Households receive utility by the consumption of agricultural goods C_A and by the consumption of manufacturing goods. C_M represents a composite index of manufacturing goods. Utility is lowered by work effort e.[5]

$$U = C_M^{\mu} C_A^{1-\mu} - e \tag{1}$$

The composite index of manufacturing goods is a CES utility function:

$$C_M = \left[\int_0^m C_i^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}} \tag{2}$$

The number of firms is given by m and the elasticity of substitution between the varieties of the manufacturing goods is $\theta > 1$. Households maximize their utility in two stages. They decide upon the optimum division of their income on agricultural and manufacturing goods. In addition they decide upon the optimum composition of the varieties of the manufacturing good. The budget constraint of household j is:

$$GC_{Mj} + P_A C_{Aj} = I_j \tag{3}$$

[5] This utility function can be extended to cover congestion costs by multiplying it with a congestion costs factor H similar to Ricci (1999). Then the agglomeration pattern changes, as we show in another paper (Zierahn; 2011).

Household j uses all of his income I_j for consumption of agricultural goods C_A at price $P_A \equiv 1$ and for consumption of the composite index of manufacturing goods C_M at price index G. Due to the standardization $P_A \equiv 1$, the prices of the manufacturing goods (and all wages) are measured relative to agricultural prices. Inserting the budget constraint into the utility function delivers:

$$U_j = C_{Mj}^{\mu} \left(I_j - GC_{Mj}\right)^{1-\mu} - e \tag{4}$$

Utility maximization ($\partial U_j / \partial C_{Mj} = 0$) leads to the consumption expenditure shares of agricultural and manufacturing goods in income. Note that the result of the utility maximization is independent of work effort:

$$C_{Mj} = \mu \frac{I_j}{G} \tag{5}$$

$$C_{Aj} = (1-\mu) I_j \tag{6}$$

The optimum division of expenditures for manufacturing goods on the individual varieties results from utility maximization over the varieties. This is equal to minimizing the expenditures for the varieties (Shepards Lemma):

$$min \int_0^m P_i C_i di \; s.t. \; \left[\int_0^m C_i^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}} = C_M \tag{7}$$

This leads to the CES manufacturing price index G:

$$G = \left[\int_0^m P_i^{1-\theta} di\right]^{\frac{1}{1-\theta}} \tag{8}$$

In the two-region-case with identical firms and iceberg transport costs $\tau \geq 1$ this leads to the manufacturing goods price index G_r in region r:

$$G_r = \left[m_r P_r^{1-\theta} + m_s (\tau P_s)^{1-\theta}\right]^{\frac{1}{1-\theta}} \tag{9}$$

whereas m_r and m_s represent the number of firms (=varieties) in the corresponding region. The demand for variety i by household j follows from minimizing expenditures for the varieties:

$$C_{ij} = \left(\frac{P_i}{G}\right)^{-\theta} C_{Mj} = \left(\frac{P_i}{G}\right)^{-\theta} \mu \frac{I_j}{P} \tag{10}$$

	Description
C_A	consumption of agricultural goods
C_M	composite index of manufacturing goods
C_i	consumption of manufacturing good i
e	disutility of work effort
G	CES manufacturing price index
I	income
$L_{A,M}$	agricultural/manufacturing employees
M	difference in expected life-time utilities
m	number of manufacturing firms (varieties)
$N_{A,M}$	agricultural/manufacturing labor force
P_A	price of agricultural goods
P_i	price of manufacturing good i
$P_t(i,j)$	transition probability from status i to status j at time t
q_i	manufacturing output of firm i
$()_{r,s}$	regions r and s
s	additional labor input due to shirking
U_j	utility of household j
U^{ns}, U^s, U^u	utility of (non-)shirking employees / unemployed
$U_{r,s}$	unemployment rate in region r (s)
$v(w)$	utility resulting from the wage
V^{ns}, V^s, V^u	expected life-time utility of (non-)shirking employees / unemployed
w	wage rate
β	fix labor input
$1-\gamma$	detection probability of shirking
δ	endogenous job creation rate
θ	elasticity of substitution between manufacturing varieties
λ	share of manufacturing employees in region r
μ	expenditure share of manufacturing goods
π	yield/profit
ρ	discount rate of utility
τ	transport costs
ϕ	variable labor input
ψ	exogenous job destruction rate

Table 1: List of Variables and Parameters

3.2 Labor Market

The labor market is modeled within the efficiency wage framework of Shapiro and Stiglitz (1984). Here the derivation of their wage curve is based on Zenou and Smith (1995).[6] Only the derivation of the wage curve for region r is presented. The wage curve for region s follows analogously. Employees (which are equal to households) receive utility $v(w_r)$ through the wage w_r in region r, which is equal to the household income I_j. The income of unemployed households is zero. Households suffer from disutility of work effort e, analogous to the utility function (1):

$$v(w_r) = C_M^{\mu} C_A^{1-\mu} \tag{11}$$

Thus, the term $v(w_r)$ is only a means to abbreviate the derivation of the wage curve. Due to disutility of work effort, employees have an incentive to shirk and hence to avoid work effort. The utility of a non-shirking employee in region r is $U_r^{ns} = v(w) - e$, the utility of a shirking employee is $U_r^s = v(w)$ and unemployed do not receive any utility $U_r^u = 0$. The employment status of the households are subject to a time-homogenous Markov process with status 0 for unemployed and status 1 for employed. The transition probabilities $P_t(i, j)$ at time t depend on the current status, the endogenous job generation rate δ_r, the exogenous job destruction rate ψ and the detection probability of shirking $1 - \gamma$.[7] The transition probabilities of non-shirking and shirking employees are then described by (see Zenou and Smith (1995) for a detailed derivation of this result):

$$P_{t,r}^{ns}(0,1) = \frac{\delta_r}{\psi + \delta_r} - \frac{\delta_r}{\psi + \delta_r} e^{-t(\delta_r + \psi)} \tag{12}$$

$$P_{t,r}^{ns}(1,1) = \frac{\delta_r}{\psi + \delta_r} - \frac{\psi}{\psi + \delta_r} e^{-t(\delta_r + \psi)} \tag{13}$$

$$P_{t,r}^{s}(0,1) = \frac{\delta_r}{\psi + \delta_r + 1 - \gamma} - \frac{\delta_r + 1 - \gamma}{\psi + \delta_r + 1 - \gamma} e^{-t(\delta_r + \psi + 1 - \gamma)} \tag{14}$$

$$P_{t,r}^{s}(1,1) = \frac{\delta_r}{\psi + \delta_r + 1 - \gamma} - \frac{\psi + 1 - \gamma}{\psi + \delta_r + 1 - \gamma} e^{-t(\delta_r + \psi + 1 - \gamma)} \tag{15}$$

The parameter ρ is the discount rate of utility. The lifetime utilities of shirking and non-shirking employees are then derived similar to Zenou and Smith (1995):

[6]Zenou and Smith (1995) construct a two-city-model with intra- and inter-city migration. They derive the Shapiro and Stiglitz (1984) efficiency wage model by using Markov processes to model the transitions from and to unemployment. For the purpose of the present model the inter-city migration is adopted to the two-region case.

[7]Those employees who are detected shirking at work are laid off.

$$
\begin{aligned}
V_r^{ns} &= \int_0^\infty \left[P_t^{ns}(1,0)U_r^u + P_t^{ns}(1,1)U_r^{ns}\right] e^{-\rho t} dt \\
&= \frac{(\delta_r + \rho)U_r^{ns} + \psi U_r^u}{\rho(\delta_r + \psi + \rho)} \\
&= \frac{(\delta_r + \rho)(v(w_r) - e)}{\rho(\delta_r + \psi + \rho)} \qquad (16) \\
V_r^{s} &= \int_0^\infty \left[P_t^{s}(1,0)U_r^u + P_t^{s}(1,1)U_r^{s}\right] e^{-\rho t} dt \\
&= \frac{(\delta_r + \rho)U_r^{s} + (\psi + 1 - \gamma)U_r^u}{\rho(\delta_r + \psi + \rho + 1 - \gamma)} \\
&= \frac{(\delta_r + \rho)(v(w_r))}{\rho(\delta_r + \psi + \rho + 1 - \gamma)} \qquad (17)
\end{aligned}
$$

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 utilities of shirking and non-shirking employees ($V_r^{ns} = V_r^s$):

$$
v(w_r) = e\frac{\rho + \psi + \delta_r + 1 - \gamma}{1 - \gamma} \qquad (18)
$$

Second, in equilibrium the inflow to unemployment ψL_{Mr} is equal to the outflow of unemployment $\delta(N_{Mr} - L_{Mr})$ (where L_{Mr} is the number of manufacturing employees and N_{Mr} is the manufacturing labor force in region r). Therefore the endogenous rate of job creation is given by:

$$
\delta_r = \psi L_{Mr}/(N_{Mr} - L_{Mr}) \qquad (19)
$$

Taking into account the definition for $v(w_r)$ and the definition of the unemployment rate $U_r = L_{Mr}/(N_{Mr} - L_{Mr})$ delivers the wage curve for region r (the wage curve for region s is constructed in the same way).

$$
w_r = \frac{G_r^\mu}{K} e \left[1 + \frac{\rho}{1-\gamma} + \frac{\psi}{(1-\gamma)U_r}\right] \text{ where } K = \left(\frac{1-\mu}{\mu}\right)^{1-\mu} \mu \qquad (20)
$$

Equation (20) directly links the wage 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.

Now, migration takes place. Individuals who migrate are unemployed in the immigration-region at first, due to search unemployment. An individual decides to migrate when her expected life-time utility as an unemployed is larger abroad than in the current status at home. However, to monitor whether migration takes place it is sufficient to compare expected life-time utilities of unemployed in both regions. The reason is that the expected life-time utility of employees is always larger than that of unemployed: $V_r^{ns} > V_r^u$. Therefore, migration takes place when $V_r^u < V_s^u$. This is true as long as we are interested in whether someone migrates instead of who (employees or unemployed) migrates. For observing migration we therefore compare expected life-time utilities of unemployed in both regions. The expected life-time utility of an unemployed in region r is given by:[8]

$$\begin{aligned} V_r^u &= \int_0^\infty \left[P_t^{ns}(0,0)U_r^u + P_t^{ns}(0,1)U_r^{ns}\right] e^{-\rho t} dt \\ &= \frac{\delta_r U_r^{ns} + (\psi+\rho)U_r^u}{\rho(\delta_r+\psi+\rho)} \\ &= \frac{\delta_r(v(w_r)-e)}{\rho(\delta_r+\psi+\rho)} \end{aligned} \tag{21}$$

Taking account of the definition for $v(w_r)$ delivers:

$$\rho V_r^u = \frac{\delta_r}{\rho+\psi+\delta_r}\left[w_r \frac{K}{G_r^\mu} - e\right] \tag{22}$$

Emigration (immigration) takes place when the expected life-time utility of unemployed in the neighboring region is larger (lower) than the expected life-time utility of unemployed in the home region.

3.3 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 as well, 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 payment in the agricultural labor market, the price of agricultural goods is equal to 1: $P_A = \partial C_A / \partial L_A = w_A = 1$. Prices and wages in agriculture are fixed to 1 and serve as reference for prices and wages in manufacturing.

Firms in manufacturing instead produce under increasing returns to scale and monopolistic

[8] See Zenou and Smith (1995).

competition. There is trade of manufacturing goods at iceberg transport costs τ. The production function in manufacturing is:

$$L_{Mi} = \beta + \phi q_i + s_i \tag{23}$$

For production firm i needs a fixed labor input β, a variable labor input ϕ per unit of output q_i and an additional labor input s_i due to shirking employees. Labor demand L_{Mi} of firm i is the sum of these three components. Due to efficiency wages there is no shirking and hence no additional labor input is needed: $s_i = 0$. Due to love for variety no combination of firms exists producing the same variety. The yield of firm i is given by:

$$\pi_i = P_i q_i - w_r(\beta + \phi q_i) \tag{24}$$

Firms maximize their profit through prices and ignore their influence on the price index G. This leads to the price setting rule for the regional price P_r which is identical for all firms of a region (due to identical wages within a region and due to identical firms):

$$\frac{\partial \pi_i}{\partial P_i} = 0 \Rightarrow P_r = \frac{\theta}{\theta - 1} w_r \phi \tag{25}$$

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

$$\pi_i = \frac{\theta}{\theta - 1} w_r \phi q_i - w_r(\beta \frac{\theta - 1}{\theta} \phi q_i) = 0 \Rightarrow 0 = w_r \left(\frac{\phi q_i}{\theta - 1} - \beta \right) \tag{26}$$

Then production and employment of a firm in equilibrium are given by:

$$q_i = \frac{\beta(\theta - 1)}{\phi} \tag{27}$$

$$L_{Mi} = \beta + \phi \frac{\beta(\theta - 1)}{\phi} = \beta\theta \tag{28}$$

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

$$m_r = L_{Mr}/L_{Mi} = L_{Mr}/(\beta\theta) \tag{29}$$

The labor input per unit of output is standardized to $\phi \equiv (\theta - 1)/\theta$, so that price and production reduce to:

$$P_r = w_r \tag{30}$$

$$q_i = \theta\beta = L_{Mi} \tag{31}$$

The fix labor input is standardized to $\beta \equiv \mu/\theta$. Then the number of firms (=varieties) in a region as well as the production of a firm are given by:

$$m_r = L_{Mr}/\mu \tag{32}$$

$$q_i = L_{Mi} = \mu \tag{33}$$

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 firms variety (taking into account iceberg transport costs τ).[9]

$$q_i = \mu I_r P_r^{-\theta} G_r^{\theta-1} + \mu I_s (\tau P_r)^{-\theta} G_s^{\theta-1} \tau \tag{34}$$

$$\Rightarrow w_r = \left[I_r G_r^{\theta-1} + I_s G_s^{\theta-1} \tau^{1-\theta} \right]^{\frac{1}{\theta}} \tag{35}$$

The latter equation represents the goods market equilibrium in 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. For lower wages, the profit of an additional firm is greater than zero so that new firms enter the market. This results in increasing employment, decreasing unemployment and increasing 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.

4 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 are constructed analogous):

[9] If one unit of the manufacturing good is transfered to the neighboring region, only $1/\tau$ units arrive. Therefore τ units have to be sent when 1 unit shall arrive.

$$G_r = \left[\frac{1}{\mu}\left(L_{Mr} w_r^{1-\theta} + L_{Ms}(\tau w_s)^{1-\theta}\right)\right]^{\frac{1}{1-\theta}} \tag{36}$$

$$w_r = \left[I_r G_r^{\theta-1} + I_s G_s^{\theta-1} \tau^{1-\theta}\right]^{\frac{1}{\theta}} \tag{37}$$

$$I_r = w_r L_{Mr} + L_{Ar} \tag{38}$$

$$w_r = \frac{G_r^{\mu}}{K} e \left[1 + \frac{\rho}{1-\gamma} + \frac{\psi}{(1-\gamma)U_r}\right] \tag{39}$$

From (36), 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, 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 price setting equation (37)[10] 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. 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 manages to gain a higher income will be able to use this advantage for attracting 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 due to its higher purchasing power. This region is further characterized by a larger number of varieties and thus a lower price index and 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 centrifugal forces resulting from the demand by the agricultural employees.

Equation (39) represents the wage curve, which is the extension of this paper 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.

For a compact illustration of the model the labor force (as a sum of agricultural and manu-

[10]This equation is labeled "wage equation" by Fujita et al. (1999).

facturing labor force) is standardized to one. This labor force is separated into agriculture (N_A) and manufacturing (N_M) according to the expenditure shares of agricultural and manufacturing goods in income. The agricultural labor force is equal in both region whereas the labor force in manufacturing is divided between the regions according to λ. Due to full employment in agriculture the corresponding labor force is equal to employment in both regions ($N_{Ar} = L_{Ar}$ and $N_{As} = L_{As}$).

$$L_{Ar} = \frac{1-\mu}{2} \tag{40}$$

$$L_{As} = \frac{1-\mu}{2} \tag{41}$$

$$N_{Mr} = \mu\lambda \tag{42}$$

$$N_{Ms} = \mu(1-\lambda) \tag{43}$$

The simultaneous equilibrium in the short term depends on the exogenous parameters: disutiliy of work effort (e), probability to observe shirking ($1-\gamma$), job destruction rate (ψ), share of expenditures for manufacturing (μ), elasticity of substitution between manufacturing goods varieties (θ) and discount rate (ρ). The model cannot be solved analytically but rather numerically, which is standard practice in New Economic Geography.

In the long term unemployed are allowed to migrate between the regions. Unemployed 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[11] and chances to find employment.[12] The agglomeration forces are similar to Fujita et al. (1999). Due to the wage curve, higher real wages in a region are always accompanied by lower unemployment in that region compared to the neighboring region. Migration behavior (expressed as the change in λ) is therefore sufficiently defined by:[13]

[11]The real wage in region r is: $w_r \frac{K}{G_r^{\mu}}$

[12]The chance to find employment depends on the endogenous job creation rate and thus directly depends on the unemployment rate.

[13]This definition of migration behavior is motivated by optimal migration decisions based on static expectations on the differences in real wages, unemployment and congestion costs between both regions (Baldwin et al.; 2003, Appendix 2.B.4). It 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 unemployed in both regions are equal.

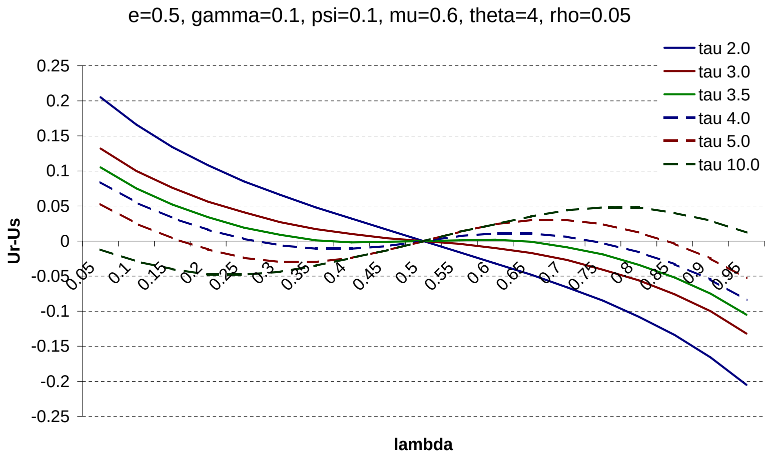

Figure 1: Equilibria and Migration

$$\begin{aligned} \dot{\lambda} > 0 \text{ for } \delta_r > \delta_s \text{ or } w_r \frac{K}{G_r^\mu} > w_s \frac{K}{G_s^\mu} \\ \dot{\lambda} = 0 \text{ for } \delta_r = \delta_s \text{ or } w_r \frac{K}{G_r^\mu} = w_r \frac{K}{G_s^\mu} \\ \dot{\lambda} < 0 \text{ for } \delta_r < \delta_s \text{ or } w_r \frac{K}{G_r^\mu} < w_r \frac{K}{G_s^\mu} \end{aligned} \tag{44}$$

In 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 λ, a short term equilibrium exists. However, if the utility of unemployed differs between the regions in the short term equilibrium, unemployed migrate leading to a new short term equilibrium. A long term equilibrium results when the utility of unemployed is equal in both regions so that no further migration occurs. For zero congestion costs, migration takes place from the region with the higher to the region with the lower unemployment rate. The difference in unemployment rates in the short term equilibrium, depending on λ, is displayed for different transport costs in Figure 1 (for the parameters $e = 0.5$, $\gamma = 0.1$, $\psi = 0.1$, $\mu = 0.6$, $\theta = 4$, $\rho = 0.05$).

Depending on transport costs τ, different situations result. For low transport costs the unemployment rate is always lower in the larger region (in the agglomeration). A marginal advantage of a region (compared to the other region) then leads to a self enforcing agglomeration process until full agglomeration is reached. The symmetric equilibrium at $\lambda = 0.5$ is instable in this case. For high transport costs the unemployment rate is always higher in the larger region so that the system returns to the symmetrical equilibrium at $\lambda = 0.5$ for initial λ. For medium transport costs, two additional equilibria (i.e. equal unemployment rates in both regions) result — in this case the symmetrical equilibrium is stable as is the equilibrium with full agglomeration. The additional equilibria then serve as thresholds that have to be crossed for the agglomeration process to be stable (i.e. to reach full agglomeration starting from symmetry).

5 Stability

Multiple equilibria result. The behavior of the system crucially depends on the stability of these equilibra. An long term equilibrium is given by equal unemployment rates in both regions, which is equal to the real wages being equal in both regions. As discussed above, the symmetrical equilibrium is instable for small transport costs but becomes stable once a certain value for the transport costs is crossed. This value marks the break point. For the equilibria at full agglomeration there is a similar pattern: They are stable for low transport costs but become instable once transport costs increase over a certain value. The value of the transport costs, where this change takes place, is the sustain point.

5.1 Sustain Point

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

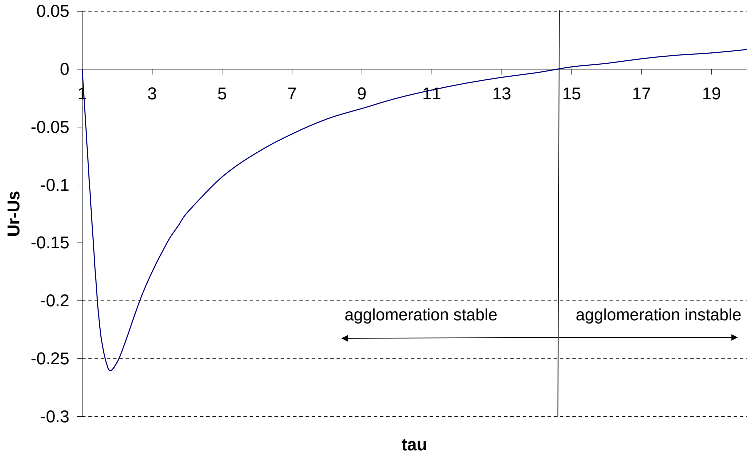

Figure 2: Sustain Point

$$G_r = \left(\frac{1}{\mu} L_{Mr} w_r^{1-\theta}\right)^{\frac{1}{1-\theta}} \qquad G_s = \left(\frac{1}{\mu} L_{Mr} (\tau * w_r)^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{45}$$

$$w_r = \left(I_r G_r^{\theta-1} + I_s G_s^{\theta-1} \tau^{1-\theta}\right)^{\frac{1}{\theta}} \qquad w_s = \left(I_s G_s^{\theta-1} + I_r G_r^{\theta-1} \tau^{1-\theta}\right)^{\frac{1}{\theta}} \tag{46}$$

$$I_r = w_r L_{Mr} + L_{Ar} \qquad I_s = L_{As} \tag{47}$$

$$w_r = \frac{G_r^\mu}{K} e \frac{\rho + \psi + \delta_r + 1 - \gamma}{1-\gamma} \qquad w_s = \frac{G_s^\mu}{K} e \frac{\rho + \psi + \delta_r + 1 - \gamma}{1-\gamma} \tag{48}$$

$$\delta_r = \frac{\psi L_{Mr}}{N_r - L_{Mr}} \tag{49}$$

Using these equations 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 cost lead to an increase of the price index in the periphery and the periphery becomes less attractive (the agglomeration becomes more stable). However, at the same time increasing transport cost lead to a decrease in the level of the wage at which firms reach their break-even point in the periphery. Thus, the periphery becomes more attractive for firms when transport costs increase (the agglomeration pattern becomes more instable). 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 instable. The net effect is illustrated in figure 2 by showing the development of the difference in unemployment rates against transport costs.

5.2 Break Point

In the break point transport costs increase to the level where the symmetrical equilibrium becomes stable. The symmetric equilibrium is stable, if a marginal increase of λ leads to an increase (decrease) of the unemployment rate in region r (s) (equally: to a decrease/increase of the chance of finding a job).[14] In this case any marginal deviation from symmetry leads to re-immigration into the marginally smaller region — the system returns to symmetry. On the other hand symmetry is instable, if a marginal increase of λ leads to a decrease (increase) of the unemployment rate in region r (s). Any deviation from symmetry then results in a self-enforcing agglomeration process. In order to find the break point, the deviation $\partial\delta_r/\partial\lambda$ for the system in the symmetric equilibrium is calculated and the value of τ is searched to find the point where the deviation is zero. At this point the symmetric equilibrium changes from instable to stable.

A special feature of the symmetric equilibrium is that the endogenous variables share the same values in both regions and the deviations of these values against λ have equal value but opposite sign in both regions. Therefore the index for the regions is dropped. The value of τ in the break point is then given by:

[14] Any marginal deviation from symmetry leads to deviations of the endogenous variables with equal value but different sign in both regions.

$$G = \left[\frac{1+\tau^{1-\theta}}{\mu}\left(L_M w^{1-\theta}\right)\right]^{1/(1-\theta)} \tag{50}$$

$$w = \left[(1+\tau^{1-\theta}) I G^{\theta-1}\right]^{1/\theta} \tag{51}$$

$$I = wL_M + L_A \tag{52}$$

$$w = \frac{G^\mu}{K} e \frac{\rho+\psi+\delta+1-\gamma}{1-\gamma} \tag{53}$$

$$\delta = \frac{\psi L_M}{\lambda N - L_M} \tag{54}$$

$$dG = \frac{G^\theta(1-\tau^{1-\theta})}{\mu}\left[\frac{w^{1-\theta}}{1-\theta} dL_M + L_M w^{-\theta} dw\right] \tag{55}$$

$$dw = \frac{w^{1-\theta} G^{\theta-1}(1-\tau^{1-\theta})}{\theta}\left[dI + (\theta-1) I \frac{dG}{G}\right] \tag{56}$$

$$dI = w dL_M + L_M dw \tag{57}$$

$$dw = \mu \frac{w}{G} dG \tag{58}$$

$$d\delta \equiv 0 = \frac{\psi}{\lambda N - L_M} dL_M + \frac{\psi L_M}{(\lambda N - L)^2}(N d\lambda - dL_M) \tag{59}$$

For small 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 takes places, leading to a core-periphery structure — the symmetric equilibrium is instable. For high transport costs export is 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 3 illustrates these effects by looking at the change of the unemployment rate (which directly follows from the change in δ) against transport costs. For low transport costs the unemployment rate increases in region r once region r has a marginally larger manufacturing labor force. Then symmetry is instable. For high transport costs the opposite is true and symmetry is stable. The break point lies at the value of τ where both effects offset each other and where the symmetric equilibrium changes from instable to stable.

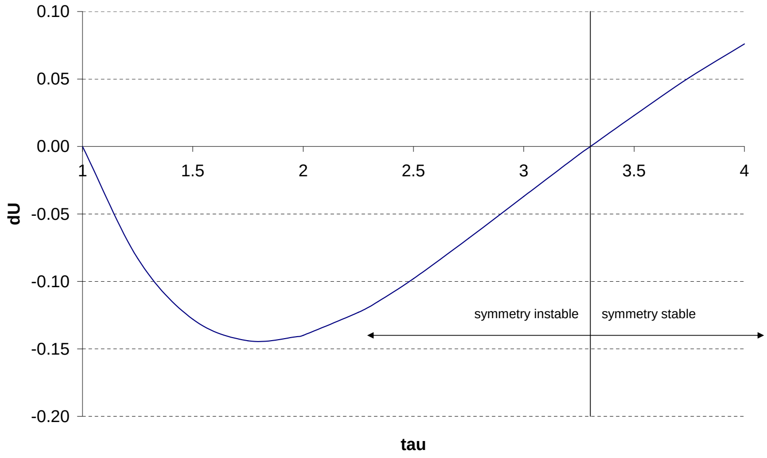

Figure 3: Break Point

5.3 Results and Parameter Variation

The long term equilibria for the above illustrated parameter constellation are summarized in figure 4 (the so called bifurcation diagram) by plotting the division of manufacturing labor force in the regions λ against transport costs τ. The continuous lines represent stable, and the dashed lines instable equilibria. For small τ the symmetric equilibrium at $\lambda = 0.5$ is instable, whereas the agglomeartion equilibria at $\lambda = 1$ and $\lambda = 0$ are stable. Increasing transport cost first lead to a stable symmetric equilibrium (the break point marks the border between stable and instable). Further increasing transport cost then lead to instable agglomeration equilibria: The agglomeration equilibria become instable and disappear (the sustain point marks the border between stable agglomeration and no agglomeration). Break and sustain points are connected through a dashed line representing the instable additional equilibria discussed earlier. These represent those thresholds that decide upon 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 elasticity of substitution leads to increasing product differentiation and decreasing mark-ups on prices resulting in a decrease of agglomeration advantages. Figures 5 and 6 represent graphical illustration of 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 μ increases or the elasticity of substitution θ decreases. This

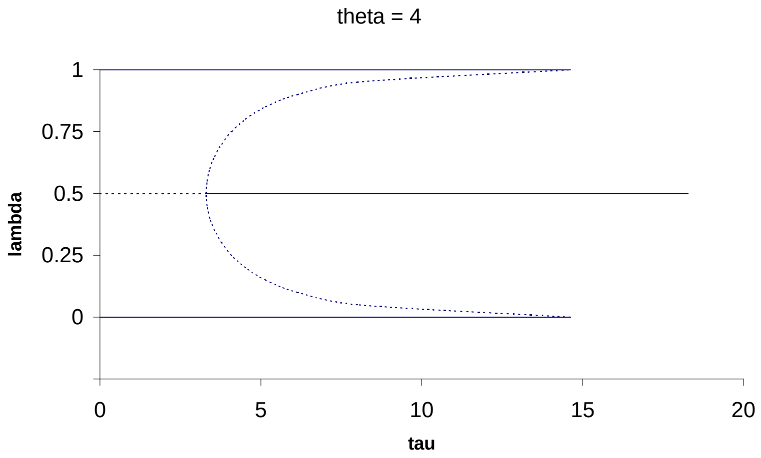

Figure 4: Bifurcation-diagram at $\theta = 4$

	$\mu = 0.2$		$\mu = 0.4$		$\mu = 0.6$	
	$\tau(B)$	$\tau(S)$	$\tau(B)$	$\tau(S)$	$\tau(B)$	$\tau(S)$
$\theta = 3$	1.669	1.718	3.055	4.471	8.718	3125
$\theta = 4$	1.373	1.393	1.972	2.339	3.302	14.62
$\theta = 5$	1.257	1.269	1.627	1.807	2.3	5

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

Table 2: Break- and sustain points for several θ and μ

is illustrated in table 2 where the transport costs at the sustain and break points are plotted against different θ and μ. The underlying parameters are $e = 0.5$, $\gamma = 0.1$, $\psi = 0.1$, $\rho = 0.05$. However, a variation of these labor market variables does not change the agglomeration pattern and hence the sustain and break points. The reason is that the agglomeration behavior of the regions stems from the goods market part of the model whereas the labor market part of the model translates the agglomeration pattern into unemployment and wages.[15]

[15]However, by choosing positive congestion costs the migration behavior changes, influencing the agglomeration pattern.

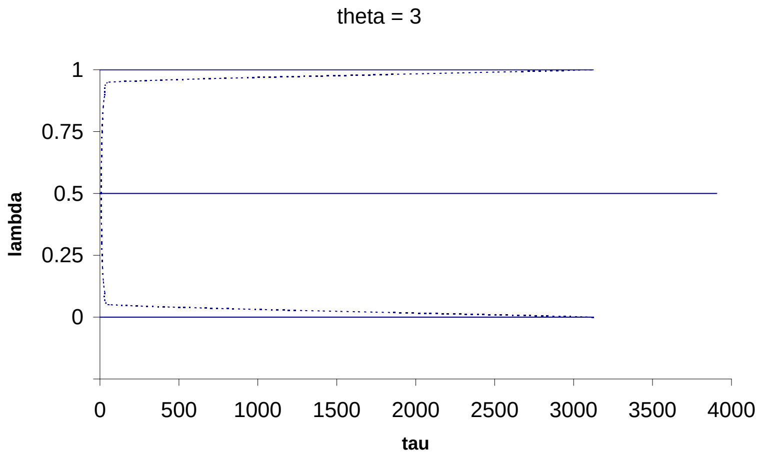

Figure 5: Bifurcation-diagram at $\theta = 3$

6 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 small transport costs full agglomeration of manufacturing in one region endogenously arises, even if both regions share the same characteristics and endowments. Only when transport costs are large enough, symmetry becomes a stable equilibrium (break point). When transport costs increase above the sustain point, agglomeration becomes instable and 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 endogenously arise through the interplay of transportation costs, increasing returns to scale and migration and how regional labor markets (especially wages and unemployment) adjust to agglomeration. Regional labor market disparities endogenously arise 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. Disparities in wages and unemployment endogenously arise through agglomeration in a similar way. However, they focus on labor market frictions in job matching processes and assume flexible wages, whereas this paper focuses on frictions in wage setting. Thus, their approach and the model presented

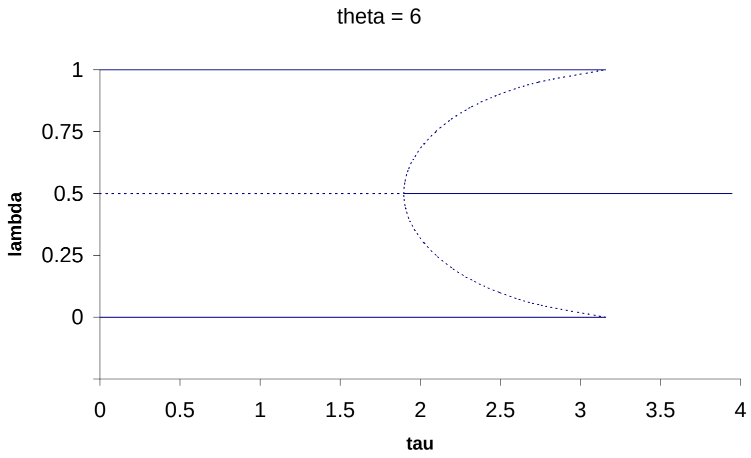

Figure 6: Bifurcation-diagram at $\theta = 6$

here complement each other by discussing different labor market frictions in the framework of the New Economic Geography.

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 paper, 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 compared to the periphery. Nevertheless, without any additional assumptions on migration full agglomeration necessarily results due to the lack of centrifugal forces. The present model instead discusses disparities of regional labor markets within the interplay of centrifugal and centripetal forces and is therefore able to distinguish under which circumstances disparities arise (or not).

7 Conclusions

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

The concept of the wage curve plays a key role, especially on 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 disparities between regional labor markets can only result from disparities in labor demand. Overman and Puga (2002) deliver empirical evidence in favor of labor demand being the main cause of regional labor market disparities in Europe. As a result regional goods markets play a key role for explaining disparities of regional labor markets. The New Economic Geography discusses how such disparities of regional goods markets endogenously arise.

Consequently, the present paper discusses how disparities of regional labor markets endogenously arise by introducing the wage curve (based on efficiency wages) into the New Economic Geography. The model presented here shows how disparities of regional goods markets endogenously arise through the interplay of increasing returns to scale, transport costs and migration and how this leads to disparities of regional unemployment rates and wages. If a core-periphery structure (endogenously) arises, unemployment is lower and wages are higher in the core compared to the periphery. The results are comparable to Epifani and Gancia (2005) who focus on frictions in job matching — opposed to frictions in wage setting, as presented here. Thus, their approach and the model presented here complement each other by discussing different labor market frictions in the framework of the New Economic Geography. The results are further comparable to Südekum (2005) who focuses on centripetal forces only, whereas the present paper discusses the interplay of centrifugal and centripetal forces.

Future research will show how the agglomeration pattern changes when congestion costs exist. Ricci (1999) discusses congestion costs in a New Economic Geography setting. However, how these congestion costs interact with regional labor markets and especially with migration decisions in the presence of unemployment is subject to future research.

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