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FIRM FORMATION AND INDUSTRIAL AGGLOMERATION UNDER MONOPOLISTIC COMPETITION - A STUDY ON GERMAN REGIONS

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Abstract

The presence of agglomeration economies tends to prompt a relocation and concentration of industries. It is also plausible that firm start-up activities reveal such effects. The present paper introduces an empirical testable model inspired by the New Economic Geography and human capital externalities literature. The novelty of this paper is that it derives a measure of agglomeration economies inspired by a microeconomic analysis, based on households' and firms' maximization behavior and reflected in the real market potential. Besides agglomeration forces, dispersion and human capital effects are separated and explicitly controlled for. This conceptual framework is empirically tested for German regions and industries. The paper sheds new light on the general mechanisms of intra-industrial agglomeration forces, as it explicitly considers the spatial distribution of economic activities. Our study provides clear evidence for the empirical significance and validy of the New Economic Geography.

Keywords: New Economic Geography, Agglomeration, Externalities, Firm Formation

JEL Classification: L13, O41, R11, R3

1. Spatial Industrial Dynamics

Firm growth and firm formation are often seen as a crucial factor for economic growth and development. From a policy perspective, firm growth is expected to: favour regional labour demand; raise local income and welfare; and reduce unemployment. Clearly, a fashionable policy aim is therefore to foster steady (regional) firm formation. However, in the presence of agglomeration forces and positive externalities a geographical industrial concentration might occur. This, in turn, makes a few privileged regions better-off, while other regions may lose. Then a clear result is the presence of regional disparities, which are usually not in line with overall policy aims. The reasons for the emergence of such agglomeration forces are: urbanization (Jacobs, 1969) and location (Marshall-Arrow-Romer) externalities; human capital externalities (Romer, 1990; Lucas, 1988); and increasing returns to scale. Duranton and Puga (2004) discuss and review several micro-based mechanisms of the occurrence of increasing returns (at least on an aggregate level). As a result, intra-industrial spillover effects may occur, and these are a crucial part of the New Trade Literature and the New Economic Geography (NEG).

On the other hand, dispersion forces, such as strong competition or the presence of (high) trade cost, may weaken agglomeration forces. Depending on the net balance of both effects, firms and sectors may be either equally distributed over regions or encouraged to agglomerate, so that, ultimately, the existence of multiple equilibria is a possible outcome. Both mechanisms are well known in the literature, and are explicitly addressed in the NEG literature launched by Krugman (1991). Therefore, solid empirical relevance on the NEG is essential to provide useful policy advice[1].

There is an extant literature which aims to identify such centripetal and centrifugal forces of industries. Main contributions relating to the identification of externalities can be found in the work of Glaeser et al. (1992) and Henderson (1995, 2003). Glaeser and Kerr (2009) provide evidence of several channels and types of urbanization and location externality in relation to firm formation. It is worth noting that their work does not rely on NEG models, and gives, therefore, more general evidence of externalities. Within an NEG setting, typically what is called a `nominal wage equation' is considered and estimated[2]. This type of equation should support the empirical relevance of the NEG. In this context, Rosenthal and Strange (2004) summarize and discuss possible ways to measure and identify agglomeration forces. One of the ways outlined by these authors is to consider firm

[1] Our study has a limitation, in that it does not test the NEG against competing theories (see, e.g., the discussion in Brakman et al., 2006).
[2] See Hanson, 2005; Brakman et al., 2004; Mion, 2003; Redding and Venables, 2004; Ottaviano and Pinelli, 2006; Niebuhr, 2006.

formation, and this is what we address in our analysis. The central question of this paper is, therefore, whether firm formation is based on the agglomeration forces and basic mechanisms of the NEG.

The branch of firm growth literature typically applies wage levels and GDP per capita as crucial explanatory variables, as observed by Bergmann and Sternberg (2007). These measures are related to labour productivity and may, therefore, act as drivers for start-up activities[3]. Agglomeration forces are frequently captured by density measures, and are often treated in empirical models in an ad hoc manner. On the other hand, NEG models typically assume constant labour productivity, while differences in wages occur due to agglomeration rents. Then, using labour productivity measures, such as wages, to explain firm formation might be misleading, as one cannot be sure whether one is measuring labour productivity or agglomeration rents.

This intriguing issue is the point of departure for our research. We focus on sector-specific regional firm growth, but avoid using the problematic labour productivity measures as crucial explanatory variables. Instead, we derive a model of firm formation which explicitly considers agglomeration and dispersion forces. The conceptual theoretical ideas in our work find their origin in Baldwin (1999). It is a micro-founded approach of household utility maximization and includes also the firm's maximization problem. The resulting model states that it is not GDP per capita or wages, but the firm's real market potential[4], that explains firm formation. Finally, it features agglomeration and dispersion forces on an aggregate level, so that it is not necessary to include agglomeration measures ad hoc. Head and Mayers (2004a) test, on a micro-level, the effect of the real market potential on a firm's location decision, and find significant effects. In the present paper, we address the question whether the suggested real market potential explains firm formation on a macro-level.

The paper is organized as follows. Section 2 outlines the theoretical background, and derives the basic theoretical equation of regional sector-specific firm growth. Next, Section 3 contains the empirical specification, introduces the database, and motivates additional control variables. Then, the estimation strategy is presented in Section 4 and the results are presented and discussed in Section 5. The paper ends with a conclusion in Section 6.

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[3] See Berglund and Brännäs, 2001; Carree, 2002; Gerlach and Wagner, 1994; Ritsilä and Tervo, 2002.
[4] For a definition of 'real market potential', see Section 2.

2. Theoretical Framework

The determinants of firm entry and firm formation are frequently addressed in the regional economics literature. Usually, regional unemployment, human capital, branch-specific needs, labour productivity, urbanization, and location externalities explain firm establishment on a regional level. The model developed in our study explicitly considers location externalities. It is grounded in, inter alia, the theoretical contributions of Baldwin (1999), who designed a model of neoclassical growth based on concepts from the New Trade Theory and New Economic Geography (NEG) literature. The subsequent subsection presents the main specification of the empirical model from a theoretical perspective,and offers also some econometric applications to German regions.

The economy is assumed to consist of households which supply their labour inelasticly such that the labour market always clears. The inter-temporal utility of households is of the CES-type with an elasticity of inter-temporal substitution equal to 1, and a time preference θ. They consume in each moment in time a variety of composite goods C_i from different branches or sectors i. Their temporal utility function is of a Cobb Douglas type, with nested CES-subutility functions for each sector (see equation (1)). The parameters a_i and σ_i denote industry-specific elasticities. The utility function of a representative household in region s is given by:

$$U = \int_0^{\infty} e^{-\theta t} \ln(U_s) dt;\ U_s = \prod_{i=1}^{I} C_{is}^{\alpha_i};\ C_{is} = \left(\sum_{n=1}^{N_i^w} (x_{ni}^{rs})^{\frac{\sigma_i - 1}{\sigma_i}} \right)^{\sigma_i/(\sigma_i - 1)} \quad (1)$$

$$\sum_{i=1}^{I} \alpha_i = 1; 0 \leq \alpha_i \leq 1; \sigma_i > 1, \quad (2)$$

where x_{ni}^{rs} is the nth variety of a particular firm producing in sector i, with N_i^w the total number of producers worldwide. This good might be produced within the home region s or imported from any other region r. A representative household maximizes its temporal utility subject to a budget constraint with an expenditure level E_s. The Marshallian demand curve of x_{ni}^{rs} can now be easily derived[5], and can be represented by:

$$x_{ni}^{rs} = \alpha_i \frac{(p_{ni}^{rs})^{-\sigma_i}}{P_{is}^{1-\sigma_i}} E_s, \quad (3)$$

where p_{ni}^{rs} is the consumer price of the good concerned in s, and P_{is} is the perfect consumer price index of sector i in region s.

As mentioned above, there may be various distinct products or producers within sector i. They might offer homogeneous or heterogeneous commodities. Within the theoretical NEG framework, the sector assignment for competitive and ‘monopolistic’ markets is given in advance. From an empirical perspective however, this is not very plausible. The crucial point here is whether households

[5] See Brakman et al., 2001.

can distinguish products or not. If they do not distinguish products, then one will end up with one competitive sector and homogeneous goods. The advantage of the CES index is that it allows us to consider those goods in the case of an infinite positive substitution elasticity[6] σ_i. Thus, we allow various producers to supply a homogeneous good, while households would consume the product with the lowest price. Then, a competitive sector results[7]. Therefore, the approach outlined here does not rely on the prior identification of sectors as competitive or 'monopolistic'.

Now the world demand $\bar{x}_{ni}^{r}$ of a single product n manufactured in region r is simply the sum of x_{ni}^{rs} over all s regions. For the sake of simplicity, we utilize the concept of the `iceberg transportation costs' T_{rs}, with $p_{ni}^{rs} = T_{rs}q_{ni}^{r}$, where q_{ni}^{r} is the mill price of a producer. The concept of iceberg trade costs states that a part of the shipped goods is melted away. Therefore, producers have to ship x_{ni}^{rs} times T_{rs}. Using these definitions, the gross demand of region s for a good produced in r is represented by:

$$\bar{x}_{ni}^{rs} = \alpha_i \frac{T_{rs}^{1-\sigma_i}(q_{ni}^{r})^{-\sigma_i}}{P_{is}^{1-\sigma_i}} E_s. \quad (4)$$

We introduce the freeness of trade[8], with $\phi_{rs} \equiv T_{rs}^{1-\sigma_i}$. Finally, gross world demand is given by:

$$\bar{x}_{ni}^{r} = \alpha_i (q_{ni}^{r})^{-\sigma_i} \sum_s^R \phi_{rs} \frac{E_s}{P_{is}^{1-\sigma}}. \quad (5)$$

Each firm faces a potential world demand, as long as there are no constraints on trade. So far, we can derive gross world demand $\bar{x}_{ni}^{r}$ based on household utility maximization. This is not just the demand for the products of an existing firm. It can also be seen as the expected demand for the products of a potential entry firm. In the following part, we will consider the firm's maximization problem to produce and supply that quantity.

Following the NEG framework, we adopt the concept of Chamberlain's monopolistic competition. There is a variable input requirement of labour proportional to output. Let $y_i = \frac{1}{b_i} l_{in}$ be the production technology of a representative firm, where l_{in} is the labour requirement. It should be noted that labour productivity is constant and equalized over all regions. Labour earns the exogenous wage rate w_i^r. There might be a minimum fixed cost requirement π_i^r to produce at all. This fixed cost,

[6] For simplicity, we assume that σ_i is constant within the industry, and therefore identical for all firms in the relevant market.

[7] Let $y_i = \frac{1}{b} l_{ik}$ the production technology of a potential competitive market, where l_{ik} is the labour requirement of the kth firm. Total labour requirement L_i equals $N_i l_{ik}$. Substitution in the CES function of that particular industry yields $C_i = \frac{1}{b} L_i N_i^{\frac{1}{\sigma_i - 1}}$. Taking $\lim_{\sigma_i \to \infty} C_i$ yields $C_i = \frac{1}{b} L_i$, which is the typical production technology of the competitive sector in the world of NEG.

[8] ϕ_{rs} tends towards 0, when trade costs increase. It takes the value 1, when trade is totally free.

or operating profit, is used to pay a dividend to shareholders, i.e. the households of the region where the firm is located. Thus, one might see it more as a profit than a cost. Maximizing (zero) profits with respect to quantity, while allowing some price-setting opportunity for each supplier, yields the pricing rule $q_{ni}^{r} = \sigma_i/(\sigma_i - 1)b_i w_i^r$. The resulting mill price is determined by a mark-up on marginal cost.

The price equation can be simplified using a theoretical conceptualization. The theoretical model of Baldwin (1999) assumes that workers are regionally immobile, but they can choose the industry in which they work. There exists at least one sector where no transportation costs occur, and which is of the homogeneous producer type. This makes the model tractable from a theoretical point of view, and allows us to normalize nominal wages $w = 1$ of the sector concerned. Because households can choose the sector in which they want to work, nominal wages over all sectors also become equalized. We can derive the pricing rule $q_{ni}^{r} = \sigma_i/(\sigma_i - 1)b_i$. The industry-specific mill price offers a constant mark-up on marginal cost. Ottaviano et al. (2002) derive in this context a model of variable mark-ups grounded on a linear utility specification.

In comparison, in trade theory, typically the price of the regional final product is normalized. In the present model this is comparable to a normalization of P_{is}, letting differences in nominal wages occur. That price normalization is the starting point to achieve the nominal wage equation, which is frequently applied in empirical work. In our analysis, we reverse the procedure and normalize nominal wages, such that the price of the final product P_{is} varies.

So far, labour mobility through migration has not yet been taken into consideration. Neglecting migration greatly simplifies the labour market without loss of general agglomeration and dispersion effects in the NEG sense (for a discussion of different theoretical models, see Baldwin et al., 2004). The assumption of immobile workers is, however, not found in reality. Migration affects economic outcomes, while regional differences in economic development drive further migration. In particular, group-specific migration patterns, such as brain drain, will affect economic performance in the future. In the outlined model, migration is not yet included, so that our analysis is limited in this respect. Shifts of the labour force from one region to another would lead to a shift in expenditures E_s. From the literature on migration, we know that net migration typically occurs from ‘poor’ to ‘rich’ regions (see Nijkamp et al., 2011). In our model, migration flows would then shift expenditures from low to high performing regions, which in turn would induce agglomeration forces. By leaving out migration flows, however, we would thus underestimate the impact of the real market potential and its accelerating effect due to trans-regional labour mobility.

The model of Baldwin (1999), however, still includes a demand-linked circular causality because firms are the mobile factors, while the operating profits are paid to households locally, which raises regional income.

Using the pricing rule, zero profits, market clearing, and equation (5), we can now derive a coherence between operating profits π_i^r and output $\bar{x}_{ni}^r$, which is given by:

$$\pi_{ni}^r = \alpha_i \sigma_i^{-\sigma_i} \left(\frac{1}{(\sigma_i - 1)} b_i\right)^{1-\sigma_i} \sum_s^R \phi_{rs} \frac{E_s}{P_{is}^{1-\sigma}}. \quad (6)$$

It should be noted here that the mark-up on marginal costs to cover π_i^r disappears in the case of $\sigma_i \to \infty$ (competitive market). A firm's operating profit π_i^r depends on the world distribution of expenditures, prices, and trade freeness[9]. $E_s/P_{is}^{1-\sigma_i}$ is then a measure of real expenditures e_{si}. The sum term is called the real market potential (Head and Mayer, 2004b). It is noteworthy that Redding and Venables (2004) split this term and relate the nominator to nominal market access and the denominator to supplier access. They discuss the effect of both measures on wages.

In the next step, we focus on P_{ir}, the (unobservable) price index. In the empirical literature this price index is often assumed to be constant over all regions, because data on regional prices are typically not available. It follows that nominal rather than real expenditures are considered. The nominal market potential is frequently used in empirical studies that investigate the implications of the NEG[10]. However, in our case with the theoretical fixing of nominal wages to unity, the price index simplifies. Using the household expenditure function, we find a coherence between P_{ir} and the regional distribution of firms of that industry[11], namely:

$$P_{ir}^{1-\sigma_i} = \left(\frac{\sigma_i}{(\sigma_i - 1)} b_i\right)^{1-\sigma_i} \sum_{r=1}^R N_r \phi_{rs}. \quad (7)$$

This is an interesting and striking feature of the model. The industry-specific regional price index appears to be a generalized average depending on the trade cost and the firms' distribution. Thus, we can proxy the unobservable price index using the observable distribution of firms. Brakman et al. (2006) show other ways to approximate the price index. First, it can be achieved with the help of the regional wage distribution. Secondly, we can apply another modelling strategy which relies on non-tradable services. We stick to our measure which is the distribution of firms within sectors as an alternative approach. Substitution of (7) in π_i^r of (6) yields:

$$\pi_i^r = \frac{\alpha_i}{\sigma_i} \sum_s^R \phi_{rs} \frac{E_s}{\sum_k^R \phi_{ks} N_{ki}} = \frac{\alpha_i}{\sigma_i} \sum_s^R \phi_{rs} e_s. \quad (8)$$

Within a sector, the firm's operating profit depends solely on the spatial distribution of expenditures and firms. We focus on the real market potential of a single region and ignore for the moment trade cost. Then we will have $RMP_r = E/N$. If the market has a size of $E = 100$ and there are 10 firms,

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[9] Every firm within an industry and region faces the same problem, so that we drop the index for the nth firm in the remaining part of our analysis.
[10] See Niebuhr (2004).
[11] For details, see Baldwin et al. (2001).

then each firm will have a revenue of 10. This makes the interpretation of the real market potential measure quite realistic: It is the market share of a single firm, and this market share depends on the location of the firm and the competitors' distribution. We now discuss the central forces from a firm's perspective. If transportation costs rise, the demand from other regions will decrease ($\phi_{rs}^{i} = T_{rs}^{1-\sigma_i} \to 0$). If these are infinitely large, supply/demand evidently takes place in the home region. However, if a region and its surrounding regions possess a high stock of firms, the denominator goes up, letting demand and therefore π_i^r decline. This pushes firms to other regions where less competition is expected (market crowding, dispersion force). If a firm is far away from such industrial concentrations, the denominator gets smaller, and π_i^r rises because of the discounting influence of ϕ (protection against competition). In contrast, being located in bigger markets in terms of expenditure levels raises π_i^r (home market effect, agglomeration forces)[12]. Unfortunately, the effects cannot be unambiguously separated because of the sum in the denominator. The strength of agglomeration and dispersion forces depends inter alia on the level of trade cost. The effects described above are similar to the discussion of the nominal market-access and supplier-access effects on wages (Redding and Venables, 2004). Here, however, these effects relate to firm's profits.

The operating profit π_i^r is (partly) unobservable, though the explanatory part is. Thus, it is therefore unfeasible to include π_i^r in an empirical model as a dependent variable, at least as long as there is no proxy available. Clearly, this operating profit is essential for the firm's location decision. A firm has an incentive to locate in a region where π_i^r – or its present value of such an income stream $PV(\pi_i^r)$ – is maximized. One useful way of modelling this effect is the application of discrete choice models on firm entries, suggested by Head and Mayers (2004a).

Following Baldwin (1999), the present value at any time can be calculated by the depreciation rate δ_i and the time preference of households[13] θ. For the moment in time $t = 0$, the present value is given by

$$PV(\pi_i^r) = \frac{\pi_i^r}{\delta_i + \theta}. \quad (9)$$

We observe a discrete firm entry in any region where $PV(\cdot)$ offers the highest value and covers the cost of invention (known as `Tobin's q'). A new firm has to be 'invented', and needs a_{Fi} units of

[12] For a theoretical discussion, see also Behrens et al., 2004.

[13] According to the model of Baldwin (1999), households invest in riskless assets that finance a research sector. The output of this sector is at least new products and thus, single firms. The operating profit is paid to households as the shareholders' dividend locally.

labour H_i of a research sector. Because of the normalization of wages, a_{Fi} represents the replacement cost of Tobin's q. Thus:

$$a_{Fi} \overset{\text{Tobin}'sq}{=} \frac{\pi_i^r}{\delta_i+\theta}. \tag{10}$$

If the firm's innovation is costly, then labour input in the research sector is a relevant factor. In the literature, human capital is usually accepted and interpreted as an engine of innovative processes. The average share of employed human capital s_H and human capital spillovers might be modeled and introduced affecting a_{Fi}.

If Tobin's q holds, we may expect a single firm start-up. The mass of new firms N_{ir}^{new} locating in a specific region is connected to the single location decision, and therefore relates to Tobin's q as follows:

$$N_{ir}^{new} \sim \frac{\pi_i^r}{a_{Fi}(\delta_i+\theta)} = \frac{\frac{\alpha_i}{\sigma_i}\sum_s^R \phi_{rs} e_s}{a_{Fi}(\delta_i+\theta)}. \tag{11}$$

The sum term $\sum \phi_{rs} e_{is}$ is a measure of the real region-specific market potential. Bergmann and Sternberg (2007) state that agglomeration forces are directly linked to regional demand. Since π_i^r relates to demand, our approach features those effects by using a microeconomic approach. However, Bergmann and Sternberg (2007) notice that the identification of agglomeration forces is frequently captured by local wages[14] or per capita income[15] in an ad hoc way. Here the crucial explanatory variable is derived from a general model and based on the firm's profit maximization and its resulting real market potential. That potential can be computed by the expenditure and the firm's distribution in space. Differences in the RMP_r could explain firm entries. Following (11), the mass of new firms is higher where RMP_r is, on average, higher. As was mentioned earlier, firms leave the market at a constant rate δ_i. The dynamic equation of the firm stock is simply the difference between entries and exits (i.e. depreciation). In the long-run, when $dN_{ir} = 0$, firm entries will be higher in larger markets where relatively more firms exit. Thus, in the empirical setting, also the stock of current firms has to be controlled for:

$$dN_{ir} = N_{ir}^{new} - \delta N_{ir}. \tag{12}$$

In the case of a competitive sector, π_i^r is 0 in the long-run. Furthermore, σ_i tends to go to infinity. However, in the short run there might be an additional premium, as long as the demand exceeds

[14] See Berglund and Brännäs, 2001; Gerlach and Wagner, 1994.
[15] See Carree, 2002; Ritsilä and Tervo, 2002.

supply, letting $\pi_i^r > 0$. Thus, the market potential is a valid instrument to capture firm entry processes in the case of competitive markets.

3. Data, Empirical Approach, and Hypotheses

3.1. Introduction

The German Establishment History Panel provided by the Institute for Employment Research (IAB) collects information on the number of firm establishments and other establishment-specific and regional-related information about German regions. It covers the total population of all German establishments which employ at least one person covered by social security. The period considered is 1999 to 2014. We split the entire period in 4 sub-periods consisting of 4 years each. The first year serves to collect the model variables and the following three years provide information on the sector-specific regional firm entries. Because this data set considers explicitly establishments and not firms, we relate the present model to establishment start-ups.

We apply the German industry classification WZ 2003 on a two-digit level. We first limit the sample, and drop the entire public sector. Furthermore, we drop sectors which are based on natural resources. The reason for the relatively rough classification of sectors is that it captures vertical linkages in production within each industry, and therefore better suits such a macro-model. In total, we consider 45 distinct sectors. Regional data, in particular on GDP, is taken from the GENESIS regional database provided by the German Federal Statistical Office. The NUTS-3 regions are aggregated to 141 labour market regions, out of which 32 belong to eastern Germany. The main criterion for the aggregation of regions is based on commuting flows. This aggregation overcomes strong local spatial autocorrelation due to a common labour market area, and captures local sector-specific linkages of neighbouring NUTS-3 regions. With 4 time periods, 141 regions and 45 distinct industries, the data set contains 25,380 observation.

The main goal is to lay the foundation for deriving the empirical model. We combine equations (11) and (12) with $dN_{ir} = 0$; then the following empirical specification results:

$$N_{ir}^{New} = \beta_{1i}\ln e_{ir} + \beta_{2i}\ln W_x e_{ir} + \beta_3 N_{ir} + \beta_4 x_{ir} + \mu_i + \mu_t + \varepsilon_{ir}. \quad (13)$$

The left-hand side represents the number of newly founded establishments in the three following years after 1999, 2003, 2007 and 2011. For instance, all RHS variables relate to the year 1999 and the LHS variable is the mass of entries in 2000 until 2002. Because there is a time lag of one year, the issue of simultaneity is partly reduced. First, there is a industry-specific effect μ_i and time- fixed effects μ_t. β_{1i} and β_{2i} relate to the influence of the RMP on firm entries and these are industry-specific. β_3 relates to the mass of already existing firms to account for differences in intra-industrial firm stocks as described in equation (12). Lastly, the variables included in the variable vector x_{ir} relate to other variables influencing Tobin's q.

3.2. Construction of the Real Market Potential Measure

The sum term $\sum_s^R \phi_{rs} e_{is}$ of π_{ir} needs more attention to derive a meaningful empirical specification. The consumption share of GDP allocated to a specific branch is scaled by α_i, the parameter of the utility function; thus, $\alpha_i GDP$ is a valid measure for sector-specific expenditures. Unfortunately, ϕ_{rs} is industry-specific, since it contains σ_i in its calculation, which is a problem from an empirical point of view. However, we know, by definition, that $0 \leq \phi_{rs} \leq 1$. This offers a strategy to approximate trade cost: if one assumes that closeby regions have higher ϕ_{rs}, values compared with distant regions (that means lower trade costs), we may use a distance-based weight matrix W. This is the typical way to approximate trade costs in empirical studies which test the relevance of the NEG[16]. There are several methods to approximate ϕ_{rs} presented amongst others by Bröcker (1989), Brakman et al. (2006), and Head and Mayer (2004b). The latter authors use trade flows between regions. Unfortunately, there are no trade flow data on a regional and sector level available in Germany, so we cannot follow this approach. Other approaches consider physical distance or neighbourhood relations to estimate ϕ_{rs}. We follow the approach of Bröcker (1989) which is based on a distance-decay function. The construction of W_x is given in Appendix A. We apply three different weight matrices: $W_{0.1}$ discounts distance only to a very limited extent, while $W_{0.5}$ discounts a moderate distance effect, and $W_{0.9}$ highly discounts distance.

Assuming a constant savings rate over all regions, regional expenditures E_r can be approximated by total regional GDP. Since we relate π_i^r to household demand, we refrain from using gross value added. We approximate any e_{is} by deflating nominal expenditures E_s with the distance-weighted firm distribution $W_x N_i$. We may now employ the weighting matrices which contain the value 1 on the main diagonal[17] to calculate e_{is}. These W_x matrices are not row-standardized for the computation of e_{is}, because this calculation is not based on an average value, but on a potential.

So far, we have computed real expenditures e_{is}. We now consider $\sum_s^R \phi_{rs} e_{is}$. We can rearrange the term to $e_{ir} + \sum_{s,r\neq s}^R \phi_{rs} e_{is} = e_{ir} + W_x e_{ir}$. Thus, we can distinguish increases in home and foreign demand, as is frequently analysed in the trade literature. The coefficient of the home region for the market potential e_{ir} should be positive when agglomeration forces dominate

[16] See Niebuhr, 2004.

[17] The 1 values are necessary, so that the stock of firms of the home region also enters the calculation of e_{is}. We do not consider an internal distance as, for example, in Brakman et al. (2006).

competition effects. A firm prefers to locate in a region where it can increase its real market potential. It might be insignificant for competitive markets. If trade is not prohibitive, we can consider that $W_x e_{is}$ capture foreign demand. W_x is one of the weight matrices as described above[18]. In the regression model we take the logarithm of both variables. The effect of foreign demand is expected to be positive. However, if the effect of e_{is} in any other region s is dominant over the potential $W_x e_{ir}$, the effect of the potential $W_x e_{ir}$ could be insignificant. For the empirical specification we employ the log of both measures for home and foreign demand, viz. $\ln e_{is}$ and $\ln W_x e_{ir}$, respectively.

3.3. Introduction of control variables

We will now to introduce additional variables that control for other (productivity) effects. Theory – especially in a New Economic Geography context – suggests that a firm has to be `invented'. The role of human capital in research activities is widely accepted. In our case, s_H denotes the regional sector-specific human capital input, measured as the intrasectoral regional share of employed people holding a university degree. Brunow and Hirte (2009) point out, that at least for Germany, there may be a bias in that measure, because not every person holding a university degree has a job that requires such a degree. On the other hand, some employees without a formal qualification hold a position which typically requires a degree. The notion of formulating human capital measures is closely related to the definition of actual and required education in the ove-reducation literature (Duncan and Hoffmann, 1981; De Groot and Maassen van der Brink, 2007). However, because of data availability, we stick to the formal qualification measure. s_H also relates to the knowledge spillover theory of entrepreneurship[19]. Audretsch et al. (2010) point out that some firm-specific R&D activities lead to new firm formation, because not all internal knowledge is solely used within that firm; rather it spills over. Griliches (1992) supports this spillover theory, as he states that individuals or firms share (their) knowledge with each another. In contrast, Minniti and Lèvesques (2010) state that entrepreneurs either invest in R&D and develop a new product or enter as imitator into the market, and find a niche for a quite similar product. This fact fits well with the underlying theoretical idea: new firms enter the market and offer a diversified product. Those imitators or researchers could be current employees. Thus, s_H does not solely measure human capital spillovers, but it also captures aspects of a knowledge-based entrepreneurial milieu. Additionally, to control for region-specific spillover effects between sectors, we add a Fractionalization index DIV_H on the distribution of the human capital shares among sectors. The more equally the human capital within the region among sectors is

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[18] The w_{rr} elements of the main diagonal are set to zero to compute We_{ir}.
[19] See Acs et al., 2004, 2005.

distributed, the larger is the potential source for human capital spillover between sectors. Bode (2004) provides some evidence for Germany that human capital spillovers are rather localized. The applied regional classification considers larger aggregated regions, so that we may expect that most human capital spillovers occur within a particular region.

We further add the variable $monopol$ to distinguish whether there is at least one establishment of that sector located in that region. An empty region might be of advantage, in that it gives monopoly power to a newcomer. This effect will be captured by the number of firms. However, a single incumbent firm might have some monopoly power, and therefore enjoy higher profits. This, in turn, attracts other firms into that region to share those profits.

There is also a wide body of literature on diversity effects (Jacobs, 1969, externalities, or urbanization externalities). Audretsch et al. (2010) discuss the importance of the diversity of individuals to focus on diversity in the sense of Jacobs externalities. Those linkages capture individual linkages and the relationship between agents, for instance, employees. Brunow and Hirte (2009) capture diversity effects based on the distribution of firms rather than on individuals. They argue that this captures inter-industrial linkages and technological spillovers. The variable DIV_N represents such technological spillover effects and is defined in terms of the distribution of firms between regional established sectors, again on the basis of a Fractionalization index, as Combes et al. (2004) suggest[20]. The more diverse the employment or distribution of firms between sectors is, the higher are both diversity measures. Another frequently applied urbanization measure is the log of the total number of regional sectors. We distinguish rather aggregated sectors at the two digit level and therefore there is little variation in such a measure. We therefore do not consider such a variable. Another measure representing the regional industry-specific diversity is the average firm size (measured in employees), because it represents the potential gains from increasing returns to scale at the firm level. Smaller firms may provide more specific, small-scale (localized) and diverse products, whereas larger firms relate – on average – more to production units with gains from internal scale effects.

Another established control variable is the (average) firm's age. There are some limitations in our data set regarding the construction of an age measure. Therefore, we add the intra-industrial regional share of firms of age 5 or more, s_{old}. An established region might have lower firm-entry perspectives, since industry is fostered, and firms are already relatively productive, so that potential newcomers face strong competition, and therefore do not enter that region. On the other hand, a higher average age might attract new firms because of the outsourcing of established firms or agglomeration forces. Hence, the effect of age is unclear a priori.

[20] $DIV = -\ln(\sum_k^K s_k^2)$, with s_k the share of employment or establishments in sector k.

Since our research field is on the whole of Germany, a dummy variable $East$ is introduced to indicate whether the region is part of eastern Germany. Berlin is seen as an eastern German region, even though there is some evidence that Berlin has some special characteristics, apart from its capital status.

The literature on firm start-ups often uses population density as a measure of urbanization and agglomeration forces[21]. In a densely populated region one may expect higher firm formation. We capture those effects explicitly in e_{ir}. In such regions, typically total GDP is higher, because there is a higher stock of wage earners. Thus, demand for products and e_{ir} increases in these areas. Clearly, our measure already controls for agglomeration forces from a micro perspective.

3.4. Descriptive Statistics

A descriptive overview of the main variables is given in Table 1. A first examination of the dependent variable shows that in about 25% of all region-industry combinations, no firm entries occur. Thus, there exist regions which are less favourable for start-up activities. In 50% of all combinations, up to 10 entries occur and 95% of all combinations experience up to 469 entries in the next three years. On average, there are almost 100 firm entries in all industry-region combinations, but this first insight does not take into account differences in sector size and is therefore biased. Interestingly, those regions which enjoy no firm entries are not necessarily “empty”. In less than 10% of all region-industry combinations “empty” regions emerge. In 50% of all combinations, up to 58 firms are located in such industry-region combinations. In 95% of all combinations, up to 1663 firms are there located. In almost 3%, a monopoly situation is given. There is a relative high variation in the real market potential measures for the home region and the sourrounding regions and also for the distribution of firms.

[21] See Armington and Acs, 2002; Audretsch and Fritsch, 1999; Brixy and Grotz, 2007; Fritsch and Falck, 2007; Reynolds et al., 1994; Sternberg and Bergmann, 2003; Sutaria and Hicks, 2004.

Table 1. Descriptive statistics and correlation of model variables

Variable	Mean	Std. Dev.	Min	Max
No. firm entries (ir)	98.65	343.39	0	8733
log RMP home (ir)	8.95	2.16	3	17.09
log RMP outside (i-r)	12.02	1.98	7.48	18.24
log No. of firms (ir)	3.98	2.15	0	10.09
share human capital (ir)	0.07	0.1	0	1
average firm size (ir)	23.01	63.25	0	2398.26
share old firms (ir)	0.64	0.24	0	1
DIV_N	0.9	0.03	0.64	0.95
DIV_H	0.93	0.01	0.92	0.95

N=25.380, ir = industry-region, DIV = diversity measure

The correlation matrix is provided in Table 2. A negative correlation between the real market potential and the number of newly established firms is observed. This contradicts our hypothesis that higher values of the market potential lead to higher firm entries. However, this correlation does not take industry-specific differences into account and therefore, a multivariate analysis has to be performed, what we are going to consider next.

Table 2. Correlation matrix

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No. firm entries (ir)	(1)	1							
log RMP home (ir)	(2)	-0.2264	1						
log RMP outside (ir)	(3)	-0.375	0.8902	1					
log No. of firms (ir)	(4)	0.4716	-0.6508	-0.8648	1				
share human capital (ir)	(5)	0.0015	0.1155	0.0437	0.0176	1			
average firm size (ir)	(6)	-0.0708	0.186	0.1765	-0.1174	0.1412	1		
share old firms (ir)	(7)	-0.0791	-0.086	-0.1153	0.1619	0.0638	0.1495	1	
DIVN	(8)	0.1037	0.117	0.0117	0.1537	0.0775	-0.025	0.0429	1
DIVH	(9)	-0.0926	-0.0788	0.0593	-0.0257	-0.1264	0.0111	0.0687	0.0874

N=25.380, ir = industry-region, DIV = diversity measure

4. Estimation Strategy

So far, we have derived a model of industry-specific firm formation as outlined in the previous sections. The present section discusses the estimation strategy. The general model based on the theoretical framework outlined above reads as:

$$y_{ir} = \beta_i x_{ir} + \gamma z_{ir} + \mu_i + \mu_t + u_{ir}, \qquad (14)$$

The dependent variable y_{ir} is the number of newly founded firms and therefore count data. We estimate Poisson and negative binomial models to account for the limited dependent variable character. The interpretation of estimates relates to elasticities for all variables in log. Alternatively, we estimate a Tobit model, because the decision to enter the market in a specific region might be latent and we observe no entries where the utility to enter in a particular region is negative (i.e. where Tobins q is less than one). For a better comparison of estimates, the log of y_{ir} is the dependent variable in the Tobit model with censoring at 0 to account for zero-entries.

According to theory, there is a set of industry-specific parameters to estimate (β_i) and others which are common for all sectors (γ). We have tested various specifications, and have come to the conclusion – based on statistical tests – that only the RMP measure of the home region is industry-specific. All other variables are also tested to be industry-specific, but it turns out that they belong to z_{ir}. So we stick to the parsimoneous model. We estimate two types of model: the Baseline Model treats β common to all sectors, whereas the Dummy Slope Model (DSM) treats β_i as industry-specific effect.

Because the model relates to industries, we expect that the industry-specific effect μ_i is correlated with some of the explanatory variables of x_{ir} or z_{ir}. In addition, the models to be estimated are nonlinear models and the usual within-transformation cannot be performed. For this reason we include indicator variables to capture such unobserved industry-specific effects. Period-specific effects are controlled by indicator variables to represent μ_t. We refrain from using region-specific effects to capture (unobserved) location-specific effects. Our analysis is based on intra-industrial comparison between regions. Thus, the identification of the effect rests on the intraindustrial between-region variation. An inclusion of region-specific effects eleminates the desired between-region variation.

5. Estimation Results

The estimation results are presented in Table 3. Reported standard errors are clustered at the level of region and industry. The table contains two main blocks, one for the baseline model without sector-specific slopes, and another which controls for slope differences (DSM). Before we turn to the interpretation, we focus on the model selection. Independent of the estimation strategy, all variables are jointly significant. Because the industry-specific slopes of the RMP are jointly significant, the DSM is preferred over the baseline model. From a theoretical point of view, the DSM is also preferred. Comparing the three different models, from a methodological point of view, the negative binomial model is prefered over Poisson if the distributional parameter is significant different from one (which represents the Poisson model). However, the Poisson model is consistent, whereas consistency issues might exist for the negative binomal model. The Poisson and neg-bin models are explicitly designed for count data and therefore partly in favour of the Tobit model. However, the deviation between all three models is not very strong, so that we can draw a general picture.

Table 3. Estimation results explaining the number of newly founded firms

	Baseline Model			**Dummy interaction model**		
	Poisson	**Neg-Bin**	**Tobit**	**Poisson**	**Neg-Bin**	**Tobit**
log RMP home (ir)1	0.104***	0.114***	0.152***	0.159***	0.182***	0.255***
	(0.007)	(0.006)	(0.008)	(0.029)	(0.022)	(0.024)
log RMP outside (ir)	0.182***	0.088***	0.042***	0.184***	0.102***	0.074***
	(0.016)	(0.011)	(0.016)	(0.014)	(0.012)	(0.016)
log No. of firms (ir)	0.915***	0.886***	0.831***	0.920***	0.877***	0.807***
	(0.009)	(0.006)	(0.008)	(0.008)	(0.006)	(0.009)
share human capital (ir)	0.086	0.296***	0.302***	0.100	0.292***	0.327***
	(0.079)	(0.054)	(0.079)	(0.073)	(0.052)	(0.077)
Constant	7.078***	6.211***	6.249***	6.732***	5.576***	4.966***
	(0.649)	(0.504)	(0.813)	(0.673)	(0.504)	(0.792)
lnalpha /sigma		-3.161***	0.551***		-3.246***	0.539***
		(0.042)	(0.005)		(0.041)	(0.005)
Control Variables	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes
Period FE	yes	yes	yes	yes	yes	yes
Slope differences	no	no	no	yes	yes	yes
Pseudo R2	0.978	0.352	0.638	0.979	0.355	0.645
log-likelihood	-92918	-77115	-18782	-91187	-76672	-18420
No. obs	25380	25380	25380	25380	25380	25380
No. Industry#Region	6345	6345	6345	6345	6345	6345
F / Chi2	568598***	651795***	7404***	794528***	739230***	5427***

Note: Cluster robust s.e. at region-industry specific level in (); 1 - sector specific slopes, if included
* p<0.1, ** p<0.05, *** p<0.01

The estimated parameters are in accordance with their expected signs and are significant. An increase in the market potential leads to a significant higher firm entry rate by about 0.114%, considering the neg-bin model in the baseline specification. Also, a relative higher market potential in the sourrounding regions yields significant higher firm entries in a region. The coefficient for the stock of firms is less than one. Thus, a 1% increase in the number of firms leads to a less than 1% higher entry rate indicating that not necessarily all depreciating firms have to be renewed. This provides evidence that somehow industries relocate (or shrink), and look for regions offering better conditions.

Our results also indicate that there are regional industry-specific knowledge spillover effects: If there is more human capital employed, a significant higher number of firm entries occurs. This effect is not visible in the (consistent) Poisson model.

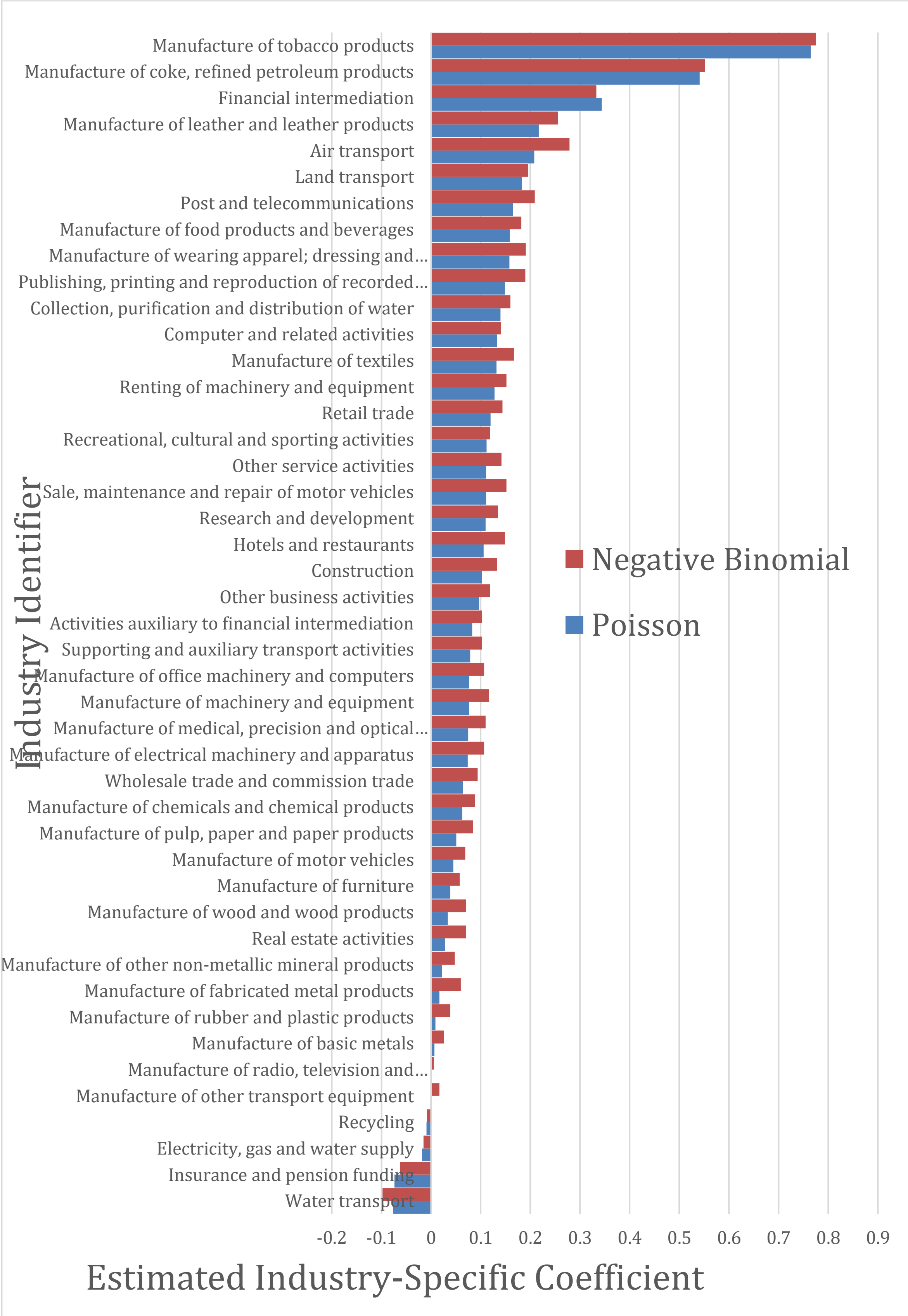
Let us consider also the differences in slopes. Figure 1 visualizes the estimated industry-specific coefficients for the RMP. As can be seen, most of the coefficients are larger than zero, indicating that indeed, the effect of the RMP differs between sectors for the relevance of firm startup activities. Both, the Poisson and Negative binomial model, deliver qualitatively the same results. Considering the different industries, we notice that especially consumption-related sectors are more sensitive to differences in the RMP. This is plausible, as the local market is the relevant consumer market instead of the export market. This confirms the suggested theory that localized or nearby consumption possibilities increase the RMP and, in the case of less competition, new firms enter the market to benefit from relative higher profits. There are a few exceptions, where negative coefficients are estimated. However, especially water supply, electricity and gas, and recycling might be exceptions where the theory does not hold because of its infrastructural character which is unrelated to profit maximisation.

Within the RMP the home-market effect and the competition effect coincide. However, because the number of existing firms is already controlled for, the competition effect is partly absorbed from the RMP and therefore the positive estimates indicate that the home-market effect is at work and we may therefore separate agglomeration from dispersion forces.

Our results are robust against modifications and especially the construction of the weight matrices, to construct the RMP. We derive the same conclusion when distance is discounted either strong or not much. Clearly, the order of magnitude changes slightly, but the overall picture remains the same.

To sum up, focusing on the real market potential clearly explains firm formation in regions. This is in line with standard NEG models, which state that the mass of varieties exhibit an externality on a branch level. Furthermore, controlling for competition effects and empty regions reveals market-crowding effects. Our empirical investigation proves the general relevance of human capital externalities and agglomeration forces, and supports their relevance in regional economics.

Figure 1. Estimated industry-specific coefficients for the Real Market Potential



6. Conclusion

This paper has developed an empirical approach to uncover the fundamental forces of the New Economic Geography literature for establishment formation. Based on the theoretical work of Baldwin (1999), an empirical approach was developed to explain regional sector-specific establishment formation. While in the literature on firm start-ups, labour productivity measures, such as wages, are frequently applied, our study designed a real market potential measure based on the firm's expected average profit. The theoretical model is tested empirically using detailed German regional data in a Panel setting. We find strong evidence that establishments will locate in regions where profit and their real market potential are higher compared with other regions. This is in line with the idea of agglomeration economies. The empirical estimates also support the presence of dispersion and competition forces. Regions with a high share of firms of a particular industry face a significantly lower firm growth rate. On the other hand, when intrasectoral competition in regions is less strong, new establishments enter the market in those regions.

Another aspect of agglomeration economies is the presence of human capital spillovers (Romer, 1990; Lucas, 1988). The present approach features and controls for human capital externalities. We find evidence that those mechanisms are present. Because of the construction of the theoretical model, we can distinguish different agglomeration forces, and may conclude that the basic mechanisms of human capital theory and New Economic Geography can explain establishment formation.

We thus conclude that the real market potential is a crucial variable for explaining establishment formation, and that agglomeration and dispersion forces are highly relevant. Our empirical estimates thus render support for the basic principles of the NEG literature.

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Appendix A. Construction of the weight matrices W_x

Tis appendix provides a concise introduction to the determination of weight matrices in our model. An element of the spatial weight matrix W_x is given by:

$$w_{rs} = \exp(-d_{rs}\tau),$$

where d_{rs} represents the distance, and τ is a distance-decay parameter. This distance-decay parameter τ depends on the average distance of neighbouring regions and a normalized distance-decay parameter γ, which is in the range of 0 and 1. γ describes the influence of distance on regional dependence. The lower γ is, the slower the reduction of interregional interdependencies with distance. The link between γ and τ is:

$$\gamma = 1 - \exp^{-\tau D},$$

where D is the average distance of all regions to their respective neighbours (see Niebuhr, 2001). In our case D is 68.24 km, and γ is chosen to be 0.1, 0.5, and 0.9, respectively, to capture the range of two extreme and one moderate decay value. The key feature here is that for $\gamma = 0.9$ the approximated weight ϕ_{rs} is 0.1, when the distance is 68.24 km. That is, the $W_{0.9}$ matrix basically considers the home region, while values of other regions are highly discounted (high trade costs). At the other extreme, for $\gamma = 0.1$ (low trade costs), the resulting weight w does not decline much with increasing distance. For a distance of about 450 km the weight is still 0.5. The moderate $W_{0.5}$ matrix gives a weight $w = 0.5$ for the average distance to neighbours, that is, neighbouring regions enter with half the weight of their own region within the model calculations.