Essays on Industrial and Services Sectors' Agglomeration in the European Union

An Empirical and Theoretical Assessment of the New Economic Geography with a Special Focus on Non-stationarity Issues

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List of Abbreviations

ADF	augmented Dickey Fuller
BE	between estimator
CES	constant elasticity of substitution
DF	Dickey Fuller
DOLS	dynamic OLS
DW	Durbin Watson statistic
ECB	European Central Bank
EU	European Union
F-Stat	F-statistic
FE	fixed effects estimator
FMOLS	fully modified ordinary least squares
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GLS	generalized least squares
iid	independent and identically distributed
IPS	Im, Pesaran, Shin test statistic
ISIC	International Standard Industry Classification
IV	instrumental variable, instrumental variable regression
Krugman-I	Krugman index of concentration
laggini	lagged Gini coefficient
LLC	Levin, Lin, Chu test statistic
OECD	Organization for Economic Cooperation and Development
OLS	ordinary least squares
PP	Phillips-Perron test
p-value	probability value
nec	not elsewhere classified
N( )	normal distribution
RE	random effects estimator
SIC	Schwarz information criterion
t-Stat	t-statistic
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
US, USA	United States of America
VIF	variance inflation factor
WTO	World Trade Organization

List of Symbols

a	product variant
agglomeration, *agglo*	variable measuring agglomeration
$B^C_{ic,t}$	Balassa index for industries' geographical concentration for one industry i in one country c at time t
$B^S_{ic,t}$	Balassa index for countries' specialization for one industry i in one country c at time t
c	country c
c	variable costs (in chapter 4)
C	total number of countries
C(i)	unit cost for composite input for each firm in sector i (in chapter 4)
c_{ij}	vector of coefficients (in chapter 5)
Cap_{it}	capital compensation in industry i at time t
CAR_{ct}	capital account restrictions in country c at time t
const	a constant
dr, do, da, dz	differential
D	first difference
D	index denoting quantities of differentiated products in the services' sector (in chapter 4)
$e_{c,t}$	total manufacturing or services' employment in country c at time point t
$e_{i,t}$	total industry i employment in the European Union at time point t
$e_{ic,t}$	industry i's employment in country c at time point t
e_{it}	error term (in chapter 5)
$\widehat{e}_{it}$	estimated residual (in chapter 5)
E(i)	a sector i's expenditures for products
$E(t_{T_i})$	mean of t_{T_i}
E_t	total manufacturing or services' employment in the European Union at time point t
EX_{ct}	exports of country c at time t
f	linear combination using a principal component
f	foreign country (in chapter 4)
F	fixed costs
$fact$	factor intensity
$fact_{it}$	factor intensity for industry i at time t
g	number of product variants
G(i)	price index for sector i

GDP_{ct}	GDP of country c at time t
$gini$	Gini coefficient
$gini_{it}$	Gini coefficient for industry i at time t
$gini_{t-1}$	lagged Gini coefficient, that is the Gini coefficient from the previous period
$growth_{it}$	growth in industry i at time t
h	home country
HIB_{ct}	hidden import barriers in country c at time t
i	industry i
i	sector, index indicating either sector 1 (industry) or sector 2 (services)
i	individual, cross section (in chapter 5)
I	total number of industries
I	identity matrix (in chapter 5)
I(0)	integrated of order 0
I(1)	integrated of order 1
IM_{ct}	imports of country c at time t
Int_{it}	intermediate inputs at current purchasers' prices in industry i at time t
$interm$, $intermediate$	intermediate goods' intensity
$intermediate_{it}$	intermediate goods' intensity for industry i at time point t
j	a firm in the other sector (either services or industry) (in chapter 4)
j	index counting number of lags (in chapter 5)
k	number of explanatory variables for industrial agglomeration
k	a firm in one sector (either industry or services) (in chapter 4)
$K_{i,t}$	Krugman index of concentration in industry i at time t
l	number of explanatory variables for services' agglomeration
L(i)	labor input in sector i
ln	natural logarithm
Ł	Lagrange function
m(r)	quantity consumed of each product variant r by a consumer
M	index denoting quantities of differentiated products in the industrial sector
MT_{ct}	mean tariff rate in country c at time t
n, N	number of observations
n	number of product variants or number of firms (in chapter 4)
N	number of cross sections (in chapter 5)
o	product variant
$open_{ct}$, $openness_{ct}$	openness in country c at time t

p(r)	price for a product variant r
p	maximum number of lags (in chapter 5)
p_i	p-value from any individual unit root test for i (in chapter 5)
$p^\star$	optimal price
P	Fisher test statistic
$P_{it}Q_{it}$	gross output at current basic prices in millions of euros for industry i at time point t
q(i)	output per firm in sector i
q	number of lags and leads (in chapter 5)
$q(i)^\star$	optimal output for sector i
Q_{it}	gross output as a volume index (1995=100)
$Q_{i(t-1)}$	lagged gross output, that is gross output from the previous period
Q_i	$I - X_{ip}[X'_{ip}X_{ip}]^{-1}X'_{ip}$ (in chapter 5)
r	product variant
R(i)	revenue for sector i
R^2	coefficient of determination
resid	residual emerging from estimating the long term regression function
$resid_{t-1}$	lagged residual, that is the residual from the previous period
s	services sector s
s_ν^2	sample variance (in chapter 5)
s_ν	sample standard deviation (in chapter 5)
S	total number of services sectors
$\widehat{S}_N$	estimator of the average of the ratio of long-run to short-run standard deviation
$scale$	scale intensity
$scale_{it}$	economies of scale in industry i at time t
$STD(\widehat{\delta})$	standard error of $\widehat{\delta}$
t	time point t
t	individual unit root test statistic in the Im, Pesaran, Shin test (in chapter 5)
$\bar{t}$	the mean of individual test statistics (in chapter 5)
t_δ	conventional t-statistic for testing $\delta = 0$ in the Levin, Lin, Chu test
$t_\delta^\star$	adjusted LLC test statistic
t_ρ	ADF test statistic (in chapter 5)
t_{ADF}	ADF test statistic not depending on nuisance parameters (in chapter 5)
t_{IPS}	IPS test statistic (in chapter 5)

T	transport costs
T_i	T time points varying across groups i (in chapter 5)
$\widetilde{T}$	average number of observations per individual in the panel
TC(i)	total costs for each firm in sector i
TIT_{ct}	taxes on international trade in country c at time t
$trade_{ct}$, $tradecosts_{ct}$	trade costs in country c at time t
$transportcosts$, $trans$	variable measuring transport costs
u_{it}, u_{ct}, u_{st}	disturbance/ error term
U	utility function
VA_{it}	gross value added at current basic prices in millions of euros at time point t in industry i
$\overline{VA_t}$	gross value added at current basic prices in millions of euros at time point t for total manufacturing or services in the EU
$Var(t_{T_i})$	variance of t_{T_i} (in chapter 5)
w(i)	wage rate in sector i
w_{it}	dependent variable (in chapter 5)
$\widehat{w}_{it}^{+}$	a transformation of w_{it} in order to correct for endogeneity underlying in OLS
$w_{it}L_{it}$	labor compensation in industry i at time point t in millions of euros
$\overline{w_tL_t}$	labor compensation at time point t in millions of euros for total manufacturing or services in the EU averaged over all industries of services
x_{it}	independent variable
$\overline{x}_i$	mean of x_{it} over time
X	set of explanatory variables
X_{ip}	matrix of observations on the p regressors $\Delta\widehat{e}_{it-j}$ (in chapter 5)
y	arbitrary variable
Y	total income of a country
z	product variant (in chapter 4)
z_{it}	a deterministic component
z'_{it}	the transpose of z_{it}
Z	Z-test by Choi

Greek symbols

α, α_i	intercept
α	extent of intermediate products received as inputs from the own sector (in chapter 4)
α_i, α_s	individual-specific effects (in chapter 5)
β, β_1, β_2,...	coefficients
β_1	share of labor working for the industrial sector (in chapter 4)
β_2	share of labor working for the services sector (in chapter 4)
$\widehat{\beta}_{DOLS}$	DOLS estimator of β
$\widehat{\beta}_{FMOLS}$	FMOLS estimator of β
γ_c	country effects
γ_i	industry effects
γ_i	vector of i coefficients (in chapter 5)
γ_s	services effects
δ_t	time effects
δ	error correction term (in subchapter 2.3.7)
δ	derivative (in subchapter 4.10)
δ	$\rho - 1$ (in chapter 5)
Δx_{it}	$x_{it} - x_{i(t-1)}$
$\widehat{\Delta}^{+}_{\varepsilon u}$	correction term for serial correlation
θ_1, θ_2	coefficients
λ	Lagrange multiplier
μ	households' expenditure on industrial products
$\mu^{\star}_{m\widetilde{T}}$	mean adjustment in the LLC test
ν	extent of intermediate products received as inputs from the other sector
ν_{it}	disturbance term (in chapter 5)
$\widehat{\nu}_{it}$	estimated residuals (in chapter 5)
$\dot{\nu}_{it}$	transformed disturbance term (in chapter 5)
$\pi(i)$	profit in sector i
ρ	$(\sigma - 1)/\sigma$
ρ	autoregressive parameter (in chapter 5)
σ	elasticity of demand/ of substitution
$\widehat{\sigma}$	estimated standard deviation (in chapter 5)
σ^2_u	variance of u (in chapter 5)
$\sigma^{\star}_{m\widetilde{T}}$	standard deviation adjustment in the LLC test
$\widehat{\sigma}^2_{\widetilde{\varepsilon}}$	estimated variance of the error term (in chapter 5)
$\widehat{\sigma}^2_{\nu}$	estimated variance (in chapter 5)
$\widehat{\sigma}^2_{0\nu}$	estimated long-run variance employing a kernel estimator

	(in chapter 5)
τ	coefficient for lagged Gini
$\Phi(\cdot)$	standard normal cumulative distribution function
φ	vector of coefficients
χ^2	chi-squared distribution
Ω	covariance matrix

1 Introduction

With the debt crisis of the euro area 2010 and thereafter which made the financial support of Greece and other euro area countries necessary, one more time questions were raised on the optimality of the European Monetary Union as a common currency area. The different euro countries are known to differ in economic performance, as regards for example productivity and inflation.[1] In this context issues of agglomeration and specialization patterns gain importance. If countries get more and more specialized they are said to be more subject to asymmetric shocks.[2] A dilemma then arises for countries forming a common currency area: they are not able to conduct monetary or exchange rate policies by themselves anymore, tools which are important in helping countries to regenerate their economies, managing the shock by themselves are absent.[3] Consequently, investigating issues of agglomeration and specialization is an important task for research in International and Monetary Economics.

Analyzing agglomeration and specialization calls for a consideration of geographical issues. Agglomeration in fact is defined as a concentration of elements (like firms etc.) in space.[4] In the following localization behavior of firms will be of interest, the division of supply and demand in space lies in the core of the analysis. Apart from Urban and Regional Economics which are able to consider location issues[5], the New Economic Geography offers an important tool in analyzing agglomeration. The New Economic Geography was set into place in 1991 when Paul Krugman established what is nowadays known as the workhorse model of New Economic Geography. Krugman investigated localization of firms within a model of increasing returns to scale, monopolistic competition and transport costs. His model revealed that localization of firms is an endogenous process based on the interplay of supply and demand localization. This process has not been very popular in Economics just until Krugman offered his comprehensive modeling framework in 1991. Krugman (1998) explains that this lack might be due to the limited technical ability to adequately model imperfect competition and increasing returns to scale. With the emergence of the Dixit and Stiglitz (1977) model of monopolistic competition this problem has been resolved. Increasing returns to scale are crucial for explaining agglomeration patterns, since only under increasing returns to scale firms have an advantage in locating in only one place making use of scale economies instead of

[1]See De Grauwe (2000).

[2]See Bayoumi and Eichengreen (1992). For a contrasting view see for example Frankel and Rose (1998). Further explanations follow in chapter 2.1.

[3]See Mundell (1961) and later chapter 2.1.

[4]See Gabler (1997), p. 69.

[5]See for example McCann (2001) for a description of Urban and Regional Economics, where the first basically deals with the economy of the city and the last deals with larger spatial areas.

serving the market from several locations.[6]

The New Economic Geography has experienced further analytical enhancements and also empirical testing over time. However, empirical work "remains comparatively less well developed".[7] The aim of this dissertation is to provide an empirical assessment of the New Economic Geography investigating industries' and services sectors' agglomeration in the European Union.

Several research questions will be addressed in the following.

1. *How did agglomeration of industrial and services sectors in the European Union develop over time?*
Krugman (1991 a) hypothesized that industrial agglomeration in the European Union should increase due to the increasing level of European integration and further liberalization. Krugman investigated agglomeration and specialization tendencies for US and EU manufacturing. His explanation for a higher level of agglomeration of US industries than of EU industries at that time was that US markets were far more liberalized than the European counterparts.

2. *What are the driving forces of agglomeration in the EU? Which role plays the New Economic Geography?*
To answer these questions explanatory factors representing Traditional Trade Theory, New Trade Theories and the New Economic Geography will be derived and tested for, employing adequate econometric analysis. This procedure is done for both industrial and services sectors' agglomeration in the EU. Several studies in the literature focus on this question, popular work including studies by Brülhart (2001), Midelfart-Knarvik et al. (2000) or Amiti (1998, 1999). Studies on services' agglomeration, however, are rare in the literature which might be due to lack of data and problems in measuring services' activities.

3. *Are New Economic Geography models able to explain agglomeration in services sectors?*
Models by Krugman and Venables for example just consider agricultural and industrial sectors. In this dissertation services sectors will be incorporated into a standard New Economic Geography model. The model depends on some crucial assumptions which are fewer usage of own intermediate products as inputs for the services' sector and the import of services being less dependent on transport costs.

[6]See Krugman (1998), p. 10.
[7]Redding (2010), p. 298.

4. *What insights can be gained from proper statistical analysis? How does consideration of non-stationarity issues add to our understanding of agglomeration?* To the best of my knowledge non-stationarity properties of variables have not been considered in studies on agglomeration, so far. Applying adequate dynamic econometric methods to the study of agglomeration is still offering a lot of potential for further research.

In particular, this dissertation consists of the following parts.

In chapter 2 the development of industrial agglomeration and countries' specialization in the European Union, the driving forces behind and dynamic tendencies are investigated. Existing research is extended using a broader data set, covering a longer period of time and applying several econometric methods. The explanatory factors are derived from Traditional Trade Theory, New Trade Theory and New Economic Geography. EU-KLEMS data are taken for 14 European countries and 20 industries covering the time from 1970 to 2005. Multicollinearity and non-stationarity issues are considered, unit root, co-integration tests and error correction modeling are conducted. The adjustment rate to the long-run equilibrium state of specialization for both the average EU and single European countries is computed. That way it is possible to make an assessment about how quickly countries might react to deviations from the long-run equilibrium of specialization, about how fast their economic structures can change.

Services sectors' agglomeration will be addressed in chapter 3. The importance of arguments representing Traditional Trade Theory, New Trade Theory and New Economic Geography for explaining agglomeration will be checked for. Non-stationarity issues will be considered. Therefore, EU-KLEMS data are taken for 14 European countries covering 22 services sectors from 1970 to 2005. As a matter of current interest, specialization of Greece will be given special attention.

In chapter 4 services sectors' agglomeration is analytically investigated within the Krugman/ Venables (1996) model. A few modifications are introduced to the model. Special feature of this modeling is to account for fewer intermediate goods received as inputs for the services sector from its own. The idea behind was to investigate whether the results from the previous chapter, that is fewer agglomeration in services and fewer importance of intermediate goods' intensity in explaining services sectors' agglomeration, can be shown and modeled within New Economic Geography models.

In a further chapter advanced panel unit root and co-integration techniques are employed in order to analyze industrial and services sectors' agglomeration in the

EU. Panel dynamic OLS will be conducted in order to adequately estimate co-integrating relationships among variables.

The last chapter concludes with a summary of the results, policy implications and some further outlook.

2 Industrial Localization and Countries' Specialization in the European Union

Summary

The aim of this study is to empirically investigate the development of Industrial Localization and Countries' Specialization patterns in the European Union, to explain the driving forces behind and to find out dynamic tendencies. Existing research work is extended by using a broader data set, covering a longer period of time and by applying several econometric methods in order to explain Localization and Specialization. Explanatory variables are derived from Traditional Trade Theory, New Trade Theories and the New Economic Geography. Taking EU-KLEMS data for 14 European countries covering 20 industries over the period from 1970 to 2005 both regional and locational Gini coefficients are computed. There is a clear increase in Industrial Concentration but only a slight increase in Countries' Specialization in the EU evident over time. Especially, low technology or labor intensive industries experienced the highest increase in Industrial Concentration. New Trade Theory's and New Economic Geography's arguments can explain both Industrial Concentration and Countries' Specialization in the EU best. As regards Countries' Specialization results indicate that trade costs seem to have declined so much and European liberalization has proceeded so far that dispersion among countries occurs again. It is important to consider multicollinearity problems of variables. Furthermore, co-integration between regression variables is being checked for. For the EU, results of an error correction modeling framework show that imbalances in European Countries' Specialization are being set off at a rate of about 63 to 79 percent (according to the regression framework taken) within the next period. New Economic Geography's arguments are the best explanatory force within the error correction model. Adjustments rates for Denmark, France, Germany, Spain and Sweden appear to be lower than for the EU as a whole. These results might be valuable for understanding agglomeration processes in the EU. Also, as European Integration continues to progress, it is important to know how and how quickly countries will specialize and industries will agglomerate.

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2.1 Introduction

The European Union experienced a great bunch of stages of integration over time. This process of integration meant a reduction of protectionism reinforced with the legal validity of the Single European Act in 1987 and therewith the implementation of the Single European Market Program. Further trade liberalization also occurred under the GATT and with the establishment of the WTO in 1995. The question arises whether ongoing integration exerts an influence on European countries' specialization and industrial agglomeration. It is important for many branches of European politics to know about agglomeration and specialization processes in the EU. If countries become more specialized, asymmetric shocks might damage single countries a lot.

This view is supported by Bayoumi and Eichengreen (1992) who found that European countries show less coherence of aggregate supply and demand shocks across countries than do US regions. Also European countries' adjustment to aggregate shocks was slower than for the US. Only a group of core European countries taken for analysis, that is Germany, France, Belgium, the Netherlands and Denmark, resemble the US in coherence of shocks. But there is also contradicting evidence concerning the relevance of asymmetric shocks existing in the literature. Frankel and Rose (1998) find that increasing trade liberalization would foster European business cycle synchronization, which makes a common currency feasible. This is primarily due to intra-industrial trade and thus equalizing economic structures across countries. On the other hand, a common currency will also lead to a higher level of trade and thus higher business cycle correlation, therewith the authors could derive the important result of optimum currency area criteria being endogenous. In fact, taking a look at recent developments, intra-industrial trade has experienced an increase over time, staying at quite a constant level from 1995 to 2005 ranging about 75 to 76 percent over all industry activity in the EU.[8] The constancy of intra-industrial trade, however, might indicate that in case of growing specialization countries' economic structures would become more and more unequal to each other, making them subject to asymmetric shocks again.

Because of European common monetary policy, one important tool in smoothing crises has become absent, European countries are not able to conduct a monetary policy themselves, any more. Mundell (1961), in his theory on optimal currency areas, pointed to the following problem for countries having a common currency. If there is a shift of demand from country B to country A, then country A will suf-

[8] This is based on own computations using sectoral data on intra-industrial trade from the OECD STAN Indicators database, averaging over 14 EU countries and 20 industrial sectors' values (see table 1 and table 4 in the following for included countries and industrial sectors). The minimum and maximum values of intra-industrial trade range between 56 (in the year 1998 for wood industry) and 90 (in the year 2001 for electrical machinery) percent.

fer from inflationary pressure and country B from unemployment. If the common central bank decides to take care of the unemployment issue, then money supply would have to be increased, which would aggravate the inflation problem in country A even further. Or, taking the other way round, taking care of stability in price levels, the central bank would have to agonize unemployment in country B. Alternatively, in case of flexible exchange rates, country B's currency would have to depreciate and country A's currency to appreciate in order to correct external imbalances. Mundell further explains that a set of countries introducing a common currency should possess a high degree of factor mobility because only then in the absence of flexible exchange rates across countries having this common currency, imbalances like unemployment or inflation can be reduced.[9] However, mobility of labor, for example, in the EU is not as high as in the US, for example. This is known to be due to differences in languages, cultural habits and preferences, etc., between the European Union's member countries. So, a higher degree of specialization and fewer labor mobility would make the EU not a good candidate for a currency union.

The aim of this study, now, is to investigate the development of industrial localization and countries' specialization in the European Union from 1970 to 2005 and to find evidence for the driving factors of both localization and specialization. Existing research work is extended by using a new data set, covering a longer period of time and by applying several econometric methods in order to explain both localization and specialization. The focus will be on evaluating the importance of Traditional Trade Theory's, New Trade Theory's and the New Economic Geography's assumptions in explaining localization and specialization. Further, dynamic tendencies of localization and specialization will be investigated by applying cointegration and error correction modeling methods. To the best of my knowledge this is the first study that explicitly considers stationarity properties of regression variables in studying agglomeration issues. In regard of the ongoing process of integration in the European Union this study gives valuable insight into the evolution of industrial structures in Europe.

2.2 Theoretical Background

Trade theories give different explanations for countries' specialization. Whereas Ricardo predicts that countries specialize according to their comparative advantage, Heckscher-Ohlin tells us that a country specializes in producing and exporting that good that is produced relative intensively with the factor the country is relatively well endowed with.

New Trade Theories emphasize that economies specialize because of making use of

[9]Due to factor mobility relationships of factor prices will equalize across countries.

scale economies in production. Using scale effects firms can reduce costs of production. Either they can produce more output at a given cost or they can reduce costs producing a given output. Thinking about a homogeneous good, countries would specialize in the good they have the higher market share in, initially. Further integration, thereby seizing international trade, would make countries' industrial structures become even more unequal. If we assume goods to be heterogeneous within a sector, however, free trade would make consumers getting access to a greater variety of products. Free trade in turn, would seize intra-industrial trade, leading to equalized industrial structures across countries.
New Economic Geography, elaborated in particular by Paul Krugman, argues that further integration would make countries become more different (Krugman (1991 b), Krugman and Venables (1995), Krugman and Venables (1996)). One has to differentiate between different stages of transport costs, however. High transport costs between countries would make them still keep the full range of industries guaranteeing a fair level of subsistence.[10] There is no agglomeration at place. According to Krugman/ Venables (1995) with falling transport costs producers of final and intermediate goods would tend to move together, each industry would concentrate in one country only. Firms for intermediate goods (upstream firms) making use of economies of scale will locate at sites where demand is high, usually this will be in the larger market (backward linkage). They can minimize transport costs this way. Demand in turn will be high in places where firms for intermediate goods are already located in, because final goods (by downstream firms) can then be produced at lower costs (forward linkage). The interaction between transport costs and trade in intermediates might lead to agglomeration. As Krugman and Venables (1995) point out, a core-periphery pattern emerges. But if transport costs continue to fall the importance of being close to markets and suppliers might decline. Lower labor costs in the periphery could make firms remove again, core and periphery regions would converge.

Formalizing theoretical considerations of Krugman and Venables allows one to derive a first simple relationship between agglomeration and explanatory factors.[11] The interaction between trade of intermediate goods and transport costs would lead to agglomeration, formally this is:

$$agglomeration = intermediate * transportcosts \tag{1}$$

Taking the logarithm this would lead to an estimation equation $lnagglo = lninterm + lntrans$ or:

[10]See Krugman, Venables (1995) pp. 860-862.

[11]In depth regression analysis follows up in the next chapters.

$$lnagglo = \theta_1 * lnintem + \theta_2 * lntrans \quad (2)$$

which further includes θ_1 and θ_2 as coefficients. This equation can be easily estimated since it is a simple log-log-model.

There exists a vast body of literature measuring and explaining agglomeration and specialization patterns. I am not going to give an exhaustive review on all of that work being done so far. I would like to point to Brülhart (1998) who gives a good review on trade and location theory and considers various studies up to the year his study was published. Further, Redding (2010) reviews some of the recent empirical studies on New Economic Geography. Here instead, only some of the relevant literature will be reported, the one that gave me most of the inspiration for the research conducted I will talk about in detail in section 2.3.

Summarizing, there exist studies that give evidence for the validity of Traditional Trade Theory in explaining agglomeration or specialization (Brülhart (2001), Kim (1995), Rübel (2003), Klüver (2000)), some find support for New Trade Theory (Amiti (1998), Amiti (1999), Kim (1995), Paluzie, Pons, Tirado (2001)) others see New Economic Geography as a main explanatory force (Amiti (1998), Amiti (1999), Ezcurra, Pascual, Rapun (2006), Davis and Weinstein (1999), Midelfart-Knarvik et al. (2000)). Whereas most studies agree with growing agglomeration tendencies, there is discordance about tendencies of specialization. Some studies find out that specialization in the EU increased (Amiti (1998, 1999)) some others find that specialization decreased over time (Paluzie, Pons, Tirado (2001), Ezcurra, Pascual, Rapun (2006)).

The following studies investigate localization and specialization tendencies in the European Union. Amiti (1998, 1999) investigates both industrial localization and countries' specialization in the EU for the period from 1968 to 1990. She finds evidence for increasing specialization in the EU, involving all countries especially between 1980 and 1990. She explains this through increasing trade liberalization in the European Union. But over the period from 1968 to 1990 there is a fall or no significant change in specialization for Portugal, Spain and the UK. According to Amiti this might be due to structural adjustment these countries had to face being late joiners to the EU. Furthermore, she can show that industries agglomerated because of scale economies and high intermediate goods' intensity. This supports the validity of New Trade Theory's and New Economic Geography's arguments in explaining agglomeration.

Brülhart (2001) finds evidence for growing industrial concentration in the EU from 1972 to 1996. Especially, labor intensive industries showed the highest increase in concentration. The author argues that Traditional Trade Theory's arguments might exhibit some explanatory power for industrial concentration, still. Further, he can show that concentration increased after 1986 -the time the European Single Market program was implemented- for some industries which are being highly sensitive to abolishing intra-EU non-tariff barriers. These industries comprise beverages, pharmaceuticals, office and computing and shipbuilding.
Midelfart-Knarvik et al. (2000) find that most European countries converged in regard of their manufacturing structures until the 1980s but then diverged. Industrial concentration became less until the 80s but then increased. The authors show that some industries initially concentrated (basically high returns to scale industries like motor vehicles, aircraft, electrical apparatus, chemical products, petroleum and coal) stayed concentrated, other industries (high technology, high skill, fast growing industries like office, computing, machinery, radio) got more dispersed. Industries being initially dispersed (lower returns to scale, low tech, the slower growing, less skilled labor intensive ones like textiles, leather, furniture, transport equipment) got more concentrated especially in low wage and low skill abundant countries. Running regressions the authors find that forward and backward linkages are important for localization and since the importance of economies of scale is declining they state that a very low level of transport costs seems to be reached. The authors could further find that there was a steady decrease in US specialization from 1970 until 1997 whereas EU specialization decreased until 1983 and then slightly increased. They show that especially electronics (office, computing, radio, tv, communication), machinery and instruments foster dispersion in the US and in Europe.
Rübel (2003) argues that Heckscher-Ohlin theory's arguments are important in explaining agglomeration tendencies in the EU. The fact that specialization from the 1960s to the 1990s is increasing but also intra-industrial trade (instead of inter-industrial trade) could be explained through fragmentation.[12] This means that components (intermediate products) are localized due to cost advantages. Since trade with intermediates would be primarily intra-industrial, intra-industrial trade could be explained to occur together with specialization.[13]
Klüver (2000) investigates industrial concentration in the EU (13 countries) over 1972-1992 for 52 industries. She finds out that overall industries' agglomeration increased by 23.53 percent, labor intensive industries' by 73.81 percent, research intensive industries' by 51.83 percent, scale intensive industries' by 9.84 percent and resource intensive industries' agglomeration by 3.34 percent. Agglomeration in la-

[12] Intra-industrial trade stayed relatively constant at a level over 50 percent from the late 70s to the beginning of the 90s but then increased again to about 65 percent, see Greenaway, Hine (1991), for example.

[13] See Rübel (2003), pp. 38 and 47-48.

bor intensive industries basically occurs in southern European countries, whereas research intensive industries agglomerate in northern European countries. The author argues that since skilled labor is primarily available in Northern European countries and unskilled labor in Southern European countries this would lend support to Heckscher-Ohlin theory's arguments being able to explain agglomeration trends.
Ezcurra, Pascual and Rapun (2006) show that overall regional specialization in the EU decreased from 1977 to 1999. Smaller regions displayed higher reductions. These are the regions that had a high level of specialization in the beginning of the investigated time period and converged towards the European average over time. However, since the 1990s there is an increase in specialization evident. The authors further find out that market potential and regional size influence specialization, therewith pointing to New Economic Geography models' relevance.
Paluzie, Pons and Tirado (2001) show in a country study for Spain that there is no specialization tendency for Spanish provinces from 1979 to 1992. A reduction in trade costs did not affect industrial location. The authors can show that Heckscher-Ohlin theory's and New Economic Geography's arguments do not explain industrial concentration but scale economies do.
Duranton and Overman (2005) investigate firm localization in the UK by assessing the departure of the actual distribution of distances between firms from distances of randomly generated counterfactuals. They find that most localized are textile or textile-related industries and media-based industries, most dispersed are food-related industries and industries with high transport costs or dependence on natural resources. Publishing, chemicals, computers and radio and TV point to localization driven by small establishments. In textiles and petroleum and other non-metallic mineral products, smaller establishments are more dispersed.

For the USA Kim (1995) argues that both resource use and scale economies could explain specialization and localization best. External economies, however, cannot explain the developments. The author thus states that Heckscher-Ohlin type arguments should not be neglected in explaining specialization trends. His results on specialization and agglomeration in the US are the following: Regional specialization in manufacturing declined slightly from 1860 to 1880 then increasing until the first world war, flattening until the second world war and falling again until 1987. Agglomeration shows about the same trend over time. The author explains that specialization occurred until the second world war because firms at that time increasingly used large-scale production methods and resources that were immobile. After the second world war decreasing scale economies and resource endowments becoming more mobile and thus regionally similar caused tendencies of despecialization. Tobacco, textiles and apparel got more regionally concentrated all over time, whereas food, paper, printing and publishing and chemicals got more dispersed from 1860 to 1947 and then remained at their respective level. Kim is being criticized for his operationalization of Heckscher-Ohlin theory by raw material intensity: theory would not predict that resource intensive industries are more agglomerated than labor- or capital-intensive ones (see Amiti (1999)).

The next two studies consider localization issues for Japan. Davis and Weinstein (1999) tested the relevance of comparative advantage versus increasing returns to scale for regional production in Japan. Investigating the effects of New Economic Geography they took a look at the home market effect described by Krugman (1980): when increasing returns and transport costs exist, production would tend to locate close to the largest market. This is because locating in one place a firm can benefit from scale economies and minimize transport costs.[14] The large demand would lead to concentration of firms which will then export that good. In contrast, according to Heckscher-Ohlin theory–assuming decreasing returns to scale in production–the highly demanded good would have had to be imported. Davis and Weinstein first run regressions controlling for base level of production, demand and factor endowments. This way they could not detect any explanatory power of New Economic Geography. However, when separating regressions on the one hand for industries being monopolistic competitive and on the other hand for industries being non-monopolistic competitive, they found significant effects of New Economic Geography's assumptions for sectors producing under increasing returns to scale, that is a coefficient for demand higher than one. These sectors comprise general machinery, electrical machinery, transportation equipment and precision instruments, textiles, paper and pulp, iron and steel, chemicals and non-ferrous metals. A further important result is that they cannot confirm the explanatory power of New Economic Geography's arguments for international specialization but only for regional data. Their explanations for this result are on the one hand lower transport costs between regions of a country, thus fostering regional location of production, on the other hand greater factor mobility across regions again fostering regional localization.
Davis and Weinstein (2002) use the bombing of Japan in World War II as a natural experiment to test for the relevance of increasing returns, random growth and fundamental locational characteristics for redistribution of Japanese population. They hypothesize that a shock would lead to permanent effects concerning city size according to random growth theory, whereas when locational characteristics were important and the shock was only temporary, then there are no permanent effects due to the shock. Increasing returns would feature both recovery and possible catastrophes changing city sizes permanently. Since Japanese population recovered to its pre-war level within about 15 years, the authors argue that locational elements determine

[14]See Krugman (1980), p. 955.

population densities and increasing returns are also important explaining increasing population in various regions over time, especially over the industrialization period.

The following two studies by Aiginger/ Paffermayr and Aiginger/ Leitner for the EU are referred to here separated from the other studies on European agglomeration, because their results are dissent. Aiginger and Pfaffermayr (2004) find decreasing geographic concentration in the EU based on value added data over the time period 1985-1998. For their analysis they use absolute concentration measures only, the Herfindahl index, the entropy index and an index of the three countries having the largest industry shares.[15] Their results comprise that especially skill intensive industries deconcentrated but capital intensive and highly globalized industries concentrated.
Aiginger and Leitner (2002) investigate concentration trends in the US compared to the EU. They use absolute concentration indices from 1987-1998. The authors found out that regional concentration is declining in the EU and the US over time. On average, concentration is lower in the EU than in the US. The EU has higher concentration levels for electronics, machinery, paper and miscellaneous industry. The strongest reduction in concentration was in metals, machinery and electronics, the strongest increase in textiles and food. The authors explain that concentration of food happened because of opening of segmented national markets and of textiles because of production shifts to the south, especially to Italy and Portugal.

In the following section I will talk about my own results on disentangling the importance of the different trade theories and the New Economic Geography in explaining agglomeration and specialization in the European Union.

2.3 Empirical Analysis

In the first part of the Empirics section I will describe how to compute measures of agglomeration and specialization. Data issues will be addressed. Localization and specialization patterns over time will be shown in part 2 and 3. The fourth part investigates potential driving factors of localization, the fifth part does so for specialization tendencies in the European Union. In the sixth part I present some robustness checks and in the seventh part I seek after dynamic changes both in localization and specialization in the European Union and make use of co-integration

[15] Absolute measures of concentration only display the share of a country's industry i level of let's say value added in total industry i's value added over all countries (also possible are employment, exports, etc.). Relative measures relate an industry's concentration to the average size of a country (see Palan (2010) for the case of specialization and here section 2.3.1.). So, using relative measures one can get more detailed information on agglomeration. Krugman (1991 a) uses relative measures as is done in many other studies, too. Consequently, comparability of Aiginger and Pfaffermayr to other studies mentioned here is not that adequate.

and error correction modeling techniques.

2.3.1 Measuring Industrial Localization and Countries' Specialization

In accordance with Krugman (1991 a) and Amiti (1998, 1999) Gini coefficients are used for measuring both localization and specialization. This method reaches back to Hoover (1936), who measured localization of US manufacturing industries from 1900 to 1930.

One has to differentiate between measurement of countries' specialization in their manufacturing production and industries' geographical concentration. The first measure relates to changes in industrial structures in countries whereas the last measure relates to concentration of industries. In the following I will talk about countries' specialization when changes in countries' industrial structures are addressed. Further, I will employ the terms industrial localization, agglomeration and concentration as synonyms relating to industries' geographical concentration.[16]

In the following, I will talk about industries' and firms' localization. Industries comprise firms as single units, plants and establishments will be used as synonyms for the term *firms*. Industries are given by the OECD ISIC Rev. 3 classification, branches and sectors will be used as synonyms for *industries*.[17]

The Gini coefficients are calculated as follows. First compute the Balassa index

$$B^S_{ic,t} = \frac{\frac{e_{ic,t}}{e_{c,t}}}{\frac{e_{i,t}}{E_t}} \tag{3}$$

for countries' specialization and

$$B^C_{ic,t} = \frac{\frac{e_{ic,t}}{e_{i,t}}}{\frac{e_{c,t}}{E_t}} \tag{4}$$

for industries' geographical concentration.

Here $e_{ic,t}$ denotes industry i's employment in country c, $e_{c,t}$ is total manufacturing employment in country c, $e_{i,t}$ denotes total industry i employment in the European

[16]M. Brülhart (1998) treats the terms specialization, concentration, clustering and localization as synonyms. Apart from this he refers to agglomeration when changes in sectors using very dissimilar inputs are addressed whereas specialization or concentration refers to sectors with quite similar inputs used. Brakman, Garretsen, van Marrewijk (2005) point to differences in the terms agglomeration, concentration and specialization (see pp. 129-132). Concentration would mean that–compared to another country–an industry concentrates in primarily one country. Agglomeration is that two industries–in a two industry, two country example–or overall industry activity clusters in one country. And specialization refers to the country's economic structure, that is which industry is predominant in one country.

[17]Duranton and Overman (2005) speak about industrial branches, sectors, industries and subindustries according to the SIC two-, three-, four- and five digit categories of the Annual Respondent Database of the Annual Census of Production in the UK. They treat the terms establishments and plants as synonyms.

Union, and E_t is total manufacturing employment in the European Union, all taken for one point in time t. The Balassa index can be thought of as a kind of relative specialization. Let's think about it in the case of industries' geographical concentration. The denominator denotes the share of total manufacturing employment in country c to total manufacturing employment in the EU. This share measures the magnitude in terms of total manufacturing employment of a country. The nominator consists of the share of industry i's employment in country c to total industry i employment in the European Union. This share measures the magnitude of an industrial sector in a country. Now, if a country possesses a low magnitude in total manufacturing employment (small value of denominator) but a high magnitude in an industrial sector's employment, the Balassa index will show up a high value indicating a country's strong specialization in the given industry. The Balassa index will be equal to one if a country's industrial employment relative to the EU equals the country's total employment share relative to the EU.
The Gini coefficient is calculated by first ranking the Balassa index in descending order. Then one constructs a Lorenz-curve, that is plotting the cumulative of the numerator on the vertical axis and the cumulative of the denominator on the horizontal axis (cumulating over countries for calculation of $gini_{it}$, that is the Gini for industrial agglomeration, and cumulating over industries for calculation of $gini_{ct}$, that is countries' specialization).[18] The Gini coefficient is equal to twice the area within a 45 degree line and the Lorenz curve. This procedure yields a Gini coefficient for one point in time and one industry i in case of measuring industrial agglomeration, and for one point in time and one country c in case of measuring countries' specialization. Computations were repeated for all time points t, industries i and countries c. So, I calculated both industry and country Gini coefficients. The Gini coefficient equals zero if an industrial sector or a country is totally equally distributed across countries or across industries, respectively. Agglomeration or specialization then will be low. The Gini coefficient approaches one the more the Balassa indexes differ from one, agglomeration or countries' specialization will be high.

Taking the Gini coefficient for measuring agglomeration is criticized for the following reasons. Palan (2010) and Amiti (1999) explain that at a more aggregated level of industries fewer specialization would be detected. As Palan points out this effect can be easily understood thinking about what happens to the area between the Lorenz curve and the 45 degree line when industries are merged: the area gets smaller, thus the Gini coefficient will become lower. Amiti (1999) addresses a special drawback of the Gini coefficient: most weight is attributed to changes in the middle values of the distribution, that is those industries changing that are closest to the European average will mostly make up the Gini coefficient. Here, in one of the later

[18] See Amiti (1998), p. 47.

sections for checking robustness of results another index measuring agglomeration, which is not driven by the problems related with the Gini coefficient will also be calculated.

The data stem from the EU KLEMS Database (2008) and can be downloaded online. EU KLEMS is a data collection project funded by the European Commission. The data collection has been done and supported by the OECD, several statistical offices, national economic policy research institutes and academic institutions in the EU. I have chosen EU KLEMS data because they seem to be most comprehensive, the OECD database was having several gaps instead. For computation of Gini coefficients national employment data were extracted. The variable taken was *number of persons engaged*. Data covering 14 European countries were taken. Luxembourg had to be discarded from the sample since data were missing for many industries. In the end I could make use of 20 industries. A further disaggregation of industries was prevented by lack of data. Employment data were available for the period from 1970 to 2005. Most of the country variables were available for this time period, however, for several industries data on value added, output and compensation (variables needed for explaining concentration and specialization) were available from 1995 to 2005 only. Furthermore, an openness index was taken from Penn World Table (2006) and an index for trade costs from Dreher (2006).
Since data on explanatory variables for Italy (that is labor compensation, capital compensation, intermediate inputs, value added, gross output as volume and as value) were missing in the EU KLEMS database, I decided to take data for explanatory variables for Italy from the OECD STAN database. Further, values given in national currency for Denmark, Sweden and the UK were converted to values in euros, using the respective exchange rates at January 4th 1999.[19] Lastly, all values for explanatory variables for all countries were deflated using the price index for gross output (1995=100). This has been done in order to cancel out trends in values over time just being caused by inflation. Using several price indices for various variables (like a special price index for developments in values of labor compensation, another one for developments in values of capital compensation etc.) was prevented by lack of data. Using either deflated or non-deflated data, however, did not change the regression results qualitatively.[20] This is corresponding to results by Amiti (1998, 1999).
The evolution of European localization and specialization will be shown in the next section.

[19] See ECB, exchange rate statistics.
[20] Non-deflated variables have been taken for analysis in my working paper version.

2.3.2 Industrial Localization

Industrial concentration tendencies over time will be shown, first.[21] The results are given in table 1.

Table 1: Industrial concentration over time

	1970	*1980*	*1990*	*2000*	*2005*	**Change 1970-2005**	Trend Test
All industries	0.1762	0.1862	0.1925	0.2095	0.2207	0.2525	0.0012**
Food, beverages, tobacco	0.1294	0.1224	0.1337	0.1075	0.1132	-0.1251	-0.0005**
Textiles, textile products	0.145	0.2169	0.2902	0.3667	0.4091	1.8213	0.0077**
Leather, footwear	0.246	0.3348	0.4389	0.5236	0.5481	1.2281	0.0092**
Wood, wood products	0.1791	0.2423	0.2763	0.3431	0.3538	0.9755	0.0051**
Pulp, paper, paper products	0.2111	0.2135	0.206	0.1484	0.1461	-0.3078	-0.002**
Printing, publishing	0.15	0.1543	0.1407	0.1639	0.1694	0.1294	0.0006**
Basic Metals	0.2083	0.1853	0.1407	0.1223	0.1501	-0.2796	-0.0026**
Fabricated Metals	0.091	0.0963	0.0835	0.077	0.0756	-0.1663	-0.0009**
Non-metallic mineral products	0.1129	0.1046	0.1156	0.1308	0.1563	0.384	0.0011**
Coke, refined petroleum, nuclear fuel	0.2368	0.2189	0.2007	0.2564	0.2989	0.2622	0.0015**
Rubber, plastics, plastics products	0.1254	0.1215	0.1225	0.1071	0.1203	-0.041	-0.0003**
Machinery equipment	0.16	0.143	0.1712	0.1539	0.1491	-0.0685	-0.0001
Motor Vehicles, trailers, semitrailers	0.1442	0.1606	0.2169	0.2652	0.2825	0.9598	0.0045**
Other transport equipment	0.2593	0.2537	0.2207	0.1917	0.1928	-0.2565	-0.0025**
Manufacturing, nec recycling	0.1236	0.1154	0.1169	0.1442	0.1624	0.3137	0.0012**
Chemical industry	0.1071	0.1194	0.1336	0.136	0.1376	0.2844	0.0009**
Office accounting, computing machines	0.3565	0.3627	0.2999	0.3485	0.3358	-0.0582	-0.002
Electrical machinery apparatus	0.1725	0.1638	0.1751	0.1608	0.1823	0.057	0.0002
Radio, TV, communication equipment	0.148	0.1609	0.1338	0.2234	0.1998	0.3501	0.0019**
Medical, precision, optical instruments	0.2182	0.2335	0.2326	0.2188	0.2307	0.0571	0.0000

Source: Own calculations based on EU KLEMS data (2008).

[21] In the table industry Gini coefficients are shown for the time points 1970, 1980, 1990, 2000 and 2005. Furthermore the change of Gini coefficients from 1970 until 2005 is presented, as well as the results applying a linear trend test over time.

As can be seen average industrial agglomeration in the EU increased from 1970 to 2005 by about 25 percent. Some industries show a sharp increase in industrial concentration over time, among these are the textile industry (182 percent), leather and footwear (about 123 percent), wood industry (about 98 percent) and motor vehicles (about 96 percent). Agglomeration declined in the branches of food, beverages, tobacco, pulp and paper, basic metals, fabricated metals, rubber and plastics and other transport equipment.

The OECD classifies industries according to ISIC Rev. 3 into four main sectors: low technology industries (comprising food, beverages, tobacco, textiles, leather, footwear, wood, cork, pulp, paper, printing and publishing and manufacturing not elsewhere classified and recycling), medium-low technology industries (comprising basic metals, fabricated metals and non-metallic mineral products, coke, refined petroleum, nuclear fuel, rubber, plastics and building and repairing of ships and boats)[22], medium-high technology industries (comprising chemicals excluding pharmaceuticals, machinery and equipment, electrical machinery, motor vehicles, trailers, semi-trailers, railroad equipment and transport equipment)[23] and high technology industries (comprising pharmaceuticals, office, accounting, computing machinery, radio, television, communication equipment, medical, precision and optical instruments).[24] Table 2 lists the results.

Table 2: Changing agglomeration in industrial sectors–OECD classification according to ISIC Rev. 3

	1970	*1980*	*1990*	*2000*	*2005*	**Change 1970-2005**	Trend Test
All industries	0.1762	0.1862	0.1925	0.2095	0.2207	0.2525	0.0012**
Low technology industries	0.1692	0.1999	0.229	0.2568	0.2717	0.6062	0.0139**
Medium low technology industries	0.1722	0.1634	0.1473	0.1475	0.1657	-0.0382	-0.0038**
Medium high technology industries	0.1686	0.1681	0.1835	0.1815	0.1889	0.12	0.0035**
High technology industries	0.2075	0.2191	0.2	0.2317	0.226	0.0892	0.0009

Source: Own calculations based on EU KLEMS data (2008).

Low-technology industries have agglomerated the most over time. In 1970 low technology industries had a Gini coefficient of 0.1692. In 2005 low-technology industry's Gini coefficient is about 0.27 compared to 0.22 for the European industries'

[22] I took the whole sector *other transport equipment* since data for just building and repairing of ships and boats were missing for many countries.

[23] I had to take the whole chemical industry sector, and could not discard pharmaceuticals, since data were lacking. Also, I took the whole sector *other transport equipment* instead of just railroad equipment and transport equipment not elsewhere classified for the same reasons.

[24] Here I used the whole chemical industry sector instead of just chemicals.

average. Agglomeration of low-technology industries therewith increased by about 61 percent. Medium-low technology industries deagglomerated over time by about 4 percent, whereas medium-high technology industries showed a significant increase in agglomeration of about 12 percent.

Grouping industrial sectors according to their use of labor, research, resources or level of scale economies, one might gain a better insight into agglomeration forces.[25] Sectors are grouped into labor- (comprising fabricated metals, textiles, leather and footwear), research- (comprising coke, petroleum, rubber, plastics, machinery equipment, motor vehicles, other transport equipment, recycling, chemical industry, office, accounting, computing machines, electrical machinery, radio, tv, communication, medical, precision and optical instruments), scale- (comprising printing, publishing, rubber, plastics, chemical industry, motor vehicles, and other transport equipment) and resource-intensive (comprising basic metals, non-metallic mineral products, wood, cork, paper, pulp, coke, refined petroleum, nuclear fuel) industries:

Table 3: Changing agglomeration in industrial sectors–classified by labor, resource, research use and extent of scale economies, based on ISIC Rev. 2

	1970	*1980*	*1990*	*2000*	*2005*	**Change 1970-2005**	Trend Test
All industries	0.1762	0.1862	0.1925	0.2095	0.2207	0.2525	0.0012**
Labor intensive industries	0.1606	0.216	0.2709	0.3281	0.3443	1.1442	0.0054**
Research intensive industries	0.1865	0.1867	0.184	0.2005	0.2084	0.1172	0.0005**
Scale intensive industries	0.1572	0.1619	0.1669	0.1728	0.1805	0.1484	0.0007**
Resource intensive industries	0.1896	0.1929	0.1879	0.2002	0.221	0.1655	0.0006**

Source: Own calculations based on EU KLEMS data (2008).

Labor intensive industries show a sharp increase in agglomeration over time, about 114 percent, supporting evidence from Brülhart (2001) and Kim (1995). This increase is much more than the increase of average European industries' concentration from 1970 to 2005 by about 25 percent. Thinking about reasons for this kind of development one should take a closer look at the countries that record a big increase in industrial concentration. The Balassa index for industries such as textiles, leather and footwear is especially high for Italy, Greece, Portugal and Spain. The argumentation behind could be that labor intensive industries have concentrated in these countries because of lower labor costs. This argumentation would support

[25] This is also done by the OECD, see OECD (1987). Klüver (2000) made use of this grouping. At that time she was using the industry classification ISIC Rev. 2. I had to reconstruct the grouping with ISIC Rev. 3 data, unfortunately, with only 20 industries at hand, this might be less precise than a higher disaggregation of industries would allow for.

Traditional Trade Theory's arguments.[26] However, this deserves further investigation. The importance of Traditional Trade Theory's assumptions will be explicitly tested for in one of the later sections.

The other industries show only moderate increases in industrial concentration over time. Resource intensive industries showed an increase of about 17 percent, scale intensive industries of about 15 percent and research intensive industries of about 12 percent, respectively. The reasoning for developments in resource intensive industries might be that agglomeration in this sector has occurred in the years before the investigation period of 1970-2005.[27] Availability of resources plays an important role in this sector. Transport costs for this sector are high because of the need to produce in the vicinity of resources. Interestingly, after a slight decline in concentration until 1990, agglomeration of these industries increased to a remarkable amount (about 18 percent) until 2005.

Scale intensive industries show a slow increase in industrial concentration over time. Research intensive industries display only a slight increase in industrial agglomeration over time. Obviously, this industry needs highly skilled labor. Traditional Trade Theory would argue that this kind of industry will agglomerate in countries that are highly endowed with high-skilled labor. Theses issues will be clarified in one of the later sections.

2.3.3 Countries' Specialization

Specialization and agglomeration are closely related to each other as has been shown by Kim (1995), for example. A growing specialization of European countries would indicate that industrial structures of European countries have become more unequal to each other.

[26]Midelfart-Knarvik et al. (2000), pp. 12-16, find that industrial structures of France, Germany, UK are characterized by strong economies of scale, a high technology and highly educated workers. Greece and Portugal, however have low technology, low returns to scale and low educated workers. This would be giving evidence for the lower-skilled cheaper labor in southern European countries. Klüver (2000) finds that labor costs are lower in the Southern European countries and higher in the Northern European countries. Further, more highly skilled labor is employed in Northern than in Southern European countries. She finds that labor-intensive industries got primarily concentrated in Southern European countries and concludes that thus Heckscher-Ohlin type arguments play a role in explaining agglomeration.

[27]See also Kim (1995), who said that specialization tendencies in the US were due to resources being immobile.

Table 4: Specialization of countries

	1970	*1980*	*1990*	*2000*	*2005*	**Change 1970-2005**	Trend Test
Europe	0.2269	0.2304	0.2286	0.2349	0.2384	0.0507	0.0003**
Austria	0.194	0.1873	0.1746	0.176	0.1671	-0.1385	-0.0004**
Belgium	0.2161	0.2096	0.2098	0.202	0.2024	-0.0633	-0.0004**
Denmark	0.2519	0.2545	0.2322	0.2159	0.2166	-0.14	-0.0014**
Finland	0.3147	0.2828	0.2545	0.2982	0.2983	-0.0519	0.0000
France	0.0944	0.083	0.0913	0.102	0.1183	0.2537	0.0004**
Germany	0.1282	0.1414	0.1723	0.1763	0.1852	0.444	0.0016**
Greece	0.3398	0.3647	0.3888	0.4	0.3874	0.1402	0.0017**
Ireland	0.322	0.3135	0.2933	0.3503	0.368	0.1427	0.001**
Italy	0.1666	0.1675	0.1755	0.1849	0.1917	0.1511	0.001**
Netherlands	0.2532	0.2903	0.2717	0.241	0.2468	-0.0255	-0.001**
Portugal	0.3386	0.367	0.4167	0.4097	0.4132	0.2202	0.0024**
Spain	0.188	0.1803	0.1739	0.1556	0.1448	-0.2298	-0.001**
Sweden	0.2498	0.2633	0.253	0.2537	0.247	-0.0114	-0.0005**
United Kingdom	0.119	0.1198	0.0928	0.1226	0.1506	0.2651	0.0003

Source: Own calculations based on EU KLEMS data (2008).

Taking a look at country Gini coefficients given in table 4 one can see that it is Germany, France, Greece, Portugal, Italy and Ireland that show a significant increase in specialization during the time period from 1970 to 2005. However, specialization shows only slight changes compared to agglomeration tendencies. It becomes evident that those countries exhibiting middle-high specialization states in the 70s tended to despecialize a little until 2005. Highly specialized countries in 1970 like Greece, Ireland and Portugal show a sharp increase in specialization until 2005 as well as those countries being only little specialized in 1970 (Germany, France and Italy, also). Besides, countries lying in the periphery of Europe like Ireland, Greece and Portugal and two important European core countries, namely Germany and France, exhibit high increases in specialization from 1970 to 2005. I can confirm results of Amiti (1998,1999) for Spain and the UK but not for Portugal which experienced an increase in specialization from 1970 to 1990.

2.3.4 Explaining Industrial Localization

In the following, I will focus on the investigation of driving factors of industrial concentration in the European Union. To address this issue an estimation equation containing variables that are supposed to excess an influence on industrial localization will be set up. Explanatory variables are taken from the two trade theories and the New Economic Geography discussed in more detail above. Amiti (1999) has specified and estimated an regression function explaining industrial agglomeration, as well. I will draw on the variables for Traditional Trade Theory and New Economic Geography taken and operationalized by her in this section. My measure for scale intensity differs from hers. For explaining specialization tendencies, which is being done in the next section, I will add further variables to the estimation function.

First, I consider Traditional Trade Theory. According to Heckscher-Ohlin, countries will specialize in producing and exporting a good that they produce relative intensively with the factor they are relatively abundant with. This is being captured by the following measure:

$$fact_{it} = \left|\frac{w_{it}L_{it}}{VA_{it}} - \frac{\overline{w_t L_t}}{\overline{VA_t}}\right|. \tag{5}$$

Here $w_{it}L_{it}$ denotes labor compensation in millions of euros in industry i at time point t and VA_{it} is gross value added in industry i at current basic prices in millions of euros at time t. The measure consists of the deviation of the share of labor compensation in value added to industries' average share of labor compensation in average value added. The absolute value of this measure is taken. The idea behind is that industries exhibiting either a high labor or a high capital intensity (represented by either high or low labor compensation compared to the European average) will show up a high level of industrial concentration. Thus a positive influence of *fact* on industrial concentration can be expected.

New Trade Theories postulate the relevance of scale economies. I try to capture this by the following measure:

$$scale_{it} = \frac{\frac{w_{it}L_{it}+Cap_{it}+Int_{it}}{Q_{it}}}{Q_{it}}. \tag{6}$$

It shall represent how per unit costs (the fraction in the nominator) evolve with output (the denominator), decreasing unit costs per given output indicating increasing economies of scale.[28] $w_{it}L_{it}$ again denotes labor compensation in millions of euros, Cap_{it} is capital compensation in millions of euros, Int_{it} is intermediate inputs at current purchasers' prices in millions of euros and Q_{it} is gross output as a volume index (1995=100). I expect a negative relationship between concentration and scale intensity, supported by the literature (see Krugman/ Venables (1995, 1996)).

New Economic Geography's arguments are going to be modeled in the following

[28]Amiti (1998, 1999) uses the fraction employment by number of firms, however, since data on number of firms were not available I decided to use an alternative modeling of scale economies. In the working paper version I used a fraction of employment over output which is the inverse of labor productivity. This measure is highly correlated with the measure for scale used here, which is not surprising since both measures describe relationships between changes in input and output. Also, the results for trade theories' and New Economic Geography's importance using the other measure in the working paper version are basically similar to results here.

way:

$$intermediate_{it} = \frac{P_{it}Q_{it} - VA_{it}}{P_{it}Q_{it}}. \quad (7)$$

Here $P_{it}Q_{it}$ denotes gross output at current basic prices in millions of euros and VA_{it} is gross value added at current basic prices in millions of euros. Industries that use a lot of intermediate inputs are expected to have stronger input-output linkages and thus show a higher concentration than other industries. Therefore a positive relationship between concentration and intermediate goods intensity can be expected. This is just representing the relationships which have already been explained in chapter 2.2.

In the following a regression function using OLS including time and industry dummies will be estimated:

$$lngini_{it} = \alpha + \beta_1 lnfact_{it} + \beta_2 lnscale_{it} + \beta_3 lnintermediate_{it} + \gamma_i + \delta_t + u_{it}. \quad (8)$$

The Gini coefficient $lngini_{it}$ is regressed on factor intensity $lnfact_{it}$, scale economies $lnscale_{it}$, intermediate goods intensity $lnintermediate_{it}$, time dummies δ_t and industry dummies γ_i, u_{it} is the disturbance term. Time dummies are taken relative to 1995, industry dummies are taken relative to fabricated metals. Further, the logs of variables are taken such as to better interpret (percentage) changes in variables. The results are given in table 5.[29] [30]

[29]Note that the p-value gives the probability of obtaining under the null hypothesis the observed value of the test statistic or a more extreme value (in direction to the alternative).

[30]A White test indicated heteroskedasticity of error terms such that White's heteroskedasticity-consistent standard errors were calculated. Further remedies like estimation with weighted least squares would be advisable, but this is not done here.

Table 5: Regression results industrial concentration

Dependent variable ln(gini) for industries	**OLS**		**OLS**		**OLS**
constant	-1.6707**	Coke, refined petroleum, nuclear fuel	0.7536**	1996	0.0166
ln(fact)	-0.0028	Rubber, plastics, plastics products	0.2947**	1997	0.021
ln(scale)	0.065*	Machinery equipment	0.5529**	1998	0.0215
ln(intermediate)	1.4573**	Motor Vehicles, trailers, semitrailers	0.8289**	1999	0.0132
Food, beverages, tobacco	-0.0388	Other transport equipment	0.7077**	2000	-0.0032
Textiles, textile products	1.3662**	Manufacturing, nec recycling	0.5338**	2001	0.0155
Leather, footwear	1.7239**	Chemical industry	0.3466**	2002	0.0261
Wood, wood products	1.3638**	Office accounting, computing machines	1.1479**	2003	0.0436**
Pulp, paper, paper products	0.5314**	Electrical machinery apparatus	0.7063**	2004	0.0423*
Printing, publishing	0.8132**	Radio, TV, communication equipment	0.7909**	2005	0.0324
Basic Metals	0.2022**	Medical, precision, optical instruments	1.2183**	N	220
Non-metallic mineral products	0.5347**			R^2	0.988
				F-Stat	500.959

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

The results show that New Economic Geography's arguments can explain agglomeration tendencies in the EU best. A one percent increase in intermediate goods intensity increases industrial concentration by about 1.46 percent. The coefficient for scale is less significant and not bearing the expected sign. Almost all of the industry effects are significant pointing towards the importance of further unobservable industry characteristics. Time effects are only significant for 2003 and 2004, probably indicating some influence of growing integration and liberalization in the EU. However, a check for multicollinearity of variables was considered being adequate. Important results occurred: regressions including industry effects produce high variance inflation factors (VIF). Therefore, regressions with industry effects might bias estimators. Via industry effects, however, industry specific unobserved effects for agglomeration can be measured, thus they are important. Leaving out these effects should only be done if there is another variable capturing across industry variation, sufficiently. This is what the variables $fact$, $scale$ and $interm$ do. So, with some caution on interpretation, another regression function discarding industry effects was estimated. In the literature one can find analyses using industry effects, time effects, both or none of them. My results are given in the following table:

Table 6: Regression results industrial concentration without industry effects

Dependent variable ln(gini) for industries	**OLS**		**OLS**		**OLS**
constant	-2.0156**	1998	-0.0769	2004	-0.1107
ln(fact)	-0.0594*	1999	-0.1046	2005	-0.1354
ln(scale)	-0.3284**	2000	-0.1463	N	220
ln(intermediate)	1.6891**	2001	-0.1399	R^2	0.429
1996	-0.0137	2002	-0.1316	F-Stat	11.89
1997	-0.0442	2003	-0.1243		

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

As can be seen, both New Trade Theory's and New Economic Geography's arguments show strong explanatory power. This way, I can confirm the results obtained by Amiti (1999). A one percent increase in intermediate goods intensity increases industrial concentration by about 1.69 percent and a one percent increase in scale intensity increases industrial concentration by about 0.33 percent. Surprisingly, factor intensity appears to be significant but does not show the expected sign. The negative sign would mean that industries get more concentrated the more factor abundance in a country equals the European average. This is in sharp contrast to Traditional Trade Theory's assumptions. Traditional Trade Theory's arguments therefore do not seem to be able to explain industrial concentration very well.

Before making a final conclusion, however, I took into account the four different industrial sectors classified by the OECD and checked for influential factors of agglomeration in all of these sectors separately (I considered sectors obtained by both the ISIC Rev. 3 and reconstructed ISIC Rev. 2 classification). The results are shown in table 7.

New Economic Geography's assumptions appear to be the main explanatory power for all of the sectors considered. The most surprising result perhaps is that intermediate goods' intensity is the main driving force for agglomeration in labor intensive industries. The results indicate that a one percent increase in intermediate goods intensity increases industrial concentration in this sector by about 12.25 percent. Economies of scale are important for almost all of the sectors. Thus, New Trade Theory's assumptions bear an overall strong importance. Factor intensity appears to be significant for medium-low technology and research intensive industries only. Interestingly, for resource intensive, scale intensive, medium-low and high-technology industries time effects are important from about 2000 on. The negative signs of time effects, however, suggest that industries' concentration became less over time.

Another way of looking at agglomeration would be to consider single time series

Table 7: Regression results agglomeration of industrial sectors–by groups of industries

	Labor intensive	*Scale intensive*	*Resource intensive*	*Research intensive*	*Low technology*	*Medium-low technology*	*Medium-high technology*	*High technology*
constant	4.6596**	-1.3945**	-4.35**	-1.5244**	-2.4195**	-2.5855**	-1.5441**	-2.3391**
Ln(fact)	0.0169	-0.2231**	-0.0409**	0.0447*	-0.2433**	0.0283**	-0.2704**	0.0216
Ln(scale)	0.2881**	-0.1107**	-1.1581**	-0.1966**	-0.6253**	-0.5565**	-0.1332**	-0.3255**
Ln(intermediate)	12.2513**	2.7316**	1.7055**	1.4423**	3.5531**	1.8995**	2.8635**	0.3529**
1996	0.1467	-0.0247	-0.0107	0.004	0.0034	0.0039	-0.0104	0.0098
1997	0.0156	-0.0509	-0.0749	0.0179	-0.0702	-0.013	-0.0629	0.0186
1998	0.0099	-0.0801	-0.1116**	0.0012	-0.1577	-0.018	-0.1079*	-0.0404
1999	0.0318	-0.1293	-0.169**	-0.042	-0.2785**	-0.0803*	-0.1055	-0.0928
2000	-0.1479	-0.158*	-0.2786**	-0.0901	-0.2842**	-0.172**	-0.124*	-0.1259
2001	-0.109	-0.138	-0.2234**	-0.1024	-0.1612	-0.1282**	-0.1216*	-0.1948**
2002	-0.0813	-0.1551*	-0.1631**	-0.0953	-0.1528	-0.0962	-0.0689	-0.2463**
2003	-0.0624	-0.1799*	-0.1997**	-0.0903	-0.2306	-0.0993	-0.0786	-0.2613**
2004	-0.2442*	-0.1555*	-0.2023**	-0.0796	-0.2209	-0.1474**	-0.0872	-0.2217**
2005	-0.3462**	-0.1789**	-0.3023**	-0.0895	-0.2041	-0.1798**	-0.1509**	-0.1813*
N	33	55	55	121	77	66	55	44
R^2	0.99	0.815	0.976	0.588	0.711	0.941	0.881	0.915
F-Stat	139.421	13.903	125.772	11.726	11.941	63.54	23.334	24.748

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

of countries or for the aggregated EU. Problematically, I do have eleven data points only, a far too small sample to conduct plausible estimation. It would be worthwhile to reestimate a regression equation for explaining industrial concentration using more observations in the future.

2.3.5 Explaining Specialization

Finding out the driving factors of countries' specialization in the EU the same explanatory variables are taken up as has been done for explaining industrial concentration. On the one hand this undertaking is justified by the incentive to disentangle the importance of different trade theories' and New Economic Geography's assumptions for countries' specialization. Furthermore, a strong correlation between specialization and agglomeration has been found out in the previous literature (see for example Kim (1995)). In addition, two more variables are added to the regression framework: country's openness and trade costs, aiming to cover further aspects of New Economic Geography. Instead of transport costs, here trade costs are taken, due to data availability. Transport costs form a part of a trade costs measure. Formally, the estimation equation is derived from theories of Krugman/ Venables (1995) (see also equations (1) and (2)) and supplemented with further explanatory factors.

The openness index is taken from the Penn World Table (2006) and defined as follows:

$$openness_{ct} = \frac{IM_{ct} + EX_{ct}}{GDP_{ct}}. \tag{9}$$

This measure is made up of imports plus exports divided by real GDP (base year 2000). It yields country c's total trade as a percentage of GDP at time point t. A positive relationship between openness and countries' specialization can be expected, liberalizing of markets, thus more trade, should go hand in hand with more specialization.

Trade costs are taken from Dreher (2006). They are operationalized by the component *restrictions* out of his index of economic globalization. The measure is composed of mean tariff rate, hidden import barriers, taxes on international trade and capital account restrictions. Dreher used principal component analysis in order to derive the indexes for globalization, the procedure can be reread in his paper. I would like to point to some drawbacks of this measure. Severe bias is to be expected since most of the time at the margins of a data series missing observations are substituted by the last available data value. Further, missing values within a time series are gained by linear interpolation, thus again, not the real world values are taken. Although there are several disadvantages in taking this index, it has nevertheless been taken within my regressions since better data could not be found for addressing trade costs so far. Proxies for trade costs could be considered, however, using the most common proxy, that is distance between countries, is not feasible here, since I do not make use of bilateral data.[31] A higher value of the variable *trade costs* indicates fewer trade costs. I expect a positive relationship between *trade costs* and countries' specialization to appear. The measure *trade costs* could be formalized as follows:

$$tradecosts_{ct} = f(MT_{ct}, HIB_{ct}, TIT_{ct}, CAR_{ct}), \tag{10}$$

where MT denotes mean tariff rate, HIB hidden import barriers, TIT taxes on international trade, CAR capital account restrictions and f denotes a linear combination using a principal component, respectively.

Applying OLS using country and time effects I estimate the following equation:

$$\begin{aligned} lngini_{ct} = \alpha + \beta_1 lnfact_{ct} + \beta_2 lnscale_{ct} + \beta_3 lninterm_{ct} \\ + \beta_4 lnopen_{ct} + \beta_5 lntrade_{ct} + \gamma_c + \delta_t + u_{ct}. \end{aligned} \tag{11}$$

The Gini coefficient $lngini_{ct}$ is regressed on factor abundance $lnfact_{ct}$, overall industries' scale economies in country c $lnscale_{ct}$, overall industries' intermediate goods intensity in country c $lnintermediate_{ct}$, openness $lnopen_{ct}$, trade costs $lntrade_{ct}$, time dummies δ_t and country dummies γ_c, u_{ct} is the disturbance term. Time dummies δ_t are taken relative to 1970, country dummies γ_c are taken relative to Germany. Further, logs of variables are taken. The results are shown in table 8.

Results suggest that New Economic Geography's arguments explain countries' specialization in the EU best. Intermediate goods intensity and trade costs are the main driving factors of specialization. Heckscher-Ohlin theory's arguments are important only to a slight extent with quite a low coefficient. Interestingly, the openness variable remained insignificant. Country effects point to the relevance of some unexplained country variation, time effects become significant with the beginning of the 1980s.[32] This indicates that ongoing integration and liberalization in the EU exerts an influence on countries' specialization. Further, it is worthwhile noting that time effects are bearing a negative sign. The negative sign would mean that the more liberalization proceeds the lower will be countries' specialization. This, however, can be explained neatly by Krugman's model. Liberalization in the European Union has proceeded so far and transaction costs have declined so much

[31] Bosker and Garretsen (2010) find that modeling of trade costs matters for market access which in turn influences spatial wage differences. They offer an alternative modeling of bilateral trade costs based on imports and goods produced and consumed in the home country.

[32] Not shown here but available from the author upon request.

that specialization in the EU became less. Suppliers settle down in both core and peripheral regions again, dispersion among countries occurs again.

Table 8: Regression results countries' specialization

Dependent variable			OLS		
ln(gini) countries	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
constant	-1.4367**	-1.3956**	-1.635**	-2.9173**	-2.7055**
ln(fact)	0.0232**	0.023**	0.0235**	0.0242**	0.0238**
ln(scale)	-0.0098	-0.0102	0.0003	-0.0209	-0.0305
ln(intermediate)	0.6346**	0.7218**	0.7104**	0.9714**	0.983**
ln(openness)			0.0545	0.0496	
ln(tradecosts)				0.356**	0.3576**
Austria	0.0845*	0.0875*	0.09*	0.0802	0.0778
Belgium	0.2228**	0.2164**	0.1798**	0.111*	0.144**
Denmark	0.3274**	0.3283**	0.3384**	0.2829**	0.2735**
Finland	0.5094**	0.5044**	0.5247**	0.4849**	0.4663**
France	-0.5855**	-0.598**	-0.5835**	-0.5862**	-0.5991**
Greece	0.8034**	0.8014**	0.8531**	0.8257**	0.7785**
Ireland	0.6096**	0.6051**	0.5902**	0.5304**	0.5437**
Italy	0.0133	0.0091	0.0195	0.0406*	0.0311
Netherlands	0.4659**	0.4605**	0.4379**	0.3746**	0.3948**
Portugal	0.7902**	0.7728**	0.7979**	0.7634**	0.7403**
Spain	0.013	0.0102	0.0419	0.0065	-0.0224
Sweden	0.4224**	0.4195**	0.4272**	0.3839**	0.3767**
UK	-0.3747**	-0.384**	-0.3746**	-0.3771**	-0.3857**
time effects	yes	yes	yes	yes	yes
N	504	490	490	490	490
R^2	0.975	0.977	0.977	0.979	0.979
F-Stat	343.627	374.859	368.463	395.307	402.207

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

However, multicollinearity was supposed to be a severe problem in the regressions (since R^2 is pretty high and the variable for *scale*, for example, is not significant). Checking for multicollinearity, I found that including country effects will increase VIFs. Redoing regressions, leaving out country effects, I got the results shown in table 9. Controlling for multicollinearity it can be seen that all of the explanatory variables attain significance. This way New Economic Geography's, New Trade Theory's and Traditional Trade Theory's assumptions are able to explain countries' specialization. Heckscher-Ohlin theory's arguments, however, bear a small importance for countries' specialization only. Openness' and trade costs' influence is not so clear. Openness is significant in one specification, only, trade costs change signs in two of four regressions. This seems to be due to the inclusion or exclusion of time effects. When no time effects are included the coefficient for trade costs captures the lower specialization of countries emerging, whereas in specifications with time effects this is captured

Table 9: Regression results countries' specialization without country effects

Dependent variable				OLS				
ln(gini) for countries	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
constant	0.112	-0.1125	-0.2005	-0.0568	-2.5463**	0.6702	-2.6208**	0.5096
ln(fact)	0.0447**	0.0488**	0.0506**	0.0476**	0.0562**	0.046**	0.0558**	0.045
ln(scale)	-0.3065**	-0.2934**	-0.2978**	-0.2953**	-0.3165**	-0.2896**	-0.3182**	-0.2938**
ln(intermediate)	1.2768**	1.1322**	1.2435**	1.1404**	1.5712**	1.0385**	1.5894**	10.803
ln(openness)			0.0808**	-0.0128	0.0114	0.0284		
ln(tradecosts)					0.6611**	-0.2164*	0.6911**	-0.1485*
country effects	no	no	no	no	no	no	no	no
time effects	yes	no	yes	no	yes	no	yes	no
N	490	490	490	490	490	490	490	490
R^2	0.672	0.646	0.677	0.646	0.6882	0.648	0.688	0.648
F-Stat	24.992	294.988	24.912	220.972	25.468	178.276	26.187	222.798

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

by time effects themselves. Averaging variables over all European countries and looking for time series properties I get the following results shown in table 10.

Table 10: Regression results specialization aggregated EU

Dependent variable ln(gini) for countries	**OLS aggregated EU**			
const	-1.0369**	-1.5859**	-1.0844**	-1.0227**
ln(fact)	0.0539**	0.0547**	0.0558**	0.0245
ln(scale)	-0.0509**	0.037*	-0.0467	0.0036
ln(intermediate)	0.3172**	0.3752**	0.3256**	0.26**
ln(openness)		0.0669**		0.0938**
ln(tradecosts)			0.0093	-0.1537**
N	35	35	35	35
R^2	0.803	0.863	0.803	0.885
F-Stat	42.212	47.252	30.66	44.641
DW	1.123	1.532	1.129	1.75

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

Results indicate that all of the variables are significant in most regression frameworks. Openness enters the regression equation with a positive sign, transport costs, however, with a negative sign. This is indicating that the lower are transport costs, that is the more liberalization has proceeded, the lower will be countries' specialization. Again, this is in favor of Krugman's model. However, I found that including openness and/or trade costs into the regressions leads to severe multicollinearity problems. Therefore, at best only the first column of values in table 10 might give valid information on the explanatory power of variables. Still, this means New Economic Geography's arguments can explain specialization best. Another trouble becomes evident looking at Durbin Watson statistics. Autocorrelation of error terms might be an important point in explaining the results here, too. Therefore one has to think about further remedies, which is what I will do in section 2.3.7.

2.3.6 Robustness Analysis

Further robustness checks shall be conducted in order to test for the relevance of the results. In a first step I considered using a different dependent variable, the so called Krugman concentration (specialization) index. This index based on Krugman's work (1991 a) has been reformalized by Midelfart-Knarvik et al. (2000). The measure is constructed as:

$$K_{i,t} = \sum_{c=1}^{C} |\frac{e_{ic,t}}{e_{i,t}} - \frac{1}{I-1}\sum_{i=1}^{I-1}(\frac{e_{ic,t}}{e_{i,t}})|. \tag{12}$$

It measures the deviation of employment in industry i in country c as a share of employment of industry i in the EU from the mean of these employment shares for the other (I-1) industries. The drawbacks of Gini coefficients (see chapter 2.2) can thus be circumvented. The results are given in table 11.

Table 11: Agglomeration according to Krugman index of industrial concentration

Industry	Krugman-I 2005	Industry	Krugman-I 1970
Most agglomerated			
Leather, footwear	0.9639	Office, accounting, computing machines	0.5286
Textiles, textile products	0.6847	Wood, wood products	0.4469
Motor vehicles, trailers, semitrailers	0.4856	Other transport equipment	0.4243
Office, accounting, computing machines	0.4751	Leather, footwear	0.4027
Coke, refined petroleum, nuclear fuel	0.4421	Medical, precision, optical instruments	0.3418
Most dispersed			
Fabricated Metals	0.1161	Fabricated Metals	0.1357
Food, beverages, tobacco	0.1561	Chemical Industry	0.1568
Pulp, paper, paper products	0.1948	Radio, TV, communication	0.1993
Rubber, plastics, plastics products	0.2208	Rubber, plastics, plastics products	0.2083
Manufacturing, nec recycling	0.2507	Motor vehicles, trailers, semitrailers	0.213

Source: Own calculations based on EU KLEMS data (2008).

As can be seen, the same industries appear to be most or least agglomerated, as is the case for employing the Gini coefficient. Especially, leather, textiles and motor vehicles are most agglomerated, whereas fabricated metals, food and pulp are least agglomerated in 2005.

Next, I added a further explanatory variable, measuring growth, to the regression equation as:

$$growth_{it} = \frac{Q_{it} - Q_{i(t-1)}}{Q_{i(t-1)}}. \qquad (13)$$

Q_{it} denotes gross output as a volume index (1995=100) at time point t. Martin and Ottaviano (2001) explain that growth leads to higher agglomeration. This happens because forward and backward linkages between production and innovation exist which make firms locating closer to a region of high growth caused by innovation processes therewith leading to agglomeration. However, it can be expected that growth is endogeneous. Martin and Ottaviano explain that a clustering of firms might well reduce costs of innovation therewith fostering economic growth. Dealing with this kind of endogeneity issue is left out for further research.[33]

[33]Instrumental variable regression might be done, one has to bear in mind that here the coefficient for growth thus might be estimated inconsistently.

Regression results are shown in table 12.

Table 12: Robustness checks

	agglomeration					
Dependent Variable	Krugman-I	Krugman-I	Gini	Gini	Krugman-I	Krugman-I
lnfact	-0.0231	0.0038	-0.0597**	0.0005	-0.0241	0.0091
lnscale	-0.2443**	0.1047**	-0.3477**	0.0868**	-0.2649**	0.1244**
lninterm	1.4442**	2.3899**	1.7231**	1.2145**	1.481**	1.9967**
growth			-1.7773**	0.1645**	-1.807**	0.1629
const	-1.3744**	-0.5626**	-2.0099**	-1.7398**	-1.3626**	-0.7148**
Time effects	yes	yes	yes	yes	yes	yes
Industry effects	no	yes	no	yes	no	yes
N	200	200	200	200	200	200
R^2	0.289	0.982	0.459	0.99	0.325	0.984

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

As can be seen, intermediate goods' intensity is significant and best in explaining agglomeration in the EU. The coefficient for Heckscher-Ohlin theory's arguments is either not significant or not bearing the expected sign. Scale economies have a small and negative influence on agglomeration when industry effects are included.[34] In regressions without industry effects scale economies are significant and bear the expected sign. Growth shows the expected positive relationship with agglomeration only when industry effects are included in regressions. Overall, the evidence for New Economic Geography's arguments to be important in explaining agglomeration in the EU appears to be robust.

2.3.7 Considering Dynamics

As has been seen above, regressions of time series point towards a problem: the Durbin-Watson statistics indicate autocorrelation of error terms. This problem might occur because non-stationarity properties of variables have not been adequately considered. In this section I will consider stationarity properties of regression variables. The idea behind is that if non-stationary variables are regressed on each other one might obtain significant results that are not meaningful, however. It's a spurious regression only. In order to handle this problem it is worthwhile to check for non-stationarity of the variables first. If a co-integration relationship between non-stationary variables can be established, that is if a linear combination of non-stationary variables appears to be stationary, one will be able to estimate an error correction model. This will enable one to differentiate between short-run and long-run influences of variables and to estimate the error correction term which can

[34]Remember that a positive coefficient of scale indicates that higher scale economies lead to fewer agglomeration.

show by how much deviations from the long-run state equilibrium will be adjusted within the next period.
Due to data constraints I was able to consider dynamics for countries' specialization only. It would be worthwhile to redo this kind of analysis for industrial concentration once data will be available. I will show results for the aggregated EU first, results for European countries themselves can be found in the appendix.

In a first step I tested variables for being non-stationary. This was done by using an Augmented Dickey Fuller test and a Phillips-Perron test applying trend and intercept estimation. The results are given in table 13.

Table 13: Co-integration test and error correction modeling for the aggregated EU

Co-integration Test and error correction model for the EU	**Unit root test trend and intercept**	**Error correction model**	**Unit root test trend and intercept**	**Error correction model**
ln(gini)	I(1)**		I(1)**	
ln(fact)	I(1)**		I(1)**	
ln(scale)	I(1)**		I(1)**	
ln(intermediate)	I(1)**		I(1)**	
ln(openness)	I(1)**		I(1)**	
ln(tradecosts)			I(1)**	
co-integrated	yes*		yes**	
D(ln(fact))		0.0096		0.0014
D(ln(scale))		0.0182		0.0353
D(ln(intermediate))		0.2774**		0.2579**
D(ln(openness))		-0.0146		0.0379
D(ln(tradecosts))				0.013
$D(ln(gini_{t-1}))$		-0.0875		-0.018
$Resid_{t-1}$		-0.6281**		-0.7876**
const		0.0019		0.0007
N		35 (33)		35 (33)
R^2		0.418		0.474
DW		1.741		1.671

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level.

All of the tested variables are I(1).[35] This enabled me to check for a co-integration relationship in a second step. The regression functions including openness and openness and trade in addition to the two trade theory and the New Economic Geography variables appeared to be co-integrated. So in a third step I conducted an error correction model estimation for these two regression frameworks using the following equation:

$$Dlngini_{ct} = \alpha + \beta_k D\mathbf{X} + \tau Dlngini_{c(t-1)} + \delta resid_{c(t-1)} + u_{ct}. \quad (14)$$

[35] I(1) means that a variable is non-stationary and integrated of the rank 1, that is differencing the variable one time makes it become stationary.

The first difference (D) of the logarithm of Gini is regressed on the first differences of a set of k explanatory variables $\mathbf{X}$, the Gini of the previous period and the lagged residual emerging from estimating the long term regression function $lngini_{ct} = \alpha + \beta_k \mathbf{X} + u_{ct}$. $\mathbf{X}$ is a vector containing explanatory variables $lnfact_{ct}$, $lnscale_{ct}$, $lninterm_{ct}$, $lnopen_{ct}$ and $lntradec_{ct}$. u_{ct} is the disturbance and δ here is the error correction term.
As can be seen in table 13, New Economic Geography's arguments serve as the best explanatory power, being highly significant. In the short-run intermediate goods intensity exerts an influence of about 0.26 to 0.28 per cent on countries' specialization. These values are lower than those I estimated before for the long-run using a simple OLS procedure, only. The error correction term is highly significant and ranges from -63 to -79 percent, respectively. This means that deviations from the long-run equilibrium state of specialization in the EU as a whole are being set off by about 63 to 79 percent within the next period (1 year).

Investigations for the European countries themselves delivered distinct results. In order to test for a co-integration relationship, variables have to be integrated of the same order. This is something I could establish for Belgium, France, Germany, Ireland, Italy, Spain, Sweden and the UK only: all of the tested variables appeared to be I(1).[36] For Denmark and Finland only the variable transport costs clearly deviates from being I(1). This seems to be mostly due to the problems related with the trade cost measure as has been explained in chapter 2.3.5. The artificially constructed series of the trade cost index leads to several time points–especially in the beginning of a time series–carrying the same values whereas for later time points real, increasing values continue. Therefore, I decided that all of the regression functions excluding transport costs can be further considered for Denmark and Finland, as well. Co-integration could be established for Denmark, France, Germany, Spain and Sweden. The results are shown in the appendix.[37] For Denmark the coefficient for factor intensity appears to be significant and the coefficient for scale intensity bears a positive sign. The error correction term ranges between 58 and 59 percent. For France the coefficients for openness and trade costs are highly significant and the coefficient of economies of scale does not bear the expected sign. The error correction term ranges between 16 and 17 percent. Regressions for Germany reveal the influence of scale economies. Coefficients for intermediate goods intensity are not consistent with theory. The error correction term is in the range of 37-40 per-

[36] Using the ADF-test or Phillips-Perron test. Last test's results are abbreviated by PP.

[37] I checked for co-integration for all of the regression frameworks where variables were integrated of the same order and conducted error correction estimation whenever a co-integration relationship was significant up to about a 0.10 p-value. Therefore I run ADF tests and used MacKinnon's critical values for co-integration tests (MacKinnon (2010)).

cent. For Spain the coefficient for scale intensity does not show the expected sign. The error correction term ranges between 36 and 43 percent. For Sweden factor intensity seems to be important for specialization. The error correction is about 33 percent. All in all, investigations show that adjustments for Denmark, France, Germany, Spain and Sweden are slower than for the EU as a whole. This means if specialization is higher/ lower than the levels of factor abundance, overall scale economies and intermediate goods' flows would suggest, it will be corrected within one year to a lower extent than it would be the case for the EU on average or for some other European countries. So the speed returning to equilibrium after a deviation occurred is lower for Denmark, France, Germany, Spain and Sweden than for the EU on average. Specialization, as measured by employment shares, is not able to change that quickly. So this study's results offer important insights for regional, structural, economic and social politics in the EU. Further, results show that lowering trade costs made France specialize more. France's level of trade costs does not seem to be as low as is the case in the third stage of the Krugman/ Venables model, where very low transport costs would induce fewer specialization.

It would be nice to have further research going on in the future on econometric dynamics of several European countries for more disaggregated industries or a larger amount of time periods such that clearer evidence might be gained about European countries' short-run and long-run driving forces of specialization.

2.4 Conclusion

My aim was to disentangle the developments and various factors influencing industrial concentration and countries' specialization in the European Union. I found out that industrial agglomeration in the European Union grew by about 25 percent from 1970 to 2005. Especially textiles, leather, footwear, wood and motor vehicles showed a large increase in agglomeration. It's basically labor intensive or low-technology industries that displayed a huge increase in concentration. Instead, countries' specialization remained rather low. However, I found that peripheral European countries like Ireland, Greece, Portugal and two core European countries, namely Germany and France exhibited high increases in specialization.
Regression results indicate on the one hand that one has to consider multicollinearity problems. If this is not being done results become biased and are hardly interpretable. New Trade Theory's and New Economic Geography's assumptions can explain agglomeration best. Traditional Trade Theory's arguments did not appear to be significant. They might play a small role for research and medium-low technology industries, though. Regarding countries' specialization I found evidence for the validity of New Economic Geography's arguments, especially. Since growing

liberalization and declining trade costs influence specialization negatively, one could argue that this gives evidence for what Krugman and Venables (1995) described for the case of ongoing reduction of trade costs. Liberalization in the European Union seems to have proceeded so far and trade costs have declined so much that specialization in the EU became less. Suppliers settle down in both core and peripheral regions again, dispersion among countries occurs.

This study appears to be the first one that considers stationarity properties of variables explaining agglomeration and specialization in the European Union. Regression results indicate that New Economic Geography's arguments are best in explaining specialization. Furthermore, for the EU as a whole I can disentangle the effect of adjusting to the long-run equilibrium state of specialization which amounts to about 63 to 79 percent (depending on which regression framework is being taken) within the next period. I could establish further valid co-integration relationships and error correction modeling frameworks for Denmark, France, Germany, Spain and Sweden, only. The results indicate that adjustments rates to long-run equilibrium for these countries are lower than for the EU as a whole.

It would be worthwhile to intensify research in the future for these countries' specialization and agglomeration patterns making use of more disaggregated industry data employing econometric methods as being shown in this paper. Since agglomeration of European industries increased considerably over time and seems to increase even further, the probability for asymmetric shocks to occur is and remains quite high. One further extension of research could thus be to model asymmetric shocks in a framework of growing industrial concentration in the European Union. Besides, it would be interesting to investigate agglomeration and specialization patterns including the new Eastern European member countries of the EU into analysis. That way it could be possible to evaluate adverse effects due to asymmetric shocks in a potentially enlarged European Monetary Union.

2.5 Appendix

Table 14: Country analysis part I

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Austria	Ln(gini), ln(fact), ln(scale) ln(intermediate)	Fact: -0.0268** Scale: 0.1236** Interm: 0.5775** R^2: 0.703, DW: 0.831	Ln(fact)=I(0), PP I(2) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(1) Ln(trade costs)=I(1) Ln(openness)=I(1)	yes*	Fact: -0.0206** Scale: 0.1827* Interm: 0.8994** Error correction term: -0.6166** R^2: 0.498, DW: 2.007
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Fact: -0.0258** Scale: 0.2625** R^2: 0.717, DW: 0.898		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Fact: -0.0151** Scale: 0.4652** Interm: 1.0248** Openness: 0.1949** Trade costs: 0.3539** R^2: 0.8, DW: 1.173		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: -0.017** Scale: 0.2818** Interm: 1.1809** Trade costs: 0.3351** R^2: 0.778, DW: 0.989		no	
Belgium	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Scale: 0.0716** R^2: 0.736, DW: 0.862	Ln(fact)=I(1), PP I(0) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(1)	no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 15: Country analysis part II

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Belgium	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Scale: 0.0455** R^2: 0.744, DW: 0.859	Ln(trade costs)=I(1), PP I(2) Ln(openness)=I(2), PP I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	R^2: 0.76, DW: 0.907		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Scale: 0.224* R^2: 0.751, DW: 0.936		no	
Denmark	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.0384** Scale: 0.266** Intermediate: 0.5038** R^2: 0.918, DW: 1.315	Ln(fact)=I(0), PP I(1) Ln(scale)=I(0), PP I(1) Ln(intermediate)=I(1) Ln(gini)=I(1) Ln(trade costs)=I(2)	yes*	Scale: 0.2507** Error correction term: -0.5944** R^2: 0.355, DW: 1.841
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Fact: 0.0421** Scale: 0.4017** Intermediate: 0.5319** Openness: 0.1058* R^2: 0.925, DW: 1.499	Ln(openness)=I(1)	yes*	Fact: 0.024** Scale: 0.2733** Error correction: -0.5842** R^2: 0.41, DW: 1.824

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 16: Country analysis part III

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Denmark	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Fact: 0.0406** Scale: 0.4001** Intermediate: 0.4898* Openness: 0.1151* R^2: 0.925, DW: 1.446		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.0414** Scale: 0.2878** Intermediate: 0.5755** R^2: 0.918, DW: 1.418		yes*	Scale: 0.2329** Error correction term: -0.6668** R^2: 0.414, DW: 1.926
Finland	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.0501** Scale: 0.0652** R^2: 0.381, DW: 0.872	Ln(fact)=I(1), PP I(0) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(1) Ln(trade costs)=I(2) Ln(openness)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Scale: 0.6177** Openness: 0.8514** R^2: 0.822, DW: 0.615		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Scale: 0.6437** Openness: 1.1491** Trade costs: -0.5392** R^2: 0.867, DW: 0.957		no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 17: Country analysis part IV

		OLS	*Unit root (at 5 %value) trend and intercept*	*Co-integrated*	*Error correction model*
Finland	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.041** Scale: 0.2486** Trade costs: 0.5916** R^2: 0.5, DW: 0.782		no	
France	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Intermediate: 2.0182** R^2: 0.391, DW: 0.185	Ln(fact)=I(1) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(2), PP I(1) Ln(trade costs)=I(1) Ln(openness)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Scale: 0.8346** Intermediate: 1.1834* Openness: 0.8607** R^2: 0.613, DW: 0.294		yes*	Scale: 0.4863** Openness: 0.5091** Error correction term: -0.1652** R^2: 0.454, DW: 2.21
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Scale: 0.8324* Intermediate: 1.4076* Openness: 0.7852** R^2: 0.615, DW: 0.291		yes*	Scale: 0.4435** Openness: 0.4448** Trade costs: 0.4284** Error correction term: -0.1558** R^2: 0.538, DW: 2.089
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Scale: 0.3913** Intermediate: 2.8862** Trade costs: 0.89** R^2: 0.514, DW: 0.293		no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 18: Country analysis part V

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Germany	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Scale: -0.7459** Intermediate: -1.6252** R^2: 0.91, DW: 0.724	Ln(fact)=I(1) Ln(scale)=I(0), PP I(1) Ln(intermediate)=I(1) Ln(gini)=I(1) Ln(trade costs)=I(1) Ln(openness)=I(1)	yes**	Scale: -0.2293* Intermediate: -0.9133** Error correction term: -0.388** R^2: 0.461, DW: 1.98
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Scale: -0.5301** Intermediate: -1.625** R^2: 0.914, DW: 0.603		yes*	Scale: -0.2996* Intermediate: -0.9956** Error correction term: -0.4004** R^2: 0.468, DW: 1.861
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Scale: -0.5165** Intermediate: -1.578** R^2: 0.918, DW: 0.6		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Scale: -0.6064** Intermediate: -1.5669** R^2: 0.917, DW: 0.651		yes*	Intermediate: -0.7976** Error correction term: -0.3688** R^2: 0.426, DW: 1.839
Greece	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Scale: -0.1545** Intermediate: 1.2877** R^2: 0.8858, DW: 1.1032	Ln(fact)=I(1) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(2)	no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 19: Country analysis part VI

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Greece	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Scale: -0.0672** Intermediate: 0.4269** Openness: 0.093** R^2: 0.933, DW: 1.113	Ln(trade costs)=I(1) Ln(openness)=I(0), PP I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Scale: -0.0515* Intermediate: 0.4286** Openness: 0.1092** R^2: 0.934, DW: 1.214		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Scale: -0.1559** Intermediate: 0.7852** Trade costs: 0.1466** R^2: 0.91, DW: 0.878		no	
Ireland	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.3729** Scale: 0.1023** R^2: 0.666, DW: 0.53	Ln(fact)=I(1) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(trade costs)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Fact: 0.3642** R^2: 0.697, DW: 0.59	Ln(gini)=I(1) Ln(openness)=I(1)	no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 20: Country analysis part VII

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Ireland	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Fact: 0.3469** R^2: 0.698, DW: 0.581		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.4201** Scale: 0.0759** R^2: 0.678, DW: 0.589		no	
Italy	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Scale: -0.1283** Intermediate: 0.495** R^2: 0.761, DW: 0.422	Ln(fact)=I(1) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	R^2: 0.769 DW: 0.43	Ln(trade costs)=I(1) Ln(openness)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	R^2: 0.769 DW: 0.43		no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 21: Country analysis part VIII

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Italy	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Scale: -0.0955** R^2: 0.767, DW: 0.436		no	
Netherlands	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.0109** Scale: 0.2551** Intermediate: 1.3892** R^2: 0.74, DW: 0.623	Ln(fact)=I(0) Ln(scale)=I(2), PP I(1) Ln(intermediate)=I(1) Ln(gini)=I(2) Ln(trade costs)=I(2), PP I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Intermediate: 1.2465** Openness: -0.2511** R^2: 0.793, DW: 0.607	Ln(openness)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Scale: 0.1476** Intermediate: 0.7717** Openness: -0.3167** Trade costs: 0.8555** R^2: 0.888, DW: 1.0258		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.0125** Scale: 0.4662** Intermediate: 1.028** Trade costs: 0.7062** R^2: 0.808, DW: 0.884		no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 22: Country analysis part IX

		OLS	*Unit root (at 5 %value) trend and intercept*	*Co-integrated*	*Error correction model*
Portugal	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.0132** Scale: -0.2563** R^2: 0.877, DW: 0.699	Ln(fact)=I(0) Ln(scale)=I(1), PP I(0) Ln(intermediate)=I(1) Ln(gini)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Fact: 0.0134** Scale: -0.2511** R^2: 0.877, DW: 0.704	Ln(trade costs)=I(2), PP I(1) Ln(openness)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Fact: 0.0061** Scale: -0.0545** Intermediate: 0.2935* Openness: -0.1286** Trade costs: 0.4826** R^2: 0.974, DW: 1.522		yes*	Fact: 0.0029** Openness: -0.0802* Trade costs: 0.3616** Error correction term: -0.7334** R^2: 0.367, DW: 2.085
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.01** Intermediate: 0.627** Trade costs: 0.3459** R^2: 0.948, DW: 0.982		no	
Spain	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.017** Scale: 0.1973** R^2: 0.889, DW: 0.956	Ln(fact)=I(1), PP I(2) Ln(scale)=I(1); PP I(2) Ln(intermediate)=I(1) Ln(gini)=I(1)	yes*	Scale: 0.1878** Error correction term: -0.3583* R^2: 0.255, DW:1.998
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Fact: 0.0156** Scale: 0.174** R^2: 0.89, DW: 0.921	Ln(trade costs)=I(1) Ln(openness)=I(1)	no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 23: Country analysis part X

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Spain	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Scale: 0.1251** Openness: -0.1993** Trade costs: 0.6141** R^2: 0.945, DW: 1.373		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.0176** Scale: 0.2553** Trade costs: 0.161* R^2: 0.901, DW: 1.079		yes**	Scale: 0.199** Error correction term: -0.4271** R^2: 0.268, DW: 1.98
Sweden	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.0074** Intermediate: -0.965** R^2: 0.594, DW: 0.456	Ln(fact)=I(1), PP I(0) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(1), PP I(0)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Intermediate: -0.9923** R^2: 0.596, DW: 0.471	Ln(trade costs)=I(1) Ln(openness)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Fact: 0.0067* Intermediate: -1.3513** R^2: 0.615, DW: 0.564		no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

Table 24: Country analysis part XI

		OLS	***Unit root (at 5 %value) trend and intercept***	***Co-integrated***	***Error correction model***
Sweden	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.0069* Intermediate: -1.3512** R^2: 0.615, DW: 0.56		yes*	Fact: 0.0038* Intermediate: -0.5493** Error correction term: -0.3347** R^2: 0.49, DW: 2.034
UK	Ln(gini), ln(fact), ln(scale), ln(intermediate)	Fact: 0.1007** Scale: -0.4605** R^2: 0.442, DW: 0.47	Ln(fact)=I(1) Ln(scale)=I(1) Ln(intermediate)=I(1) Ln(gini)=I(1) Ln(trade costs)=I(1) Ln(openness)=I(1)	no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness)	Fact: 0.0766** Intermediate: 1.357** Openness: 0.2475** R^2: 0.542, DW: 0.515		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(openness), ln(trade costs)	Fact: 0.0564** Scale: 0.5697** Intermediate: 1.8413** Openness: 0.9985** Trade costs: -1.1554** R^2: 0.75, DW: 0.989		no	
	Ln(gini), ln(fact), ln(scale), ln(intermediate), ln(trade costs)	Fact: 0.0962** Scale: -0.4612** R^2: 0.45, DW: 0.482		no	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken for OLS regression. For unit root tests significance at a 5 percent level. Co-integration is said to exist until a 10 percent level.

3 Services Sectors' Agglomeration in the European Union

Summary

Services sectors' agglomeration in the European Union, its development over time, its driving factors and dynamic tendencies will be empirically investigated in this study. Locational Gini coefficients are computed taking EU-KLEMS data for 14 European countries covering 22 services sectors over the period from 1970 to 2005. Overall, services sectors' agglomeration in the European Union decreased over the years between 1970 and 2005. Analysis shows that for most of the individual services sectors considered agglomeration decreased over time, leading to further dispersion of economic activities. Only the branches of retail trade, other water transport and financial intermediation record a significant increase in agglomeration. Agglomeration tendencies of services sectors can be explained by Heckscher-Ohlin theory's and the New Economic Geography's assumptions, however, New Economic Geography's arguments are not as important as has been proven to be the case for industrial agglomeration. Some evidence for intra-sectoral trade explaining equalizing economic structures for services sectors is given. Non-stationarity of variables is being checked for and error correction methods or regression in differences is employed. Further, specialization and agglomeration tendencies of Greece will addressed. A huge percentage of the Greek services' employees worked in branches like hotels and restaurants, transport and storage, retail trade, sale of motor vehicles, public administration and education compared to the EU. I argue that this kind of specialization made Greece vulnerable to asymmetric shocks, which can be verified by the current debt crisis in the European Union.

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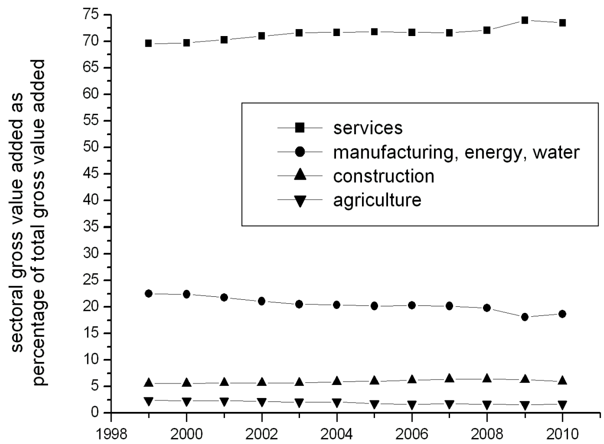
3.1 Introduction

Agglomeration of services has not been studied extensively in the literature so far. This might be due to difficulties related to measurement of services which manifests in lack of services' data in many data sources. Services are different from industrial goods for several reasons. First, the production and consumption of services usually occur at the same time and in the same location (Copeland and Mattoo (2008)). Further, services cannot be stored. Consequently, they are regarded as non-tradables. This fact alone suggests that one can expect services to be more dispersed than manufacturing goods because manufacturing goods could be produced in another place than where they are being consumed and they can be stored and transported to a place where they are demanded for, thus making clustering of manufacturing firms possible. Further differences between industrial goods and services become clear taking a look at the following graphics.

Figure 1: Gross value added by sectors

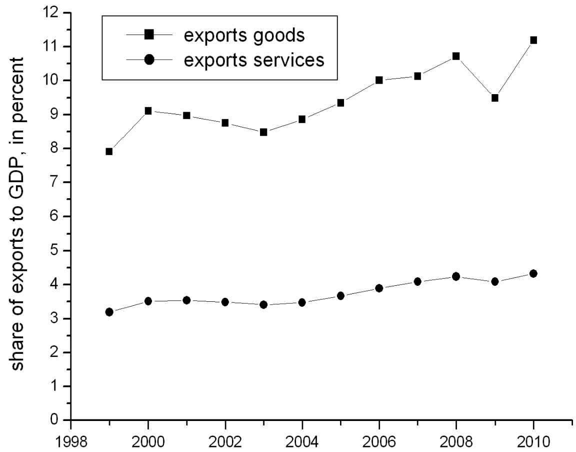


Source: Own graphic based on data from Eurostat, data on gross value added, national accounts aggregates and employment by branch (NACE), EU27 taken.

On the one hand it can be seen that services make up about 70 percent of total gross value added in the EU from 1999 to 2010, indicating the huge importance of services for generating GDP in the EU.

The EU's services exports to extra-EU, however, make up just a small share of about 3-4 percent of GDP from 1999 to 2010 whereas goods' exports range between 8 and 11 percent. Services are important in forming GDP in the EU, however, they are less traded. So, what can we expect about specialization on services in the EU? As Jovanovic (2005) states there are different tendencies of countries' specialization in services to be expected. Small and open countries which are net importers of

Figure 2: Exports in goods and services



Source: Own graphic based on data from Eurostat, globalization indicators, EU27 taken.

industrial goods might specialize in services in order to generate income to pay their imported manufacturing goods.[38] The author points for example to the Netherlands specializing in trade and transport, Austria in tourism, Norway and Greece in shipping and Switzerland and Luxembourg in financial services.

In the following, agglomeration of services sectors in the European Union will be investigated covering the years from 1970 to 2005 making use of EU KLEMS data. It has to be shown whether the ideas of New Economic Geography can be applied to explain developments in services sectors' agglomeration. Research on developments in services sectors' agglomeration is scarce. A thorough investigation of statistical properties of variables and regression frameworks related to services sectors' agglomeration is even harder to find. I will identify explanatory factors and dynamic tendencies of services sectors' agglomeration in the European Union. Explanatory factors for services sectors' agglomeration are derived from two different branches of trade theories, that is Traditional Trade Theory and New Trade Theory, and the New Economic Geography. Dynamic tendencies of localization will be discovered by applying co-integration and error correction modeling techniques. Whereas a very recent paper by Ellison, Glaeser and Kerr (2010) investigated the importance of Marshallian forces for co-agglomeration of industries, I will focus on just one of the Marshallian externalities for explaining services' agglomeration: linkages between firms' supply and demand for intermediate goods.[39] Thus, this study might deliver

[38]See Jovanovic (2005), p. 413.

[39]Marshall (1938) differentiates three reasons for firms benefitting from clustering: 1. a local labor pool, which offers a large enough number of workers available for a firm, also the skills of workers should be adequate, 2. information spillovers, that is information is easily available and

some new and interesting results on services sectors' agglomeration in the European Union.

3.2 Literature Review and Theory

Current literature on investigating developments of services sectors' agglomeration is scarce. Most of the literature has focused on doing research on industrial localization, so far.[40]

As concerns the European Union most of the studies find growing localization trends of manufacturing industry (like Midelfart-Knarvik et al. (2000), Brülhart (2001), Amiti (1998, 1999)), reasons for this trend differ from study to study.[41] The question remains whether ongoing integration in the EU will make concentration grow as has been the case for the US (see Krugman (1991 a)).

The following studies give insights for the case of services' agglomeration.

Jennequin (2008) finds that overall services sectors experience only a very slight increase in concentration in the European Union. Finance, insurance, real estate and business services are most agglomerated and transport, storage and communication are least. What stands out, however, is that water transport is most highly agglomerated (using a more disaggregated level of services sectors) and increased most over the time from 1991 to 1999 for 7 European countries (comprising Denmark, Finland, France, Germany, Hungary, Italy and Norway). Jennequin explains that this might be due to the fact that only a small workforce is employed in this branch thus biasing the agglomeration measure towards high degrees of agglomeration. Further, the author explains that the most dispersed sectors like post, land transport or education are sectors that are most influenced by being close to demand[42], so these sectors necessarily need to be dispersed (less agglomerated) and present wherever people live.

Midelfart-Knarvik et al. (2000) investigated services' concentration in the EU considering only five services sectors. They find out that services sectors are highly agglomerated compared to industrial sectors. They rule out the possibility that increased international trade in services caused the high level of agglomeration because

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eases buying and selling decisions for example, and 3. input-output linkages, where it is assumed that firms will benefit from cheaper inputs when they are clustered together. Firms can realize economies of scale when clustering in an area because of the aforementioned reasons. Economies of scale are external to a single firm and internal for the cluster, that is what the term externalities refers to.

[40] See the analysis in chapter 2 in this dissertation.

[41] Amiti (1998, 1999) for example explains that ongoing integration in the EU leads to further agglomeration. Agglomeration can be best explained by increasing returns to scale and intermediate goods' intensity, pointing to the relevance of New Trade Theory and New Economic Geography. Midelfart-Knarvik et al. (2000) find that forward and backward linkages known from New Economic Geography models are important in explaining agglomeration.

[42] See Jennequin (2008), pp. 301-303.

services are non-tradable to a great extent. Financial services, insurance, business, communication and real estate activities are the sectors that are the most concentrated over time and also those that deagglomerated most between 1982 and 1995. Transport services are the most dispersed services over time; in turn this sector shows the highest increase in agglomeration over time. The authors see changes in demand as a reason for the increasing developments. Both demand for final consumption and for intermediate goods would have risen. Part of this increase in demand would be due to outsourcing of services activities from within manufacturing firms, part to a real shift. Thus, clustering of final consumption and intermediate goods would be advantageous. Further, the authors state that the following industries make heavy use of services: office and computing, pottery, glass and products, non-metallic minerals, radio, tv, communication, drugs and medicine, paper and paper products and printing and publishing. These industries use finance and insurance, real estate and business services and communication intensively. Also, these manufacturing industries dispersed a lot over 1970-1997. Therefore, the authors conclude that dispersion in services might be related to dispersion in manufacturing industries.

The following study deals with investigating co-localization, that is localization of firms within industries or services next to each other. Wernerheim (2010) investigates co-location patterns of services and industries in Canada. He finds that services locate next to other industry, universities and research institutes or public administration. Specifically, he shows that in metropolitan areas most of the industries are co-located whereas in non-metropolitan areas this is not necessarily the case. Depository credit intermediation is most strongly correlated with other miscellaneous services and thus more dispersed. The author explains that this is due to the fact that even in very small towns banks and some services have to be present. Universities are co-located with computer systems design and related services which is itself related to architectural, engineering and related services. The author further shows that finance and insurance are least agglomerated in metropolitan areas –see the reasons for dispersion of banks given above– and that management of companies and enterprises is least agglomerated in non-metropolitan areas. He explains that for the development in management it could be that these highly specialized services are less demanded in non-metropolitan areas such that it makes sense to locate away from other competitors. In metropolitan areas information and cultural industries and public administration are most agglomerated. He further shows that the heaviest users of business services are travel and advertising, professional, scientific and technical services, wholesale trade, information and cultural industries, manufacturing, and finance, insurance, real estate and leasing.[43]

[43]See Wernerheim (2010), pp. 742-743.

In order to explain services sectors' agglomeration, I will derive explanatory variables from two different branches of trade theories and the New Economic Geography. These theories point to different reasons for countries to specialize. Heckscher-Ohlin theory states that a country specializes in producing and exporting that good that is produced relative intensively with the factor the country is relatively well endowed with. New Trade Theories focus on scale economies in production. Using scale effects firms can either produce more output at a given cost or a given output at lower costs. Both divergence and equalizing of countries' economic structures is possible. Divergence happens in case of a homogeneous good through further integration when countries specialize in one good then trading it. In case a heterogenous good is concerned, consumers could get a greater variety of products through free trade. Intra-sectoral trade would seize, leading to equalized sectoral structures across countries. New Economic Geography (see Krugman (1991 b)) deals with forward and backward linkages occurring among firms and workers. If workers move to a region the rise in expenditure increases the incentive of firms to locate there, too (home market or market size effect (backward linkage)). Then firms locating in one place will lead to the price index for goods to fall–products get cheaper because of competing firms–which increases the incentive for workers to move to this place (price index effect (forward linkage)). These two effects are agglomerative forces. However, there is another, deagglomerative force to think about, for a new competing firm in a market has a negative impact on demand of all firms in the market (market crowding out effect), which means lower profits for a single firm and thus lower wages such that workers will not like to move to that region anymore (see Krugman (1991 b)).

3.3 Empirical Analysis

The empirical analysis will comprise the following parts: In the first part measuring agglomeration of services sectors will be explained and data issues will be addressed. Localization patterns of services sectors over time will be investigated in part two. Special attention is given to specialization and agglomeration tendencies for the Greek economy. The third part focuses on the driving factors of services sectors' agglomeration. In part four robustness checks are conducted. In the fifth part variables are checked for being non-stationary, co-integration and error correction modeling techniques will be applied. In former work of mine I have also dealt with measurement of agglomeration and gaining explanatory variables for explaining agglomeration.[44] This has been done for investigating industrial agglomeration and countries' specialization in industries for the EU, however. In the following, analysis in section 3.3.1, 3.3.3 and 3.3.4 resembles my work for industrial agglomeration.

[44]See the analysis in chapter 2 in this dissertation.

3.3.1 Measuring Services Sectors' Agglomeration

I will first employ Gini coefficients for measuring localization as is done in Krugman (1991 a) and Amiti (1998, 1999). Localization addresses concentration of services sectors, agglomeration is just taken as a synonym for concentration or localization. Further, services comprise services' firms as single units. Plants and establishments will be used as synonyms for the term *firms*. Services are given by the OECD ISIC Rev. 3 classification, branches and sectors will be used as synonyms.

Gini coefficients are calculated as follows. First the Balassa index will be computed by using the formula:

$$B_{sc,t} = \frac{\frac{e_{sc,t}}{e_{s,t}}}{\frac{e_{c,t}}{E_t}}. \tag{15}$$

Here, $e_{sc,t}$ denotes services sector s's employment in country c, $e_{c,t}$ is total services sectors' employment in country c, e_s denotes total services sector s's employment in the European Union, and E_t is total services sectors' employment in the European Union, all at time t.[45] The Gini coefficient is gained by ranking the Balassa index in descending order, then constructing a Lorenz-curve by plotting the cumulative of the numerator on the vertical axis and the cumulative of the denominator on the horizontal axis (cumulating over countries for calculation of $gini_{st}$ that is the Gini for services' agglomeration). The Gini coefficient is equal to twice the area within a 45 degree line and the Lorenz curve.[46] The Gini coefficient equals zero if a services sector is totally equally distributed across countries, then agglomeration will be low. The Gini coefficient approaches one the more the Balassa indices differ from one, agglomeration will be high.

The data are taken from the EU KLEMS Database (2008) and can be downloaded online. EU KLEMS is a data collection project funded by the European Commission. The data collection has been done and supported by the OECD, several statistical offices, national economic policy research institutes and academic institutions in the EU. For computation of Gini coefficients national employment data were extracted. The variable taken was *number of persons engaged*. Data covering 14 European countries and 22 services sectors could be employed, Luxembourg had to be discarded from the sample since data were missing for many services sectors.[47] A further disaggregation of services sectors was prevented by lack of data. Data

[45] See for example Amiti (1998, 1999) for the method of calculation. In chapter 2 of this dissertation further explanations on the Balassa index are given.

[46] See Amiti (1998), p. 47.

[47] Included countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, UK.

were available for the period from 1970 to 2005.
Values given in national currency for Denmark, Sweden and the UK were converted to values in euros, using the respective exchange rates at January 4th 1999.[48] Furthermore, all countries' values for explanatory variables were deflated using the price index for gross output (1995=100). This has been done in order to cancel out trends just being caused by inflation. Using several price indices for various variables was prevented by lack of data. However, it did not matter for qualitative results whether deflated or non-deflated data were taken.[49]

3.3.2 Services Sectors' Agglomeration

The development of services sectors' agglomeration in the European Union is shown in the following table. Only data points for 1970, 1980, 1990, 1995, 2000 and 2005, respectively, are shown in the table for reasons of lucidity. Further, changes in agglomeration over time were calculated and a linear trend test was applied to check for significance of changes.

As can be seen in tables 25 and 26 total services sectors' agglomeration in the European Union decreased by about 22 percent from 1970 to 2005 (for 18 services, since data are available for some sectors only from 1995 to 2005). Most of the services sectors show a significant decrease in agglomeration as is the case for wholesale trade, other inland transport, other air transport, other supporting and auxiliary transport activities, insurance and pension funding, activities related to financial intermediation, real estate activities, renting of machinery and equipment, computer and related activities, research and development, other business activities, education, health and social work, other community and social services and private households with employed persons. This is in line with Midelfart-Knarvik et al. (2000) who find financial services, insurance, business and real estate activities to deagglomerate, as well. As can be seen further, only retail trade, other water transport and financial intermediation except of insurance and pension funding showed a significant increase in agglomeration. Agglomeration of financial intermediation except insurance and pension funding and retail trade, however, still remains at a low level, only its change over time is huge compared to all other sectors. This contrasts Jennequin (2008) and Midelfart-Knarvik et al. (2000) who find finance to be highly agglomerated. However, their results might be due to the composition and definition of services sectors they use. Concentration in financial intermediation except insurance and pension funding records a 46 percent change, concentration in retail trade a 76 percent change, respectively. Agglomeration in water transport was pretty high in 1970 exhibiting a Gini coefficient of 0.35 which increased to 0.38 in

[48] See ECB, exchange rate statistics.
[49] Non-deflated data have been taken for analysis in my working paper version.

2005. A high level of agglomeration for water transport has also been found out by Jennequin (2008). Agglomeration in water transport is not surprising since water transport is highly determined to be localized, at best in places next to the river or sea and is dependent on active, frequently used waterways. Agglomeration in retail trade and financial intermediation except insurance and pension funding, however, deserves further attention. This development points to changing economic structures, financial services and retail trade get more and more clustered, presumably in economically very active regions.

Table 25: Services sectors' concentration over time

Agglomeration	*1970*	*1980*	*1990*	*1995*	*2000*	*2005*	**Per cent change 1970-2005 (1995-2005)**	Trend Test
All services sectors	0.186	0.1804	0.1653	0.1575	0.1513	0.1458	-0.2161	-0.0012**
(18 sectors)								
(22 sectors)				0.1702	0.1643	0.159	-0.0658	-0.001**
(13 sectors)	0.1182	0.1159	0.1089	0.1	0.0982	0.0997	-0.1565	-0.001**
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	0.0723	0.0897	0.095	0.0764	0.078	0.0844	0.1674	0.0001
Wholesale trade and commission trade, except of motor vehicles and motorcycles	0.1123	0.0922	0.0832	0.0902	0.0862	0.0845	-0.2476	-0.0006**
Retail trade, except of motor vehicles and motorcycles; repair of household goods	0.0445	0.0778	0.0635	0.0783	0.0821	0.0784	0.7618	0.0007**
Hotels and restaurants	0.1347	0.155	0.1441	0.1407	0.1437	0.1495	0.1099	-0.00004
Other Inland transport	0.0838	0.0971	0.0895	0.0749	0.0785	0.0755	-0.099	-0.0003**
Other Water transport	0.3521	0.3351	0.3275	0.3873	0.3817	0.3849	0.0932	0.002**
Other Air transport	0.2042	0.2166	0.1806	0.1984	0.1901	0.1784	-0.1263	-0.0004**
Other Supporting and auxiliary transport activities; activities of travel agencies	0.1663	0.1367	0.1368	0.1084	0.0949	0.0813	-0.5111	-0.0022**
Post and telecommunication	0.0857	0.0789	0.0805	0.0768	0.0806	0.0923	0.077	0.00001
Financial intermediation, except insurance and pension funding				0.0545	0.0635	0.0795	0.4587	0.0022**
Insurance and pension funding, except compulsory social security				0.1852	0.1813	0.1733	-0.0643	-0.0018**
Activities related to financial intermediation				0.1686	0.1527	0.1344	-0.2028	-0.0023**

Source: Own calculations based on EU KLEMS data (2008).

Table 26: Services sectors' concentration over time, continued

Real estate activities	0.2371	0.2614	0.2257	0.1879	0.1782	0.1831	-0.2278	-0.0027**
Renting of machinery and equipment	0.4578	0.42	0.333	0.2749	0.2446	0.1891	-0.5869	-0.0082**
Computer and related activities	0.3068	0.2746	0.2709	0.2524	0.2241	0.2008	-0.3455	-0.0025**
Research and development	0.4126	0.4106	0.3746	0.3559	0.3556	0.346	-0.1614	-0.0023**
Other business activities	0.1898	0.1772	0.1434	0.1285	0.108	0.0925	-0.5126	-0.003**
Public admin and defense; compulsory social security	0.1176	0.1003	0.1134	0.1101	0.1224	0.1143	-0.0281	0.0002
Education	0.1047	0.0968	0.0961	0.0901	0.0802	0.0822	-0.2149	-0.0006**
Health and social work	0.1508	0.1472	0.142	0.1294	0.1226	0.1287	-0.1466	-0.0009**
Other community, social and personal services	0.1147	0.0807	0.0761	0.074	0.0719	0.078	-0.32	-0.0007**
Private households with employed persons				0.5017	0.493	0.4875	-0.0283	-0.0014**
Transport and Storage	0.0566	0.0758	0.0775	0.0614	0.0552	0.0502	-0.1131	-0.0005**
Financial intermediation	0.1135	0.0645	0.08	0.0676	0.076	0.0869	-0.2344	-0.0008**
Renting of machinery and equipment, research and development and other business activities	0.1922	0.1865	0.1385	0.1171	0.0995	0.0835	-0.5656	-0.0036**

Source: Own calculations based on EU KLEMS data (2008).

For the following regression analysis explanatory variables were not available for all of the 22 services sectors. Therefore, a Gini index for 13 services was computed and sectors had to be aggregated for transport and storage (comprising the sectors other inland transport, other water transport, other air transport, other supporting and auxiliary transport activities, activities of travel agencies), financial intermediation (comprising financial intermediation except insurance and pension funding, insurance and pension funding except compulsory social security and activities related to financial intermediation) and renting of machinery and equipment, research and development and other business activities (comprising renting of machinery and equipment, computer and related activities, research and development and other business activities). As can be seen, thus information on a high level of agglomeration for water transport and the increase of agglomeration in pure financial intermediation gets lost.

Taking a look at the countries where services sectors got actually localized in, one can draw some interesting conclusions. The three countries a sector got most or least agglomerated in 1970 and 2005 are listed in table 27. Only 13 sectors are considered for the analysis.

Table 27: Services sectors' concentration evaluated by the Balassa index

	Highest Balassa Index		Lowest Balassa Index	
	1970	2005	1970	2005
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	Denmark Portugal Italy	Portugal Greece Italy	Sweden Spain France	Belgium Netherlands Sweden
Wholesale trade and commission trade, except of motor vehicles and motorcycles	Portugal Netherlands Belgium	Portugal Denmark Austria	Greece Spain UK	Greece UK Ireland
Retail trade, except of motor vehicles and motorcycles; repair of household goods	Ireland Spain UK	Greece Portugal Spain	Sweden Netherlands France	Sweden Belgium Finland
Hotels and restaurants	Portugal Austria Greece	Greece Spain Portugal	Netherlands Sweden Denmark	Sweden Denmark Belgium
Transport and storage	Greece Finland Spain	Greece Finland Austria	Netherlands France Italy	UK Portugal Netherlands
Post and telecommunications	Ireland Austria Belgium	Ireland Finland Belgium	Spain Portugal Netherlands	Portugal Italy Netherlands
Financial intermediation	Germany Belgium Netherlands	Ireland UK Germany	Sweden Italy Ireland	Finland Portugal Sweden
Real estate activities	Finland Portugal Austria	Finland Sweden Austria	Greece Italy Ireland	Greece Italy Portugal
Renting of machinery and equipment, research and development and other business activities	Netherlands France UK	Netherlands Belgium UK	Portugal Finland Spain	Portugal Greece Spain
Public admin and defense; compulsory social security	Germany Belgium France	Belgium Portugal France	Denmark Spain Finland	UK Netherlands Sweden
Education	Sweden Belgium Ireland	Sweden Greece France	Spain Netherlands Germany	Netherlands Spain Austria
Health and social work	Sweden Finland Denmark	Denmark Sweden Finland	Spain Belgium Greece	Greece Spain Portugal
Other community, social and personal services	Italy Sweden Ireland	Ireland Sweden UK	Portugal Belgium France	Belgium Portugal France

Source: Own calculations based on EU KLEMS data (2008).

Taking a closer look at Greece for reasons of current interest, one can see that transport and storage activities, hotels and restaurants, retail trade, sale of motor vehicles and educational services got highly concentrated in Greece. So, a large share of Greek employees in services sectors is working in services related to tourism for example, compared to the employment share of Greece within the EU. These tendencies are not surprising. Tourism has been important for Greece since ages, for people want to go and see Greece's cultural heritage from the ancient times. Further, Greece is known to be a maritime nation and still Greece owns the highest share of the world merchant fleet. It amounts to 15.96 percent of the world fleet's tonnage.[50] Greece's high Balassa Index for education has to be interpreted as Greece having a higher employment share in that branch than its employment share in total EU employment would suggest. Overall, the public sector employs a lot of workers. Mitsopoulos and Pelagidis (2011) conclude that "The number of public sector employees, both permanent and in short-term contracts, in the central government, general government entities and companies owned by these is, according to all available pieces of evidence, excessive and inadequately managed.".[51] Working in the public sector is highly attractive, since average monthly salary is about 45 percent higher (data from 2006) than the average private sector's salary, also public sector's pension terms are good, early retirement is possible and public sector's jobs are secure.[52] Government spending was related to changing governments over time. Whereas from 1991 to 2004 primary expenses of the central government were held around 13.7 - 15.6 percent of GDP, from 2004 until 2009 the new government increased expenditures to 20.5 percent of GDP.[53] The absolute value thus increased enormously since GDP grew rapidly over time. The authors point out that the enormous increase in government spending was due to salaries that had to be paid because more and more people were hired for the public sector over time and because of needs of social security funds for public sector employees' pensions.

Further, in the EU financial services are mostly concentrated in Ireland, UK and Germany. The time before the beginning of the financial crisis the financial sector of the UK was functioning very well. In its staff report the IMF (2007) talks about a steady rise of net exports of financial services for the UK from 1995 to 2005 from 10 billions US Dollars to about 35 billions with a very sharp increase from 2003 to 2005.[54] At that time financial services from the UK flourished, the system was said to be open and flexible to capital flows and "in a position of strength".[55]

Health and social work and other community, social and personal services are most localized in the Northern European countries like Denmark, Sweden, Finland, Ireland and UK. This just demonstrates the fact that the Northern European countries, Denmark, Finland and Sweden have a big social welfare system, so a lot of people of the Northern European countries' services workforce are working in the branches of health and social work. Andersen et al. (2007) talk about the 'Nordic Model' as a special economic and social system being existent for the Northern European countries Denmark, Finland, Iceland, Norway and Sweden. These countries are comprehensive welfare states with transfers to households and publicly provided social services, high public and private spending for child care, education, and research

[50] See UNCTAD (2010), p. 35. Japan is following with a share of 15.73 and China with a share of 8.96 percent.

[51] Mitsopoulos and Pelagidis (2011), p. 224.

[52] See Mitsopoulos and Pelagidis (2011), p. 173.

[53] See Mitsopoulos and Pelagidis (2011), p. 207.

[54] See IMF (2007), p. 21.

[55] IMF (2007), p. 26.

and development, and good labor market institutions, which comprise strong labor unions, good wage coordination, generous unemployment benefits and active labor market policies.[56] As can be seen, the highest share of services' employment working in educational services compared to the European average in fact is given in Sweden. Some further interesting facts are that retail trade activities are also strongly concentrated in Portugal and Spain in 2005. Retail trade is least concentrated in Sweden, Belgium and Finland. Financial services in turn, are least concentrated in Finland, Portugal and Sweden. Further, the share of services' employment in the branch of health and social work is least agglomerated in Greece, Spain and Portugal in 2005.

In table 28 a closer look is taken at the level of specialization of the Greek economy in 2005, evaluated by using Balassa indices.

Table 28: Greece–Balassa index in 2005

	Total EU services' employment in millions	in percent	Greeces services' employment in millions	in percent	Balassa index
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	3898.17	3.1	109	4.17	1.34
Wholesale trade and commission trade, except of motor vehicles and motorcycles	7559.61	6.01	108	4.12	0.69
Retail trade, except of motor vehicles and motorcycles; repair of household goods	14811.8	11.78	427	16.34	1.39
Hotels and restaurants	8558.84	6.81	276	10.58	1.55
Transport and storage	7418.67	5.9	229	8.76	1.48
Post and telecommunications	2539.28	2.02	51	1.96	0.97
Financial intermediation	5068.3	4.03	99	3.79	0.94
Real estate activities	1800.98	1.43	3	0.11	0.08
Renting of machinery and equipment, research and development and other business activities	20799.83	16.55	294	11.26	0.68
Public admin and defense; compulsory social security	11671.86	9.29	303	11.61	1.25
Education	11690.25	9.3	287	10.99	1.18
Health and social work	17012.05	13.53	206	7.87	0.58
Other community, social and personal services	8490.68	6.75	151	5.79	0.86

Source: Own calculations based on EU KLEMS data (2008).

With a value of 1.55 for the Balassa index, most of the Greeks employed in services –that is 10.58 percent– works in the branch of hotels and restaurants, whereas only 6.81 percent of total EU services' employment is working in this branch. The Balassa index is also high for (in descending order): transport and storage, retail

[56]See Andersen et al. (2007), pp. 13-14; 42; 51. However, this type of welfare state involves higher taxes to be paid by residents.

trade, sale of motor vehicles, public administration and education. These facts correspond to results from table 27. In addition, we learn that Greek employment is also explicitly high in the branch of public administration, indicating the high number of employees in the public sector.

In 2010 salaries of public sector's employees were decided to be reduced, public administration was more and more consolidated and with 2011 public sector's jobs were decided to be axed. These undertakings were done and planned in order to increase public saving. As has been seen from the data, this means a reduction of employment in branches that Greece got specialized in. In fact, the austerity programs will cause Greek employment and thus the economic structure to change immensely, which might first cause unemployment to increase, but a more diversified economic structure for the future might give the chance for the Greek economy to be less likely to suffer from asymmetric shocks. It is in fact that kind of specialization in services related to tourism–like hotels and restaurants, transport and storage, retail trade–or services financed by the public sector–public administration and education–which made the Greek economy vulnerable. The vulnerability shows itself in the current debt crisis of the EU: Greek employees in the public sector will suffer from unemployment or shortages in earnings, further, ever since a large number of employees always was dependent on a well functioning tourism.

3.3.3 Explaining Services Sectors' Agglomeration

How can we explain agglomeration? This issue has been addressed in a bunch of research studies mainly focusing on agglomeration in industrial sectors, only. Explaining services sectors' agglomeration, however, is a task that has not been given much attention to, yet. In the following the driving factors of services sectors' concentration in the European Union will be investigated. To address this issue an estimation equation containing variables that are supposed to excess an influence on services sectors' localization is being set up. Explanatory variables are taken from the two trade theories and the New Economic Geography discussed in more detail above. Amiti (1999) has specified and estimated a regression function explaining industrial agglomeration. The variables for Traditional Trade Theory and New Economic Geography I want to test for in my regressions are taken and operationalized in the way that Amiti has done in her study. My measure for scale intensity, however, differs from hers.

Traditional Trade Theory shall be operationalized as:

$$fact_{st} = |\frac{w_{st}L_{st}}{VA_{st}} - \overline{\frac{w_t L_t}{VA_t}}|. \tag{16}$$

Here $w_{st}L_{st}$ denotes labor compensation in millions of euros in services sector s at time point t and VA_{st} is gross value added at current basic prices in millions of euros in services sector s at time t. The measure consists of the deviation of the share of labor compensation in value added to services sectors' average share of labor compensation in average value added. Taking the absolute value of this measure captures a basic element of Heckscher-Ohlin's theory: services sectors exhibiting either a high labor or a high capital intensity (represented by either high or low labor compensation compared to the European average) will show up a high level of services sectors' concentration. A positive influence of *fact* on services sectors' concentration can be expected.

New Trade Theories postulate the relevance of scale economies. I try to capture this by the following measure:

$$scale_{st} = \frac{\frac{w_{st}L_{st}+Cap_{st}+Int_{st}}{Q_{st}}}{Q_{st}}. \qquad (17)$$

$w_{st}L_{st}$ denotes labor compensation in millions of euros in service s at time t, Cap_{st} capital compensation in millions of euros, Int_{st} intermediate inputs at current purchasers' prices in millions of euros and Q_{st} is gross output as a volume index (1995=100). A negative relationship between concentration and scale intensity can be expected. This is because the more output can be produced at a per unit cost, the lower will be the measure *scale*. Increasing returns to scale positively influences agglomeration, since firms will want to locate closer to each other in order to reap off scale economies (see Krugman (1979, 1980)).

New Economic Geography's arguments are going to be modeled in the following way:

$$intermediate_{st} = \frac{P_{st}Q_{st} - VA_{st}}{P_{st}Q_{st}}. \qquad (18)$$

$P_{st}Q_{st}$ denotes gross output at current basic prices in millions of euros and VA_{st} is gross value added at current basic prices in millions of euros. Services sectors that use a lot of intermediate inputs are expected to show a higher concentration than other services sectors, based on assumptions of New Economic Geography models (see Krugman/ Venables (1995, 1996)). Therefore a positive relationship between concentration and intermediate goods' intensity is assumed.

A regression function using OLS including time and services sectors' effects has been estimated:

$$lngini_{st} = \alpha + \beta_1 lnfact_{st} + \beta_2 lnscale_{st} + \beta_3 lnintermediate_{st} + \gamma_s + \delta_t + u_{st}. \quad (19)$$

The log of the Gini coefficient is regressed on the logarithm of factor intensity, scale economies and intermediate goods' intensity, sectoral dummies γ_s and time dummies δ_t. Time dummies are taken relative to 1970, services dummies are taken relative to the sector *sale, maintenance and repair of motor vehicles*. The logs of variables are taken such as to better interpret (percentage) changes in variables. The results are given in table 29.[57]

The results demonstrate that New Economic Geography's arguments can explain services sectors' agglomeration tendencies in the EU best. The coefficient for scale economies does not bear the expected sign. Some services' dummies are significant and point to unobserved services sectors' characteristics. Time effects are significant from 1984 on. A one percent increase in intermediate goods' intensity increases services sectors' concentration by about 0.77 percent. The influence of intermediate goods' intensity for services' agglomeration appears to be lower as is the case for industrial concentration.[58]

I further found that including services effects into regressions increases variance inflation factors, pointing to multicollinearity problems. Leaving out services effects I get the regression results shown in table 30.

As can be seen, now factor intensity is highly significant and the coefficient for scale intensity is still not having the expected sign. New Economic Geography's arguments do not seem to have any importance in explaining agglomeration in services. This points to intermediate products' intensity being important in explaining within variation of services' agglomeration, only. These issues will be clarified elsewhere.[59] The positive sign for scale economies might indicate a situation that has been explained before in chapter 3.2 for the case of a heterogenous good. Through increasing liberalization consumers get access to a greater variety of products, intrasectoral trade increases, economic structures across countries equalize. However, this deserves further robustness checks and a more disaggregated level of analysis done in the next chapters.

[57]A White test indicated heteroskedasticity of error terms such that White's heteroskedasticity-consistent standard errors were calculated. Further remedies like estimation with weighted least squares would be advisable, but this is not done here.

[58]See the analysis in chapter 2 in this dissertation.

[59]See the following analysis in chapter 5 of this dissertation.

Table 29: Regression results services sectors' concentration

Dependent variable ln(gini) for services	**OLS**		**OLS**		**OLS**		**OLS**
constant	-1.0858**	Health and social work	0.2336**	1983	0.112	1997	0.1415
ln(fact)	0.0016	Other community, social and personal services	-0.3707**	1984	0.13*	1998	0.1529*
ln(scale)	0.3994**	1971	0.0201	1985	0.1393*	1999	0.153*
ln(intermediate)	0.7722**	1972	0.0605	1986	0.1778**	2000	0.172*
Wholesale trade and commission trade, except of motor vehicles and motorcycles	-0.4559**	1973	0.0665	1987	0.1927**	2001	0.1941**
Retail trade, except of motor vehicles and motorcycles; repair of household goods	-0.406**	1974	0.0379	1988	0.177**	2002	0.1978**
Hotels and restaurants	0.196**	1975	0.0624	1989	0.1759**	2003	0.2157**
Transport and Storage	-0.8818**	1976	0.0683	1990	0.1934**	2004	0.2317**
Post and telecommunications	0.1939**	1977	0.0868	1991	0.1868**	2005	0.2385**
Financial intermediation	-0.5751**	1978	0.0859	1992	0.1743**	N	468
Real estate activities	0.8644**	1979	0.1002	1993	0.1596**	R^2	0.903
Renting of machinery and equipment, research and development and other business activities	-0.1083	1980	0.1029	1994	0.1516*	F-Stat	77.305
Public admin and defense; compulsory social security	0.0049	1981	0.1023	1995	0.1411*		
Education	0.3476**	1982	0.1038	1996	0.1299		

Source: Own calculations based on EU KLEMS data (2008).
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors taken.

Table 30: Regression results services sectors' concentration without services sectors' effects

Dependent variable ln(gini) for services	**OLS**		**OLS**		**OLS**		**OLS**
constant	-1.8677**	1978	0.0631	1989	0.1156	2000	0.1142
ln(fact)	0.1111**	1979	0.0644	1990	0.118	2001	0.1289
ln(scale)	0.2573**	1980	0.0712	1991	0.1086	2002	0.1141
ln(intermediate)	-0.0876	1981	0.067	1992	0.1121	2003	0.1172
1971	0.0097	1982	0.0538	1993	0.0766	2004	0.1315
1972	0.0371	1983	0.0521	1994	0.0739	2005	0.141
1973	0.0565	1984	0.0838	1995	0.0814	N	468
1974	0.0815	1985	0.0831	1996	0.0713	R^2	0.258
1975	0.0628	1986	0.1156	1997	0.0801	F-Stat	3.931
1976	0.0541	1987	0.1703	1998	0.0949		
1977	0.0642	1988	0.1162	1999	0.0855		

Source: Own calculations based on EU KLEMS data (2008).
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors taken.

Running a regression on a time series aggregated over all services sectors delivered the result that all variables neither have explanatory power nor show up the expected sign.[60] The Durbin Watson statistic pointed to the potential underlying problem that biases the results: variables might be non-stationary. This problem will be adequately addressed in section 3.3.5.

3.3.4 Robustness Checks

In the following, robustness will be tested by using a different measure for agglomeration. The Krugman index as having been taken in Krugman (1991 a) will be employed. Midelfart-Knarvik et al. (2000) took an alternative modeling of this measure which is:

$$K_{s,t} = \sum_{c=1}^{C} |\frac{e_{sc,t}}{e_{s,t}} - \frac{1}{S-1}\sum_{s=1}^{S-1}(\frac{e_{sc,t}}{e_{s,t}})|. \tag{20}$$

$K_{s,t}$ measures the deviation of the share of services' employment for sector s in country c relative to this sector's total EU employment from the other (S-1) services sectors' mean of these sectoral shares. As can be seen in the following, the same agglomeration tendencies for services sectors emerge as in case of taking the Gini coefficient.[61] Real estate activities are most highly agglomerated in 2005 and transport and storage activities are least agglomerated.

[60]Results not shown here since there is no significance of variables in that regression function. These results are available from the author upon request.

[61]Note that just 13 sectors are taken for analysis here since data are missing for the years until 1995 for several sectors.

Table 31: Services sectors' agglomeration by Krugman index of concentration

Services sector	Krugman-I 2005	Services sector	Krugman-I 1970
Most agglomerated			
Real estate activities	0.2622	Real estate activities	0.3357
Hotels and restaurants	0.2343	Renting of machinery and equipment and other business activities	0.3052
Health and social work	0.189	Hotels and restaurants	0.2282
Public admin and defense, compulsory social security	0.1794	Public admin and defense, compulsory social security	0.2074
Wholesale trade and commission trade, except of motor vehicles and motorcycles	0.1727	Health and social work	0.1972
Most dispersed			
Transport and storage	0.0928	Retail trade, except of motor vehicles and motorcycles; repair of household goods	0.096
Other community, social and personal services	0.1063	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	0.0993
Retail trade, except of motor vehicles and motorcycles; repair of household goods	0.11	Transport and storage	0.108
Financial intermediation	0.1151	Post and telecommunications	0.1139
Post and telecommunications	0.132	Education	0.1498

Source: Own calculations based on EU KLEMS data (2008).
Note: Since for 1970 data are not available for financial intermediation, insurance and pension funding, activities related to financial intermediation and private households, Krugman indices were calculated for 13 services sectors only, aggregating the 3 sectors of financial intermediation, transport/storage and renting of machinery/equipment/research/development/other business activities.

I add a further explanatory variable to the regression framework. Martin and Ottaviano (2001) point to the relevance of growth in explaining agglomeration. This is due to forward and backward linkages emerging from a process of innovation. Firms will cluster in a region of high growth caused by innovations. Growth is modeled as:

$$growth_{st} = \frac{Q_{st} - Q_{s(t-1)}}{Q_{s(t-1)}} \qquad (21)$$

with Q_{st} denoting gross output as a volume index (1995=100). Running regressions with the Krugman index of concentration including growth as further explanatory variable I get the results shown in table 32.

As can be seen, factor intensity is highly significant in most of the regressions, although its influence is pretty small when industry effects are controlled for. Coefficients for scale economies and growth do not bear the expected sign. Intermediate goods intensity is just significant when industry effects are controlled for. Again, results point to fewer importance of New Economic Geography's arguments in explaining services' agglomeration compared to effects for industrial agglomeration. Overall, results discovered before appear to be robust. In future research, endogeneity issues should be addressed, Martin and Ottaviano (2001) for example point to growth and agglomeration forming a circular process.

Table 32: Robustness checks, services

agglomeration						
Dependent Variable	Krugman-I	Krugman-I	Gini	Gini	Krugman-I	Krugman-I
lnfact	0.1405**	0.0288**	0.1107**	-0.0008	0.1332**	0.0267**
lnscale	0.2935**	0.328**	0.2518**	0.374**	0.2808**	0.3046**
lninterm	0.0696	0.6266**	-0.0851	0.8019**	0.0629	0.668**
growth			-0.6396	-0.9421**	-1.9293**	-0.989**
const	-1.1768**	-0.7891**	-1.833**	-1.0535**	-1.1024**	-0.726**
Time effects	yes	yes	yes	yes	yes	yes
Industry effects	no	yes	no	yes	no	yes
N	468	468	455	455	455	455
R^2	0.315	0.878	0.267	0.909	0.334	0.883

Source: Own calculations based on EU KLEMS data (2008).
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. White standard errors are taken.

Robustness checks further confirm the positive sign for scale economies. This is true for running the analysis considering various services sectors and time periods. Investigating agglomeration of single services sectors, however, reveals that not for all of the services sectors the coefficient for scale economies bears a positive sign nor is it significant (see regression results for OLS in tables 35 to 37 in the appendix; the other results are explained in the next section). In fact, a positive, significant coefficient is the case for wholesale trade, financial intermediation, real estate activities, renting of machinery, public administration, education, health and social work and other community services. Scale economies are not significant for sale of motor vehicles, hotels and restaurants, transport and storage and post and telecommunications. The results, however, become different when taking care of non-stationarity issues, which is done in the next section.

3.3.5 Investigating Dynamics for Services Sectors' Agglomeration

Regression results for aggregated services sectors pointed towards a serious problem: non-stationarity of variables will deliver spurious regression results. The focus in this study is to deal with these non-stationarity issues. Therefore, in a first step variables were checked for non-stationarity using an Augmented Dickey Fuller and Phillips-Perron test with trend and intercept estimation. In a next step co-integration of variables was being tested for.[62] If applicable an error correction model was being set up, otherwise variables (that are integrated of the same order) were differenced and regressed on each other. So either the regression framework:

[62]Co-integration was assumed until a 10 percent level of significance.

$$Dlngini_{st} = \alpha + \beta_l D\mathbf{X} + \tau Dlngini_{s(t-1)} + \delta resid_{s(t-1)} + u_{st} \tag{22}$$

or

$$Dlngini_{st} = \alpha + \beta_l D\mathbf{X} + u_{st} \tag{23}$$

was estimated. The first difference (D) of the logarithm of Gini is regressed on the first differences of a set of l explanatory variables **X** and for the error correction regression also on the Gini of the previous period and the lagged residual emerging from estimating the long term regression function $lngini_{st} = \alpha + \beta_l \mathbf{X} + u_{st}$. **X** is a vector containing explanatory variables $lnfact_{st}$, $lnscale_{st}$ and $lninterm_{st}$. u_{st} is the disturbance and δ is the error correction term.

For the case of aggregated services sectors I first checked for non-stationarity of the variables *lngini*, *lnfact*, *lnscale* and *lninterm*. Applying ADF-tests with trend and intercept estimation I could show that *lngini*, *lnscale* and *lninterm* are I(1), *lnfact* appears to be I(1) according to the Phillips-Perron test. In a next step I checked for co-integration, however, an ADF-test applying MacKinnon's critical values revealed there is no co-integration present for a regression framework consisting of *lngini* as the dependent and *lnfact*, *lnscale* and *lninterm* as the independent variables. So in a further step I conducted a regression in first differences resulting in the following estimation equation:

$$Dlngini_{st} = -0.0104 - 0.0021 * Dlnfact_{st} - 0.1772 * Dlnscale_{st} - 0.1119 * Dlninterm_{st} \tag{24}$$

with $N = 35$, $R^2 = 0.069$ and $DW = 1.325$. None of the coefficients is significant. This might also be due to the fact that aggregating services reduces the level of information such that no influences can be shown by regressions, either. As has been seen before in tables 25 and 26 agglomeration varies over services sectors. The same is true for the other three independent variables. One can see that by aggregating variables variation in variables gets lost.[63] Also, a usual OLS regression delivered no significant results, as has been mentioned yet in chapter 3.3.3.

In a next step I investigated non-stationarity issues for the different services sectors (13 sectors taken). Results on checking for non-stationarity of variables can be found in table 34, OLS and error correction regressions can be found in tables 35-37.

[63] See table 33 in the appendix. Only for aggregated lnscale the variation is still quite high.

Difference regression has to be conducted in case variables integrated of the same order are not co-integrated. Variables for whole sale trade, financial intermediation, real estate activities and education were not all integrated of the same order, all other regression frameworks had variables that are integrated of the same order and co-integration among variables exists, thus error correction modeling is needed, in no case, however, first difference regression was required.

Results by error correction modeling are that wholesale trade is significantly and positively influenced by factor intensity, for agglomeration of public administration and defense/ compulsory social security intermediate goods' intensity is important. OLS would point to far more relationships like the importance of intermediate goods' intensity for wholesale trade, factor intensity and scale economies for retail trade, factor intensity for transport and storage, intermediate goods' intensity for financial intermediation, factor intensity and intermediate goods' intensity for real estate activities and public administration and factor intensity for other community services. However, these relations might be spurious, only, since by taking OLS non-stationarity of variables is not adequately dealt with.

Summarizing, results point to the need of investigating influential factors of services' agglomeration on a more disaggregated level.

3.4 Conclusion

In this study I could show that services sectors' agglomeration in the European Union decreased continuously over 1970 to 2005. Only retail trade, water transport and financial intermediation except insurance and pension funding record a significant increase. I could further show that some services like retail trade activities, hotels and restaurants, transport and storage and education got primarily concentrated in Greece, meaning that a large share of Greek employees in services is working in these sectors compared to the employment share of Greece within the EU. I argued that this kind of specialization made Greece vulnerable to asymmetric shocks, especially seen during the current debt crisis of the EU. The Greek economy made itself dependent on a well functioning tourism and cherished a big public sector employing a lot of workers. Controlling for multicollinearity and running robustness checks I find that factor intensity can explain agglomeration in services. So, it can be interpreted as Heckscher-Ohlin type arguments being able to explain agglomeration of services in the EU. Obviously, services agglomerate due to availability and/or quality of labor or capital inputs. The influences I could detect are not that large in magnitude, but significant. Intermediate goods' intensity and therewith New Economic Geography's arguments seem to be important for within variation of services' agglomeration, only, and are not as important in explaining agglomeration as is the case for industrial concentration. This result appears to be robust. The coefficient for scale economies bears a positive sign, which appears to be a robust result. This might indicate that intra-sectoral trade can explain agglomeration tendencies in services. In case of a heterogenous good, increasing returns to scale and further economic integration would make consumers getting access to a greater variety of products, economic structures across countries would equalize. Not all of the services sectors considered, however, display significant or positive coefficients for economies of scale and thus appear not to be subject to intra-sectoral trade effects for agglomeration. I showed that non-stationarity of variables has to be considered and adequate econometric methods have to be used in order to get valid regression results. Considering non-stationarity issues makes most of the relationships given by OLS become insignificant. Factor intensity would be influencing agglomeration of the wholesale trade sector and intermediate products' intensity is important for explaining agglomeration in public administration and defense/ compulsory social security, only.

Further research could investigate services' agglomeration using more disaggregated data. Also, the analysis could be redone from a country perspective, investigating specialization in services sectors either for the whole European Union or for single countries. Co-localization of industries and services offers another avenue for future research.

3.5 Appendix

Table 33: Summary Statistics

Variable	Observations	Mean	Standard Deviation	Min	Max
gini	468	0.1092	0.0463	0.0445	0.2705
fact	468	0.1551	0.1524	0.001	0.6369
scale	468	0.3292	0.1954	0.0358	1.3195
interm	468	0.3928	0.1006	0.1782	0.5882
lngini	468	-2.2882	0.3686	-3.1125	-1.3074
lnfact	468	-2.3689	1.1541	-6.9307	-0.4512
lnscale	468	-1.2743	0.5934	-3.331	0.2772
lninterm	468	-0.9718	0.2835	-1.7248	-0.5308
aggregated lngini	36	0.1092	0.0081	0.0979	0.1192
aggregated lnfact	36	0.1551	0.0051	0.1468	0.1681
aggregated lnscale	36	0.3292	0.1053	0.172	0.5557
aggregated lninterm	36	0.3928	0.0154	0.3756	0.4277

Source: Own calculations based on EU KLEMS data (2008).

Table 34: Unit root tests

	lnfact	lnscale	lnintermediate	lngini
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	I(1)	I(1)	I(1)	I(1)
Wholesale trade and commission trade, except of motor vehicles and motorcycles	I(0)	I(1)	I(1)	I(1)
Retail trade, except of motor vehicles and motorcycles; repair of household goods	I(1)	I(1)	I(1)	I(1)
Hotels and restaurants	I(1)	I(1)	I(1)	I(1)
Transport and storage	I(1)	I(1)	I(1)	I(1), PP I(0)
Post and telecommunications	I(1)	I(2), only at 10% level I(1)	I(1)	I(1)
Financial intermediation	I(1)	I(1)	I(1)	I(2)
Real estate activities	I(1)	I(2), only at 10% level I(1)	I(0)	I(1)
Renting of machinery and equipment, research and development and other business activities	I(1)	I(1)	I(0), PP I(1)	I(1), PP I(2)
Public admin and defense; compulsory social security	I(0), PP I(1)	I(1)	I(1)	I(2), only at 10% level I(1)
Education	I(1)	I(0)	I(2), only at 10% level I(1)	I(1)
Health and social work	I(1)	I(1)	I(1), PP I(2)	I(0), PP I(1)
Other community, social and personal services	I(1)	I(1)	I(1)	I(1)

Source: Own calculations based on EU KLEMS data (2008).
Note: Unit root tests at 5 percent level including trend and intercept; both ADF and Phillips-Perron (PP) tests are conducted, PP results are mentioned in the table when they deviated from ADF-test results.

Table 35: Sectoral analysis, OLS and error correction regressions, part I

	OLS		Error correction	
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	lnfact: 0.1959 lnscale: -0.2657 lninterm: -2.5655	R^2: 0.089 DW: 0.187	lnfact: 0.1397** lnscale: 0.0015 lninterm: -0.8532 Laglngini: 0.2787* Error correction term: -0.1283*	R^2: 0.302 DW: 1.901
Wholesale trade and commission trade, except of motor vehicles and motorcycles	lnfact: 0.015 lnscale: 0.3301** lninterm: 1.1966*	R^2: 0.526 DW: 0.573		
Retail trade, except of motor vehicles and motorcycles; repair of household goods	lnfact: 0.7996** lnscale: -0.8732** lninterm: -0.5294	R^2: 0.652 DW: 0.36	lnfact: -0.0012 lnscale: 0.2119 lninterm: -0.4093 Laglngini: 0.5475** Error correction term: -0.1646**	R^2: 0.423 DW: 1.952
Hotels and restaurants	lnfact: -0.1916** lnscale: 0.0386 lninterm: 0.5412	R^2: 0.341 DW: 1.04	lnfact: 0.0012 lnscale: -0.1781 lninterm: -0.1718 Laglngini: 0.1006 Error correction term: -0.5493**	R^2: 0.379 DW: 2.016

Source: Own calculations based on EU KLEMS data (2008).
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. For OLS white standard errors taken.

Table 36: Sectoral analysis, OLS and error correction regressions, part II

	OLS		Error correction	
Transport and storage	lnfact: 0.1915* lnscale: -0.1698 lninterm: -2.5773**	R^2: 0.596 DW: 0.391	lnfact: 0.0619 lnscale: -0.2022 lninterm: -0.9829 Laglngini: 0.335* Error correction term: -0.2207*	R^2: 0.246 DW: 1.751
Post and telecommunications	lnfact: -0.1081** lnscale: -0.0629 lninterm: -0.038	R^2: 0.135 DW: 0.403	lnfact: -0.0443 lnscale: -0.0648 lninterm: -0.261 Laglngini: 0.2968 Error correction term: -0.3051*	R^2: 0.206 DW: 2.21
Financial intermediation	lnfact: 0.0125 lnscale: 0.4826** lninterm: 1.9885**	R^2: 0.416 DW: 0.261		
Real estate activities	lnfact: 2.5134** lnscale: 0.142** lninterm: 0.975**	R^2: 0.858 DW: 0.701		
Renting of machinery and equipment, research and development and other business activities	lnfact: -0.005 lnscale: 0.5503** lninterm: -0.1513	R^2: 0.95 DW: 0.273	lnfact: -0.012* lnscale: 0.0098 lninterm: 0.3685 Laglngini: 0.3709** Error correction term: -0.1881**	R^2: 0.387 DW: 1.864

Source: Own calculations based on EU KLEMS data (2008).
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. For OLS white standard errors taken.

Table 37: Sectoral analysis, OLS and error correction regressions, part III

	OLS		Error correction	
Public admin and defense; compulsory social security	lnfact: 0.479** lnscale: 0.3255** lninterm: 1.0739**	R^2: 0.46 DW: 0.426	lnfact: 0.1718 lnscale: 0.0952 lninterm: 0.991** Laglngini: 0.5961** Error correction term: -0.298**	R^2: 0.466 DW: 2.271
Education	lnfact: -0.4551** lnscale: 0.1076** lninterm: -0.2729**	R^2: 0.862 DW: 0.658		
Health and social work	lnfact: -0.449** lnscale: 0.2377** lninterm: -0.4864**	R^2: 0.872 DW: 0.676	lnfact: -0.1232 lnscale: -0.0876 lninterm: -0.2812 Laglngini: 0.2711 Error correction term: -0.2568*	R^2: 0.213 DW: 1.807
Other community, social and personal services	lnfact: 0.0463** lnscale: 0.2966** lninterm: -1.1763**	R^2: 0.63 DW: 0.488	lnfact: -0.0047 lnscale: -0.1761 lninterm: 0.0609 Laglngini: 0.4498** Error correction term: -0.3023**	R^2: 0.313 DW: 2.176

Source: Own calculations based on EU KLEMS data (2008).
Note: Significance checks based on p-values. ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. For OLS white standard errors taken.

4 Modeling Services Sectors' Agglomeration in a New Economic Geography Model

Summary

This study investigates agglomeration tendencies in the Krugman and Venables (1996) model incorporating both an industrial and a services sector. Special feature of this modeling is to account for fewer importance of intermediate goods received for the services sector, a fact that has been shown in Empirics. In the following it is on the one hand assumed that intra-sectoral inputs are less existent in the services sector, whereas there exist intra-sectoral inputs within the industrial sector. On the other hand, imported services are assumed to be less dependent on transport costs. The results show different strengths of agglomeration for both the industrial and services sector depending on initial values of strength of intra-sectoral and inter-sectoral inputs, consumers' preferences, scale economies and transport costs. It can be shown that the fewer extent of agglomeration in services sectors (of those sectors that meet the model's assumptions) seen in reality can be proven. For reasons of comparison the case of fewer inter-sectoral inputs for services is also being modeled.

4.1 Introduction

The idea of this study is to investigate dynamic agglomeration tendencies by incorporating a services sector–taking account of its special features–into the New Economic Geography model by Krugman and Venables (1996). In that way, Krugman's models considering an agricultural and an industrial sector or just industrial sectors will be enhanced by focusing on both industries and services. In many countries services are the most important branch of the economy, generating most of the economy's value added. This is justifying services' incorporation into Theory and Empirics.

Empirics have shown that intermediate goods' intensity plays a less important role in explaining services' agglomeration than it does for industrial agglomeration.[64] Intermediate products can be stemming either from a sector itself–intra-sectoral inputs–or from another sector–inter-sectoral inputs. Looking at data from Eurostat in table 38 one can see that some services are characterized by fewer intra-sectoral inputs used. Among these services are sale, maintenance and repair of motor vehicles, retail trade, hotels and restaurants and public administration. Thus, it will be interesting to see whether the results of New Economic Geography regarding agglomeration and specialization tendencies will also hold when services are included into the modeling framework. In chapter 4.7 the case of fewer inter-sectoral inputs for services is also addressed for comparison.

Table 38: Intra-sectoral and imported inputs for the services' sector in 2005

	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	Retail trade, except of motor vehicles and motorcycles; repair of household goods	Hotels and restaurants	Public admin and defense; compulsory social security
Own sectoral input	8756	2927	3586	3920
Inputs from industrial sectors higher than own sectoral input	Motor vehicles, trailers and semi-trailers: 17488	Rubber and plastic products: 2977	Food products and beverages: 71058	Other transport equipment: 8193
		Coke, refined petroleum products and nuclear fuels: 3643		Machinery and equipment n.e.c.: 6862
		Pulp, paper and paper products: 3424		Printed matter and recorded media: 4898
		Food products and beverages: 4222		
Imported inputs	5.29 percent	3.54 percent	5.1 percent	6.73 percent

Source: Own calculations based on Eurostat data, input-output tables, aggregate on 17 euro countries taken for the year 2005, final use table "*use05bpea*".
Note: Data for *own sectoral input* and *inputs from industrial sectors higher than own sectoral input* given in millions of euros, current prices; data for imported inputs given as percentage of total inputs (domestic and imported).

[64]See chapters 2 and 3 of this dissertation.

4.2 Literature Review and Theory

For the following analysis the model of Krugman and Venables (1996) is taken, incorporating some modifications. These modifications will be talked about in greater detail in the next section. To understand where this model is stemming from and what was following up some literature review will be given in this section.

New Economic Geography models reach back to Krugman's investigations on increasing returns to scale and trade in his papers of (1979) and (1980). Krugman made use of the Dixit/Stiglitz (1977) framework on monopolistic competition and product diversity. By modeling increasing trade in differentiated products, Krugman by that time offered a model which was being able to explain intra-industrial trade. In his (1979) paper Krugman shows that with increasing returns to scale agglomeration will occur due to factor mobility. So trade does not have to be existent. Instead if labor could migrate and there is no trade because of tariffs or transport costs, then labor would concentrate in the region that has a higher population, initially, usually offering a higher real wage and a greater variety of goods. So, history would matter for the initial state of population and subsequent agglomeration. In his (1980) model Krugman adds transport costs to his model. Therewith he is able to explain localization of a firm producing under monopolistic competition: the firm will locate close to the largest market in order to reap off scale economies and to save transport costs. Then, this firm will export the good which is characterized by a high domestic demand. Krugman calls this effect the *home market effect*.[65] So, Krugman could show that trade is caused by increasing scale economies and does not need to occur because of different factor endowments or technology as has been the cause in Traditional Trade Theory. In 1991 Krugman published his seminal work on New Economic Geography. In this piece of work he could show that agglomeration is an **endogenous** process: on the one hand manufacturing firms want to locate in the region with larger demand. They can save transport costs that way and realize scale economies. On the other hand demand is high where manufacturing firms locate. This is because living and producing next to (other) manufacturing firms will offer the possibility to buy cheaper goods (inputs). These processes are called backward and forward linkages, respectively.[66] Another explanation for the endogenous process lies in the description of two agglomerative, centripetal, and one deagglomerative, centrifugal, force(s). The centripetal forces are the price index and home market effect, the centrifugal force is the competition effect.[67] The home market effect involves that with workers moving to a region expenditures will increase, being an incentive for firms to locate there, too. The price index effect makes ag-

[65]See also Krugman (2009), pp. 564-565.
[66]See also Fujita and Krugman (2004), p. 145.
[67]See Krugman (1991 b), pp. 491 and 496; Brakman and Garretsen (2009), p. 19.

glomeration close to a larger market more attractive for consumers/workers because more firms in the larger market will reduce the price index and thus real wages increase. The competition effect deals with the following: if more firms move to a place, demand for an individual firm will decrease. Profits will thus fall and wages will decline, fewer workers would want to move to this region. In Krugman and Venables (1995) a model with one agricultural and one manufacturing sector (which is monopolistically competitive) is taken, besides final goods also intermediate goods are produced by the manufacturing sector and labor is immobile interregionally (in contrast to Krugman (1991 b)) and only mobile across sectors. Intermediate goods are the main force leading to agglomeration. This is because in this model intermediate goods' usage creates forward and backward linkages. Intermediate goods' production will locate in larger markets thus saving transport costs. This is the backward linkage. Final goods' production will locate close to intermediate goods' production, lowering production costs that way. This comprises the forward linkage. A core-periphery pattern with industry in the core and agriculture in the periphery will emerge. Countries in the periphery will suffer from declining real incomes.[68] This happens because demand for labor increases in the industrializing region, thus increasing real wages in this region. As transport costs continue to fall, however, a convergence of real incomes might come into place with countries in the periphery gaining and those in the core losing. This might happen because lower wages are offered for production in the periphery, and lower transport costs will make it feasible for demand and supply to be apart from each other. Manufacturing would move to the periphery. Krugman (1991 c) addressed another issue on where location will take place. This could be either due to history or due to expectations/self-fulfilling prophecy. In his model if the interest rate is sufficiently large, so future is heavily discounted, then history matters more than expectations.[69] This is because in that case individuals do not care much about future actions of other individuals, so no prophecies are relevant. Second, if the strength of external economies is small, there is not much interdependence among decisions, such that no expectations are important. Finally, if the adjustment is slow then history matters. Krugman explains that then factor rewards would be close to current levels for a long time, no matter what the expectations are.

There are other authors enhancing Krugman's theories.
Venables' models (1995, 1996) focus on intermediate goods' usage or input-output linkages between firms as a force for agglomeration. Intermediate goods' usage would create forward and backward linkages, the same reasonings as in Krugman/Venables (1995) apply. Venables (1996) shows that with strong vertical linkages and some

[68]See Krugman, Venables (1995), p. 861.
[69]See Krugman (1991 c), p. 664.

trade costs, agglomeration will occur. When vertical linkages get weaker and transport costs smaller, dispersion of firms might occur because firms might relocate due to wage differentials.[70] Forslid and Ottaviano (2003) remodel the core-periphery model of Krugman (1991 b) adding skill heterogeneity of workers. The higher the skills, the more mobile are workers supposed to be interregionally. Their model becomes analytically solvable because of this assumption which is in contrast to Krugman's models which require numerical simulation studies, instead. They reach this result because equilibrium prices are equalized across regions and independent from the location of firms and workers.[71] Agglomeration of manufacturing would increase for the region with more skilled workers (who are only working for the manufacturing and not for the agricultural sector) for a given wage because in that region consumer surplus will be higher due to higher purchasing power.[72] This, in turn, is due to lower price indices because of more domestic manufacturing firms, fewer imported varieties and thus fewer effects of trade costs. Forslid and Ottaviano call this effect the cost-of-living effect. The authors present two other effects which are at work. On the one hand the market crowding effect. For a given level of transport costs and expenditures on manufactures, a larger number of skilled laborers will cause a larger number of manufacturing firms in that region, thus competition increases. This in turn decreases on the one hand the price index, on the other hand local demand per firm. Operating profits thus decrease and so do wages of skilled workers. This is a deagglomerative force. The other effect is the market size effect. Having more firms in a region would also mean increased wages for skilled workers, more demand on manufacturing, thus being an agglomerative force. Frohwerk (2008) enhances the Krugman/ Venables (1996) model by introducing asymmetric transport costs between the two sectors. He finds that decreasing transport costs in just one sector will lead to lower production costs of both sectors such that stable and instable equilibria like in the Krugman/ Venables model would evolve. However, the production costs of the respective sector would decrease more than is the case for the other sector. This would make production of this sector's good increase. Asymmetric transport costs would make one country producing both sectors' goods, so labor in this country would be distributed on both sectors. However, this crucially depends on the height and difference between both sectors' transport costs. If one sector's transport costs lie above the sustain point, the other sector's ones have to be low enough in order to generate agglomeration.[73] Martin and Ottaviano (2001) show that growth and agglomeration are mutually self-reinforcing. They incorporate innovation processes into their model. Agglomeration fosters growth by

[70]See Venables (1996), p. 342.

[71]See Forslid and Ottaviano (2003), p. 234.

[72]See Forslid and Ottaviano (2003), p. 235.

[73]The sustain point characterizes a level of transport costs where agglomeration becomes possible. At the break point agglomeration is necessary, transport costs have become low enough.

reducing costs for innovations. So, it is getting more attractive to innovate, thus growth increases. On the other hand growth positively influences agglomeration because then the sector having benefited from innovations expands and other firms move to it because of increasing returns. Ottaviano (1999) enhances the Krugman (1991 c) model by considering trade and migration costs. If a reduction in trade and migration costs induced by economic integration is small, then history matters, the initial advantage of the larger region is preserved. If costs decrease a lot, however, then expectations become important, migration can occur thus fostering agglomeration, because firms then could move to different places due to labor mobility. Ottaviano, Tabuchi and Thisse (2002) enhance the Krugman (1991 c) model by substituting the CES utility function by a quasi-linear utility function with a quadratic subutility instead. Further, transport costs are modeled as units of the numeraire-good. Still, results are comparable to Krugman (1991 c). They show that if workers expect that a region which was lagging behind will improve, this will come true in case trade costs have an intermediate level. This happens because forward and backward linkages are then strong enough to compensate migrating workers for utility losses. Compensation occurs via rises in wages. The utility losses on the other hand are happening when regions' level of agglomeration changes. Fujita and Thisse (1996) summarize some of the most important features of New Economic Geography models. They point out that increasing returns to scale are a strong centripetal (agglomerative) force, whereas transportation costs and spatial dispersion of demand are centrifugal (deagglomerative) forces.[74] The reduction in transport costs would lead to agglomeration since firms can thus reduce costs and price competition increases which makes firms differentiate their products in order to reduce price competition[75]. This is an advantage for consumers.[76]

New Economic Geography's modeling is also seen critically in the literature. Martin (1999) criticizes New Economic Geography for not being a new branch of science, and for not being geography, thus pointing to a false naming of this branch. New Economic Geography would just redo regional science's and urban economics' models, using more mathematics. According to Martin empirical analysis is hard to do since the theoretical models are "...too abstract, oversimplified, and too idealised...".[77] Studies would neglect other causes for agglomeration like local infrastructure, local institutions, state spending and intervention, regulatory arrangements, foreign investment and disinvestment and global competition.[78]

[74]See Fujita and Thisse (1996), p. 368.

[75]See Fujita and Thisse (1996), pp. 368-369.

[76]Further models explaining clustering of firms and households, especially of cities can be found in Fujita and Thisse (2002).

[77]Martin (1999), p. 70.

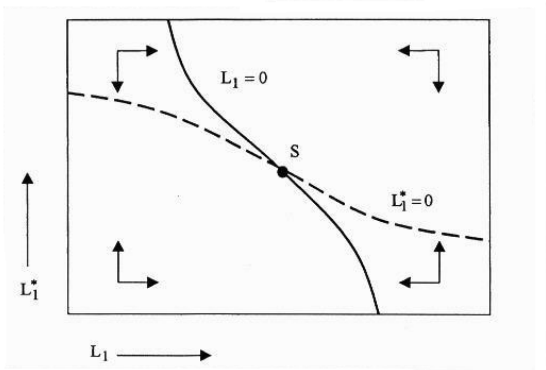
[78]See Martin (1999), p. 70.

In the following, the Krugman/ Venables (1996) model will be addressed. The model considers two monopolistically competitive manufacturing sectors, intermediate goods taken for production for either good and labor being immobile across countries but mobile between sectors. The authors show that intermediate goods' usage creates forward and backward linkages, thus fostering agglomeration. The forces behind are the same as has been explained above for the Krugman/ Venables model (1995). But there is no core-periphery emerging since two industrial sectors are taken. However, it can be shown that every industry will locate in a different country.
Studying the long-run equilibrium enables one to derive relationships between agglomeration, transport costs and the other parameters of the model. I will focus on this task describing the Krugman/ Venables (1996) model here, and later when modeling services' agglomeration, as well.
In the long-run laborers will move between sectors–to the sector that offers higher wages–until wages in the two sectors equalize. The dynamic behavior can be depicted by the following 3 graphs.[79] On the horizontal axis home labor force L_1 and L_2 will be shown, on the vertical axis foreign labor force $L_1^\star$ and $L_2^\star$. Employment in sector 1 is measured from the left bottom corner, moving to the right or up indicating more employment in sector 1. The curves $L = 0$ and $L^\star = 0$ are displaying distributions of labor where wages across sectors are equalized, that is for home $w_1 = w_2$ or for foreign country $w_1^\star = w_2^\star$. Below the line $L_1^\star = 0$ wages in sector 1 are bigger than for sector 2 in foreign country such that labor would move to sector 1. Above that line wages in sector 1 are lower than for sector 2 for foreign country, so workers would move to sector 2. Left of the $L_1 = 0$ curve wages in sector 1 are bigger than in sector 2, so workers would want to move to sector 1, right to that curve wages in sector 1 are lower than in sector 2, workers would move over to sector 2. Points in the upper left and lower right corner are specialization points of countries. Middle-high transport costs are determined by the sustain- (upper limit for transport costs) and the break-point. At the sustain-point agglomeration is possible, at the break-point agglomeration is necessary.

In the case of high transport costs, given by figure 3, there exists a symmetric and stable equilibrium. There is no agglomeration at place, industrial structures between the two countries are equal to each other. As Krugman/Venables say forward and backward linkages are not strong enough to lead to agglomeration.[80]

[79]See Krugman, Venables (1996), pp. 963.
[80]See Krugman/Venables (1996), pp. 963-964.

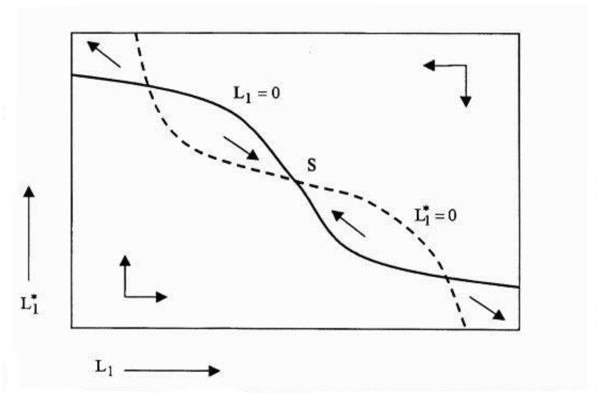
Figure 3: Krugman/Venables (1996) equilibrium at high transport costs



Source: Graphic taken from Krugman and Venables (1996), p. 964.

At middle-high transport costs 5 equilibria evolve. The symmetric equilibrium is stable and so are the points of a sector's total agglomeration in one country only. In between lie 2 instable equilibria. If initially both sectors are distributed relatively equally between countries, the symmetric equilibrium will be achieved, there is no agglomeration at place, countries' industrial structures are quite similar. But if initially the sectors are distributed unequally among countries, then a tendency for agglomeration is prevalent, either the point in the upper left (sector 1 agglomerated in foreign country and sector 2 in home country) or in the lower right corner (sector 1 agglomerated in home country and sector 2 in foreign country) will be attained.

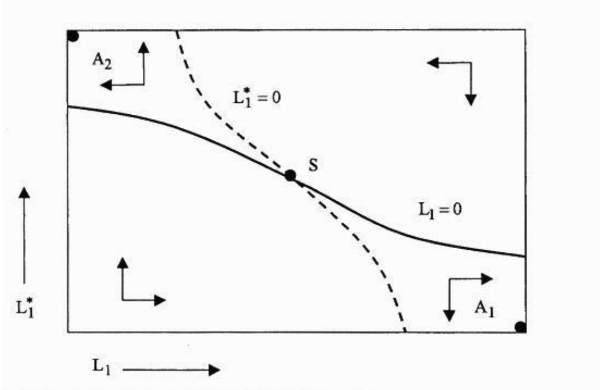
Figure 4: Krugman/Venables (1996) equilibrium at middle-high transport costs



Source: Graphic taken from Krugman and Venables (1996), p. 965.

At low levels of transport costs, 3 equilibria emerge. The symmetric equilibrium is instable, stable equilibria exist for agglomeration of a sector in one country only, lying in the points A_1 or A_2. In A_2 sector 1 is agglomerated in foreign country and sector 2 in home country, in A_1 sector 1 is concentrated in home country and sector 2 in foreign country. Forward and backward linkages cause sectors to get agglomerated. The backward linkage describes intermediate goods' localization close to a large final goods' industry due to saving transport costs and making use of economies of scale, the forward linkage deals with final goods' production locating close to intermediate goods' industries receiving cheaper inputs that way such that costs for the final goods' industry are low enough in order to export.[81] Each industry will concentrate in one country, only.

Figure 5: Krugman/Venables (1996) equilibrium at low transport costs



Source: Graphic taken from Krugman and Venables (1996), p. 964.

4.3 Modeling Framework

Models developed by Krugman and Venables[82] do either consider an agricultural and an industrial sector or two industrial sectors. The idea for this study, now, is to model an economy comprising both a services and an industrial sector, taking account of special features that characterize services. It can be assumed that by considering fewer intra-sectoral inputs to exist for the services sector, the model's results will differ from those arising from common New Economic Geography modeling frameworks. In addition, I will assume imported services to be less dependent on transport costs referring to Frohwerk's (2008) study on asymmetric transport costs. However, as will be seen in the following, I will employ a different formal implementation than Frohwerk did. The Krugman and Venables (1996) model is taken in the following. Changes occur due to taking account of services' special features. I will talk about differences compared to the Krugman/ Venables model in the following where it is adequate. The description of the modeling framework follows Krugman and Venables (1996), Fujita, Krugman, Venables (1999), Klüver (2000) and Frohwerk (2008).

The household's utility function is composed of using both industrial and services products to a share of μ and $1-\mu$. The original Krugman/Venables (1996) frame-

[81]See Krugman/ Venables (1996), p. 961.

[82]See Krugman (1991 b), Krugman and Venables (1995), Krugman and Venables (1996).

work assumed equal shares for expenditures instead. Industrial and services' products are used by the firms interchangeably to the extent of ν. The industrial sector is supposed to receive from its own intermediate inputs to the extent of α. α shall be greater than ν. I further model that the services sector does not make use of its own intermediate products. In Empirics a lower influence of intermediate goods' intensity on services sectors' agglomeration compared to industrial agglomeration has been detected.[83] Further, in table 38 the services sectors receiving fewer intra- than inter-sectoral inputs have been listed. In modeling no intra-sectoral inputs for services I thus decided to take a rather strong assumption in order to be able to figure out better the importance of certain services' characteristics by theoretical modeling. Labor is distributed to both industrial and services' products to the extent of β_1 and β_2. Labor is mobile across sectors, thus workers have abilities to work either in an industrial or in a services sector, but immobile internationally. Both sectors produce under monopolistic competition. Transport costs T are modeled as iceberg transport costs. This means a lower fraction of the shipped good will arrive in its destination. By shipping some parts of the good melt away like an iceberg does. A value of 1 means that there are no transport costs, a value greater than 1 means there exist transport costs. It is further assumed in my modeling framework that importing services from another country bears zero transport costs. I follow Frohwerk's (2008) study on asymmetric transport costs in doing so. Technical implementation, however, deviates from his procedure. Again, thus a restrictive assumption is chosen, but it will enable one to figure out this characteristic's importance in theoretical modeling. I decided to take on this assumption because real data display a rather low level of imported services (see table 38). The amount of transport costs to be born by producers and consumers might be considered to be low because there is only a few services imported.[84] [85] Further, home and foreign country shall be symmetric, so the same aforementioned assumptions apply for both home and foreign country.

The demand side is modeled as follows. Households have a Cobb-Douglas utility function:

[83]See chapter 3 of this dissertation.

[84]As regards transport costs for inputs, Schöler (2005), p. 48, points to transport costs being not important for localization decisions of firms, since 1. inputs like labor, information and further equipment are easily and almost everywhere available, 2. transport costs might be very low for information and monetary transactions, and 3. if firms get clustered and transport costs increased for trading tasks, then it would mean an increase in transport costs for all firms in the same way. Schöler points to transport costs being potentially important only for consumers' decisions, but importance might decrease with the increasing use of internet transactions. In the following I will also assume that transport costs are not important for importing services for consumption, either.

[85]Ellison, Glaeser, Kerr (2010) point to lower transport costs for some services, for example for call center activities.

$$U = M^{\mu} * D^{1-\mu}. \tag{25}$$

Households' expenditure on either an industrial or a services product shall be denoted by μ or $1-\mu$, respectively. M is an index denoting quantities of differentiated products in the industrial sector, D is an index denoting quantities of differentiated products in the services sector. M and D are representable via sub-utility functions of CES-type:

$$M = (\int_0^n m(r)^{\rho} dr)^{\frac{1}{\rho}} \tag{26}$$

and

$$D = (\int_0^g m(o)^{\rho} do)^{\frac{1}{\rho}}. \tag{27}$$

The elasticity of substitution and of demand according to the CES-utility function is σ, where[86]

$$\rho = \frac{\sigma - 1}{\sigma}. \tag{28}$$

Note that $\sigma > 1$ and $0 < \rho < 1$. n and g are the numbers of product variants or firms for the industrial or the services sector. m(r) denotes a consumer's consumed quantity of each product variant r of the industrial sector. As can be seen, the household's utility increases with the number of product variants consumed. This modeling is known as the love of variety approach. Further, from the production side, it is assumed that each firm produces just one variant. This is due to the fact that increasing returns to scale are modeled via fixed costs. If there are increasing returns to scale then average costs will decrease and so will fixed costs per unit.[87] Thus, it is better for a new firm to produce a new product variant than sharing a market with another firm. This again is due to the fact that more firms in a market would induce lower output for each firm and thus higher per unit costs, further, the more firms there are in a market, the tougher will be competition and firms can set only lower prices, which would make their profits diminish.[88] For an increasing σ or $\rho = 1$ product variants are perfect substitutes.[89] Lowering σ or ρ denotes a higher level of product differentiation.

[86]See Klüver (2000), pp. 41.
[87]See Krugman, Obstfeld (2009 b), pp. 119.
[88]See Krugman, Obstfeld (2009 b), p. 122.
[89]See Klüver (2000), p. 40.

In order to determine the optimal demand function, expenditures have to be minimized:[90]

$$min \int_0^n p(r) * m(r)dr \tag{29}$$

s.t.

$$M = (\int_0^n m(r)^\rho dr)^{\frac{1}{\rho}} \tag{30}$$

and

$$min \int_0^g p(o) * m(o)do \tag{31}$$

s.t.

$$D = (\int_0^g m(o)^\rho do)^{\frac{1}{\rho}}. \tag{32}$$

p(r) and p(o) denote the prices for a product variant. Just focus on the manufacturing sector for a moment. Similar considerations are valid also for the services sector. First order conditions for two arbitrary product variants a and z are:[91]

$$\frac{m(a)^{\rho-1}}{m(z)^{\rho-1}} = \frac{p(a)}{p(z)} \tag{33}$$

and thus:

$$m(a) = m(z) * (\frac{p(a)}{p(z)})^{\frac{1}{1-\rho}}. \tag{34}$$

Equation (33) shows that the marginal rate of substitution is equal to the relation of goods' prices. This result is straightforward, I will show the optimization procedure behind in the mathematical appendix part A.
Inserting m(a) into the sub-utility function delivers the compensated demand function:[92]

$$m(z) = (\frac{p(z)^{\frac{1}{\rho-1}}}{(\int_0^n p(a)^{\frac{\rho}{\rho-1}} da)^{\frac{1}{\rho}}}) * M. \tag{35}$$

[90]See Klüver (2000), p. 56.
[91]See for example Fujita, Krugman, Venables (1999), pp. 47.
[92]See Klüver (2000), p. 57.

Multiplying the above equation by p(z) on both sides and integrating the term over all differentiated products one gets expenditures for all variants of goods:

$$\int_0^n p(z)m(z)dz = (\int_0^n p(a)^{\frac{\rho}{\rho-1}}da)^{\frac{\rho-1}{\rho}} * M. \tag{36}$$

The expression in front of M is considered being a price index G(i) for i=1,2 sectors, where i=1 denotes the industrial sector and i=2 the services' sector:

$$G(i) = \int_0^n (p(a)^{\frac{\rho}{\rho-1}}da)^{\frac{\rho-1}{\rho}}. \tag{37}$$

Taking account of consumed goods taken from foreign country f, the price index of sector i in home country h is:[93]

$$G(hi) = (n(hi) * p(hi)^{1-\sigma} + n(fi) * (p(fi) * T)^{1-\sigma})^{\frac{1}{1-\sigma}}. \tag{38}$$

n(hi) and n(fi) are number of varieties of sector i's product, p is the price charged which is in the Krugman/Venables model assumed to be the same for each variety and T is iceberg transport costs.

In the Krugman/ Venables model it is further assumed that this price index G is also the price for intermediate products. This means the consumption good with its variants equals the intermediate product with its variants.[94] Further, equation (38) displays that it is more advantageous for firms if there exist a lot of product variants, that is n is big, because then the price index will be small, production costs are lower (forward linkage).[95]

Production occurs under monopolistic competition. The total cost functions for each firm in both the industrial (1) and the services sector (2) are:[96]

$$TC_1 = C_1 * (F + c * q_1) \tag{39}$$

and

$$TC_2 = C_2 * (F + c * q_2). \tag{40}$$

[93]See Krugman, Venables (1996), p. 962; Klüver (2000), p. 163; Frohwerk (2008), p. 5.
[94]See Klüver (2000), p. 164.
[95]See Klüver (2000), p. 164.
[96]See Krugman, Venables (1996), p. 962.

c represents variable costs, q_i is output per sector i and F fixed costs. C_i is the unit cost for the composite input. The idea behind is that an input consists of two elements, one is labor, the other one intermediate products.[97] Because of this it follows:

$$C_1 = w_1^{\beta_1} * G_1^{\alpha} * G_2^{\nu} \tag{41}$$

and

$$C_2 = w_2^{\beta_2} * G_1^{\nu}. \tag{42}$$

w_i is the wage rate in sector i. C_2, my cost share for the services' product differs from Krugman/Venables because I assume no intra-sectoral inputs received for this sector. G_1 and G_2 are price indices for intermediates from own (to the input share α) and from the other sector (to the input share ν). The input share of labor for sector 1 is $\beta_1 = 1 - \alpha - \nu$ and for sector 2 it is $\beta_2 = 1 - \nu$. The two sectors are otherwise symmetric that is c, F, ν and σ are the same for both the services and the industrial sector.

The price maximizing profit is given by the Amoroso-Robinson-relation, since each sector is monopolistically competitive and each firm bears a constant elasticity of demand σ:[98]

$$p(k)^{\star} = w(k)^{\beta_k} * G(k)^{\alpha} * G(j)^{\nu} * c * \frac{\sigma}{\sigma - 1} \tag{43}$$

where

$$C(k) = w(k)^{\beta_k} * G(k)^{\alpha} * G(j)^{\nu}. \tag{44}$$

k and j here and henceforth shall denote each a firm in the two different sectors, that is industry and services. I will show the procedure of derivation for $p(k)^{\star}$ via the Amoroso-Robinson-relationship in the mathematical appendix part B. Profit maximization to get the optimal output is:[99]

$$\pi(i) = p(i)q(i) - C(i) * (F + c * q(i)). \tag{45}$$

[97]See Krugman, Venables (1996), p. 962.

[98]See Krugman, Venables (1996), p. 962; Klüver (2000), p. 166; Frohwerk (2008), p. 6.

[99]See Klüver (2000), p. 166; Frohwerk (2008), p. 6.

Inserting the profit maximizing price into the profit equation yields the firm's optimal output, where profit is equal to zero (which is demanded by the market form of monopolistic competition):[100]

$$q(i)^{\star} = (\sigma - 1) * \frac{F}{c}. \tag{46}$$

Profit is –seen over a long time– for a single producer equal to zero, because market entry and leave in monopolistic competition is free.

Some standard notations are introduced:[101]

$$c \equiv \frac{\sigma - 1}{\sigma}. \tag{47}$$

Variable costs shall be equal to the inverse of pricing mark-up (we got this term through the Amoroso-Robinson-relation). The optimal price then becomes:

$$p(k)^{\star} = w(k)^{\beta_k} * G(k)^{\alpha} * G(j)^{\nu}. \tag{48}$$

Here, in my modeling, I will have two different optimal prices since it is assumed that the services sector does not receive intermediate inputs from itself. Then:

$$p_1^{\star} = w_1^{\beta_1} * G_1^{\alpha} * G_2^{\nu} \tag{49}$$

and the price of sector 2 will be

$$p_2^{\star} = w_2^{\beta_2} * G_1^{\nu}. \tag{50}$$

That means when setting their price firms in sector 2 (services sector) will not have to consider prices for intra-sectoral inputs G_2. The optimal output becomes:

$$q(i)^{\star} = F\sigma. \tag{51}$$

Further, it shall be that fixed costs are:[102]

$$F = \frac{1}{\beta_i \sigma}. \tag{52}$$

[100]See Krugman, Venables (1996), p. 962; Klüver (2000), p. 166; Frohwerk (2008), p. 6.
[101]See for example Fujita, Krugman, Venables (1999), pp. 54.
[102]See Klüver (2000), p. 168.

Thus, optimal output becomes:

$$q(i)^\star = \frac{1}{\beta_i}. \tag{53}$$

Employment levels and number of firms (n(i)) are given by the equation:[103]

$$w(i)L(i) = \beta_i * n(i) * p(i) * q(i)^\star \tag{54}$$

where $w(i)L(i)$ is labor compensation, β_i is the labor share and $n(i)p(i)q(i)$ is the value of total production. Inserting optimal output this will become:

$$w(i)L(i) = n(i) * p(i) \tag{55}$$

or

$$n(i) = \frac{w(i)L(i)}{p(i)}. \tag{56}$$

We can derive the following sectoral price indices, by inserting numbers of firms n(i) and optimal price $p(k)^\star$ into the formula of the price index as given by equation (38):[104]

$$G_{h1} = (L_{h1} * w_{h1}^{(1-\beta_1\sigma)} * G_{h1}^{-\alpha\sigma} * G_{h2}^{-\nu\sigma} + L_{f1} * w_{f1}^{(1-\beta_1\sigma)} * G_{f1}^{-\alpha\sigma} * G_{f2}^{-\nu\sigma} * T^{1-\sigma})^{\frac{1}{1-\sigma}} \tag{57}$$

$$G_{h2} = (L_{h2} * w_{h2}^{(1-\beta_2\sigma)} * G_{h1}^{-\nu\sigma} + L_{f2} * w_{f2}^{(1-\beta_2\sigma)} * G_{f1}^{-\nu\sigma} * T^{1-\sigma})^{\frac{1}{1-\sigma}} \tag{58}$$

$$G_{f1} = (L_{f1} * w_{f1}^{(1-\beta_1\sigma)} * G_{f1}^{-\alpha\sigma} * G_{f2}^{-\nu\sigma} + L_{h1} * w_{h1}^{(1-\beta_1\sigma)} * G_{h1}^{-\alpha\sigma} * G_{h2}^{-\nu\sigma} * T^{1-\sigma})^{\frac{1}{1-\sigma}} \tag{59}$$

$$G_{f2} = (L_{f2} * w_{f2}^{(1-\beta_2\sigma)} * G_{f1}^{-\nu\sigma} + L_{h2} * w_{h2}^{(1-\beta_2\sigma)} * G_{h1}^{-\nu\sigma} * T^{1-\sigma})^{\frac{1}{1-\sigma}}. \tag{60}$$

As can be seen, a sector's price index depends positively on its own price index

[103] See Krugman, Venables (1996), p. 963; Klüver (2000), p. 169; Frohwerk (2008), p. 7.
[104] See for a notation in case of the Krugman/ Venables (1996) model: Klüver (2000), p. 169 and Frohwerk (2008), p. 7.

and all other price indices. This can be explained by the price indices influencing marginal costs, thus influencing the price setting of a firm.[105] [106] Further, the price index positively depends on transport costs. This set of price indices differs from Krugman/ Venables (1996) in that I consider no intra-sectoral inputs for the services' sector. Further, I do not explicitly control for different transport costs for the two sectors as Frohwerk (2008) does. T is the same in all of the four equations. However, since leaving out G_{f2} and G_{h2} from equations (57) and (59), respectively, does not alter the height of transport costs for equations (58) and (60) –they are still T– I can thus model transport costs having a value of 1 for the service's input imported from another country in equations (57) and (59).

Total income is:[107]

$$Y = w_1 * L_1 + w_2 * L_2 \tag{61}$$

where w is the wage, L(i) is labor in sector i and $L_1 + L_2 = 1$. What matters for a sector's location is expenditures on a sector's products.[108] Consumers' expenditures and demand for intermediate goods make up a sector's expenditures, labeled E(i).[109] They are here given by:

$$E_{h1} = (w_{h1} * L_{h1} + w_{h2} * L_{h2}) * \mu + \frac{\alpha * w_{h1} * L_{h1} + \nu * w_{h2} * L_{h2}}{\beta_1} \tag{62}$$

$$E_{h2} = (w_{h2} * L_{h2} + w_{h1} * L_{h1}) * (1 - \mu) + \frac{\nu * w_{h1} * L_{h1}}{\beta_2} \tag{63}$$

$$E_{f1} = (w_{f1} * L_{f1} + w_{f2} * L_{f2}) * \mu + \frac{\alpha * w_{f1} * L_{f1} + \nu * w_{f2} * L_{f2}}{\beta_1} \tag{64}$$

$$E_{f2} = (w_{f2} * L_{f2} + w_{f1} * L_{f1}) * (1 - \mu) + \frac{\nu * w_{f1} * L_{f1}}{\beta_2}. \tag{65}$$

Taking a look at equations (62) and (63) one can see that home country's households' expenditures is divided to a share of μ for industrial goods and to the share

[105] See Klüver (2000), p. 170.

[106] See equations (57) to (60) and the appendix part B. In the appendix it is shown how–via the Amoroso-Robinson relationship–the optimal price is determined by setting marginal costs equal to marginal revenue. So, the optimal price depends on marginal costs, the total cost function depends on the two sectors' price indices, and each price index involves domestic and imported inputs.

[107] See Krugman, Venables (1996), p. 963.

[108] See Krugman, Venables (1996), p. 963.

[109] See Krugman, Venables (1996), p. 963; Klüver (2000), p. 171; Frohwerk (2008), p. 8.

of $1-\mu$ for services' products. Krugman/ Venables' model instead made households consume to a share of one half from each sector. $w_{h1} * L_{h1} + w_{h2} * L_{h2}$ gives total income Y which is spent on consumption. The last term in the equations describes firms' expenditure on intermediate goods. In Krugman/ Venables (1996) the share of labor taken for production is the same for both sectors. In my modeling, as can be seen, labor input shares differ, that is β_1 for producing the industrial good and β_2 for producing the service. Equation (62) shows for expenditures in home for the industrial good, that in the nominator of the last term the extent of labor compensation spent by firms is displayed, that is $\alpha * w_{h1} * L_{h1}$ due to intra-sectoral inputs and $\nu * w_{h2} * L_{h2}$ due to inter-sectoral inputs for the industrial sector. As can be seen, in my modeling there is no term for intra-sectoral inputs for the services' sector included (see equations (63) and (65)).

Looking back to the compensated demand function in equation (35), one can write for demand of a single product variant z substituting by the price index $G(i)^{\frac{1}{\rho-1}}$ from equation (37):[110]

$$m(z) = M * (\frac{p(z)}{G(i)})^{\frac{1}{\rho-1}}. \tag{66}$$

Instead of M the expenditure E has to be inserted, since the consumed good is assumed to equal the intermediate good in production as has been said before, further, also demand from both home and foreign country shall be considered, thus:[111]

$$m(z) = E(hz) * [\frac{p(z)}{G(hi)}]^{\frac{1}{\rho-1}} + E(fz) * [\frac{p(z)}{\frac{G(fi)}{T}}]^{\frac{1}{\rho-1}}. \tag{67}$$

Taking account of all variants here for sector i, and using the version with σ and q instead of ρ and m -again since the consumed good is assumed to equal the intermediate good for production- one can write:[112]

$$q(i) = p(i)^{-\sigma} * (E(hi) * G(hi)^{\sigma-1} + E(fi) * (\frac{G(fi)}{T})^{\sigma-1}). \tag{68}$$

This is sales of home-based firms in industry i. Inserting the optimal price and optimal quantity will deliver the wage equation:[113]

$$\frac{(w(hk)^{\beta_i} * G(hk)^{\alpha} * G(hj)^{\nu})^{\sigma}}{\beta_k} = G(hk)^{\sigma-1} * E(hk) + G(fk)^{\sigma-1} * E(fk) * T^{1-\sigma}. \tag{69}$$

[110]See also Fujita, Krugman, Venables (1999), pp. 47.
[111]See Klüver (2000), p. 61; Frohwerk (2008), p. 5.
[112]See Krugman, Venables (1996), p. 963; Klüver (2000), p. 171; Frohwerk (2008), p. 8.
[113]See Klüver (2000), p. 172; Frohwerk (2008), p. 8.

Thus the wage equations can be derived:

$$w_{h1} = (\beta_1 * (G_{h1}^{\sigma-1} * E_{h1} + G_{f1}^{\sigma-1} * E_{f1} * T^{1-\sigma}))^{\frac{1}{\beta_1\sigma}} * G_{h1}^{\frac{-\alpha}{\beta_1}} * G_{h2}^{\frac{-\nu}{\beta_1}} \quad (70)$$

$$w_{h2} = (\beta_2 * (G_{h2}^{\sigma-1} * E_{h2} + G_{f2}^{\sigma-1} * E_{f2}))^{\frac{1}{\beta_2\sigma}} * G_{h1}^{\frac{-\nu}{\beta_2}} \quad (71)$$

$$w_{f1} = (\beta_1 * (G_{f1}^{\sigma-1} * E_{f1} + G_{h1}^{\sigma-1} * E_{h1} * T^{1-\sigma}))^{\frac{1}{\beta_1\sigma}} * G_{f1}^{\frac{-\alpha}{\beta_1}} * G_{f2}^{\frac{-\nu}{\beta_1}} \quad (72)$$

$$w_{f2} = (\beta_2 * (G_{f2}^{\sigma-1} * E_{f2} + G_{h2}^{\sigma-1} * E_{h2}))^{\frac{1}{\beta_2\sigma}} * G_{f1}^{\frac{-\nu}{\beta_2}}. \quad (73)$$

As can be seen, transport costs reduce foreign (home) countries' expenditures on industrial products E_{f1} (E_{h1}) and wage w_{h1} (w_{f1}) in the home (foreign) country for the industrial sector (as can be seen from equation (70), higher transport costs mean a reduction in foreign country's expenditures for the industrial good–since the term $1-\sigma$ is negative–and taking the lower value of the expression in the brackets to the power of $\frac{1}{\beta_1\sigma}$ will reduce the value of w_{h1}). I differ from Krugman/ Venables in not having own services inputs and therewith its price indices for the services sectors' wages. I further assume that importing services from the other country is not bearing transport costs (see explanations for equations (57) to (60)). So here, for expenditures, I control for different sectors' transport costs formally as is done in Frohwerk (2008). This contrasts my formal modeling for price indices, where I took just one T for each price index (see equations (57) to (60)).

4.4 Dynamics

In the short-run, employment is fixed and wages will differ. For the long-run the assumption of labor being mobile across sectors involves that if wage in one sector is higher than in another sector, workers will move over to the sector offering a higher wage. This will happen until wages between both sectors equalize. So in the long-run an equilibrium will emerge where wages in both sectors are equal to each other.[114]

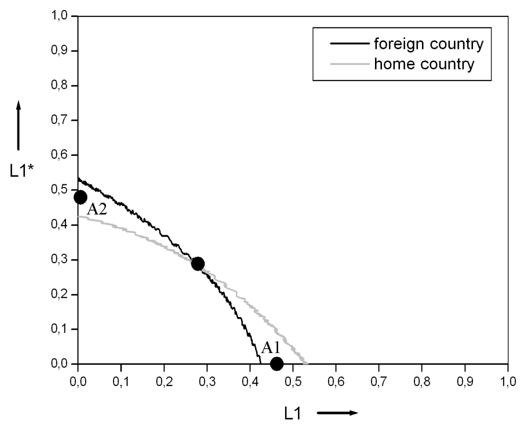
For a dynamic investigation, the employment of sector 1 in home country at a given employment of sector 1 in foreign country needs to be computed where home country's wages for both sectors are equal to each other. I programmed the simulation

[114]See Krugman, Venables (1996), p. 963.

in Ox, resembling Frohwerk (2008) who programmed the simulation in Scilab. My Ox-Code can be found in the technical appendix.[115] The simulation is run to generate values for home country's labor distribution. The line for foreign country is generated by mirroring values at a 45 degree line. This is due to the symmetry between the two countries, so when wages between sectors in home country are equal to each other they deliver a distribution of labor in home between sector 1 and 2 which is equal to labor distribution between sector 1 and 2 in foreign when wages in foreign country equalize. The following graphics can be interpreted the same way as has been done in chapter 4.2 for the Krugman/Venables (1996) model.

As can be seen from figure 6 at a low level of transport costs (T=1.5) 3 equilibria emerge, one with about one third of manufacturing employment and two thirds of services' employment in home and in foreign. The two other equilibria comprise either home having some manufacturing and some services' employment and foreign being 100 percent specialized in services (point A1) or foreign having some manufacturing and some services' employment and home being 100 percent specialized in services (point A2). The points A1 and A2 are stable equilibria, the third one at a manufacturing employment share of about one third is an instable equilibrium. Further explanations are given in section 4.5.

Figure 6: Equilibria for labor distribution at T=1.5, $\mu=\frac{1}{3}$



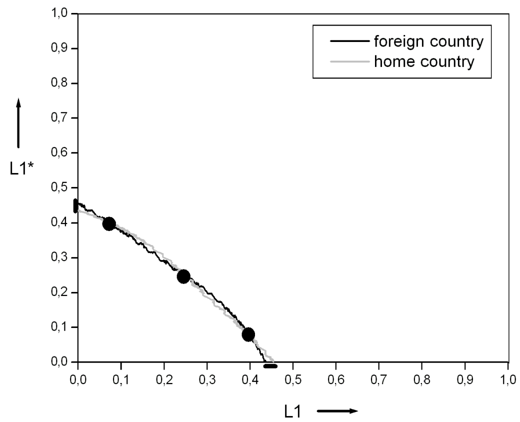
Source: Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=4, alpha=0.5, ny=0.1, my=0.33.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

At medium levels of transport costs (T=2.2) one can see from figure 7 that 5 equilibria emerge. As is the case for low level transport costs, equilibria involve either a

[115]Within the 1000 iterations of the simulation for some constellations up to 4 outliers emerged, which were not further considered for drawing the lines for the following graphics. This undertaking is justified by the high number of remaining observations. Further, with more iterations run, let's say 10000 etc., the outlier rate would converge to zero making these few outliers negligible.

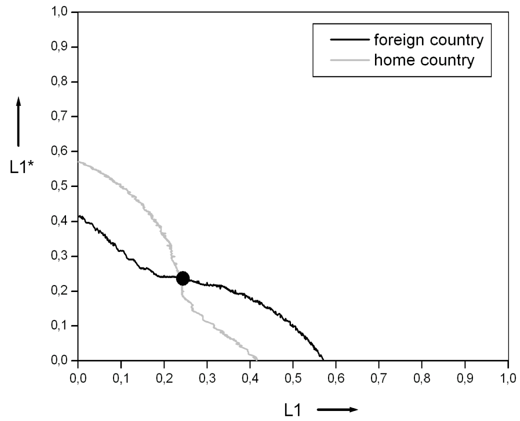
share of about one third of manufacturing employment for both countries (1 stable equilibrium), some manufacturing and some services for one and 100 percent services for the other country (2 stable equilibria lying on the axes), or some manufacturing and some services in one country and mostly services' employment in the other country (2 instable equilibria).

Figure 7: Equilibria for labor distribution at T=2.2, $\mu=\frac{1}{3}$



Source: Own graphic based on own simulations run with 1000 iterations, T=2.2, sigma=4, alpha=0.5, ny=0.1, my=0.33.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

Figure 8: Equilibria for labor distribution at T=4.0, $\mu=\frac{1}{3}$



Source: Own graphic based on own simulations run with 1000 iterations, T=4.0, sigma=4, alpha=0.5, ny=0.1, my=0.33.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

For a high level of transport costs only one stable equilibrium emerges. There is no agglomeration of either industries or services, the employment shares respond to consumers' preferences in about one third of manufacturing.

I further investigated how changes in consumers' preferences affect employment shares and agglomeration tendencies. I considered households' expenditure shares of $\mu=\frac{1}{2}$ and $\mu=\frac{2}{3}$. The graphics are shown in the appendix of graphics. The following conclusions can be drawn. If one increases the share of manufacturing goods in consumers' preferences to one half or two thirds, equilibria keep qualitative features as I described them in the case of $\mu=\frac{1}{3}$. The equilibria's values of employment shares, however, increase accordingly.

4.5 Discussion

Results show that agglomeration tendencies are comparable to common New Economic Geography model settings employing agricultural and industrial sectors, only. However, here consumers' preferences, the height of transport costs, no transport costs assumed for imported services and the fact that the services sector will not receive intermediate goods from its own sector, will influence the model's results.

It has been seen that at high levels of transport costs no agglomeration will occur. Forward and backward linkages are not strong enough to lead to agglomeration. The distribution of labor shares for industrial goods or services depends on initial consumers' preferences.
At middle-high levels of transport costs 5 equilibria evolve. If industries and services are distributed relatively unequally in the beginning, they will agglomerate more and more. If they are relatively equally distributed, then they will agglomerate according to consumers' preferences in either industrial or services' products.
At low levels of transport costs there exist 3 equilibria. The equilibrium with equal manufacturing/ services' employment shares for the two countries is unstable, stable equilibria lie on the axes. If industries and services were in the beginning very unequally distributed across the two countries, then their distribution would move further to the specialization points lying on the axes.
The degrees of specialization further depend on consumers' preferences in the beginning. If consumers preferred services goods over industrial products ($\mu = 1/3$) then foreign country specializes to some extent in industrial products and some other in services products and home country specializes 100 percent in services, or home country specializes to some extent in industrial goods and some other in services products and foreign country specializes 100 percent in services. So there would not be full agglomeration of sectors in one country only, the industrial sector is

present in one country, only, but services will be produced in both countries. One country would exclusively produce services. This corresponds to transportability of manufactured products in reality, thus industrial goods can be produced in just one country, only, and be exported to another country. Services production, however, will be kept in both countries. There is less agglomeration of this sector evident. This corresponds to a higher degree of non-tradeability of these products.
Higher consumers' preferences for industrial products lead to clearer agglomeration tendencies ($\mu = 1/2$ and $\mu = 2/3$). Then the country that produces industrial products would give up producing services to a greater extent.

The explanation for these tendencies could be the following. Let's assume that initially home produces just the industrial good and foreign country the service. Reducing transport costs will lead to lower price indices in equations (57) to (60). Production costs for both goods will decrease. Let's assume firms in home want to produce services goods. Since no services' inputs are used for services, the price index for services can be expected to become lower than the price index for industries for one country. Production of services is cheaper, they will be more and more produced. Further, real wages in the service sector might increase due to the lower price index. Thus, workers would like to work for the services sector, as well. Consequently, the services sector will not just be located in the foreign but also in the home country. Home country has both industrial and services' production. This explained the forward linkage effect. In Frohwerk (2008) it was the reduction of one sector's transport costs, instead, which made production of this sector's good more attractive such that one country produced both goods. In my modeling the extent of intra- or inter-sectoral inputs taken for production is crucial for agglomeration tendencies.[116] The backward linkage effect means that more workers moving to home country, willing to work in the services sector increases expenditures (see equations (62) and (63)), thus more services firms would like to localize in home country, too.

The results emerging from simulations done for graphics 6 to 8 display a lower level of agglomeration for the industrial sector than would be expected by consumers' given preferences for manufacturing goods μ. In figure 6, for example, the instable equilibrium does not lie in the point $(\frac{1}{3}, \frac{1}{3})$, but in a lower distribution share of employment across countries. This could be explained by a higher real wage offered from the services sector which makes it more attractive for employees to work rather in the services sector. This becomes clear looking at equations (70) and (71) for home country, for example. Services wages do in this modeling not depend on transport costs. If this were the case, then wages would be lower. Further, the

[116]See in the following also chapter 4.7.

price index for services inputs $G_{h2}^{\frac{-\alpha}{\beta_2}}$ does not enter the services' wage equation, thus services' wage does not experience any further reduction, wage is not multiplied by $G_{h2}^{\frac{-\alpha}{\beta_2}}$ which lies in this model between 0 and 1 (according to the strength of intra-sectoral and inter-sectoral linkages α and ν).

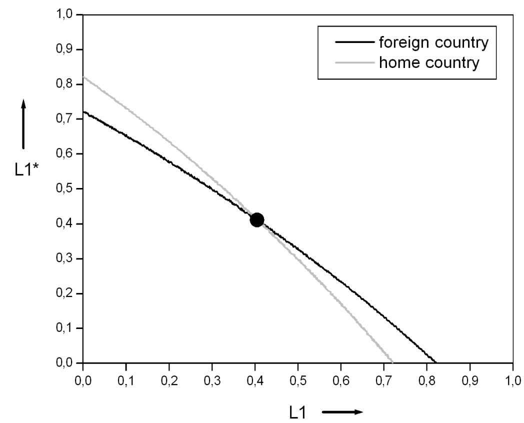
Summarizing, my modeling corresponds to common New Economic Geography models' results as far as general behavior of equilibria is concerned. In addition to this, fewer services' agglomeration, a fact that is seen in reality, can be shown

4.6 Parameter sensitivity

There are special assumptions in the Krugman/ Venables (1996) model which are essential for generating the model's results. Especially, it is required that intra-sectoral input-output linkages are stronger than inter-sectoral ones. This would mean that cost and demand linkages are stronger within each industry than between industries.[117] I have checked for the model's results in case intra-sectoral linkages get smaller and inter-sectoral ones get bigger.

In figure 9 one can see that if $\alpha - \nu$ is not big enough, here being 0.1 since $\alpha = 0.3$ and $\nu = 0.2$, then even at very low transport costs no agglomeration will occur, services and industries rather stay dispersed. This result does not depend on consumers' preferences, the case of $\mu = \frac{1}{3}$ and $\mu = \frac{2}{3}$ can be found in the appendix of graphics.

Figure 9: Equilibria for labor distribution at T=1.5, $\mu = \frac{1}{2}$, α=0.3, ν=0.2



Source: Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=4, alpha=0.3, ny=0.2, my=0.5.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

As Krugman (1991 b) points out, a higher elasticity of substitution, that is a

[117] See Krugman, Venables (1996), p. 966.

higher sigma, represents lower scale economies.[118] This is a deagglomerative force. This relationship comes from modeling internal economies of scale. They can be modeled by the fraction:[119]

$\frac{average costs}{marginal costs}$.

This term shall model whether firms can realize profits in which case they would generate a price bigger than average costs.[120] Since in the long-run equilibrium the price taken by a monopolist equals average costs[121], marginal costs are $C(i) * c$ and in equilibrium it has to be that marginal revenue equals marginal costs, that is $p(i) * \rho = C(i) * c$, one could write:[122]

$$\frac{average costs}{marginal costs} = \frac{p(i)}{C(i) * c} = \frac{1}{\rho} = \frac{\sigma}{\sigma - 1}. \tag{74}$$

Thus, with a higher sigma, the ratio of average costs to marginal costs decreases. Returns to scale in production for a firm will shrink. As can be seen in the following, indeed with increasing economies to scale, that is lower sigma, agglomeration will occur at much higher levels of transport costs, yet.

Figures 10 and 11 show for a higher sigma (σ=6) that lowering transport costs from 3.0 to 1.5 will not yield the same results as in the case of $\sigma = 4$ from figures 6-8. Even at very low transport costs there are still 5 equilibria existing and not 3. At transport costs of 3.0, which are quite low, no agglomeration will occur (see figure 10).

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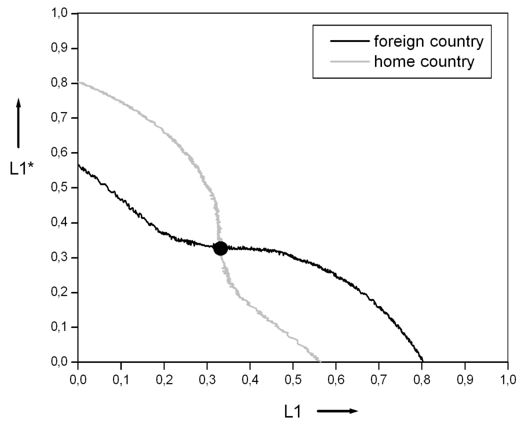
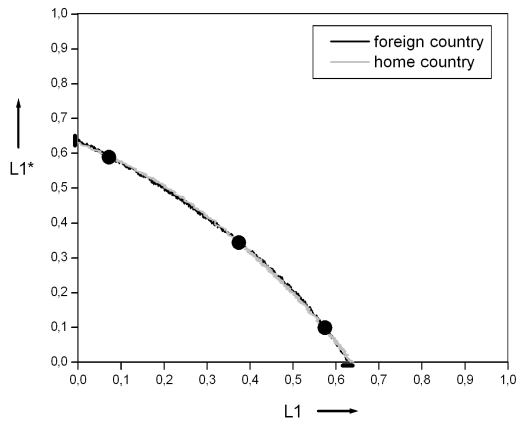
[118]See Krugman (1991 b), p. 497; see also Klüver (2000), p. 49.
[119]See Helpman, Krugman (1985), p. 33.
[120]See Krugman, Obstfeld (2009 b), p. 123.
[121]See Perloff (2001), pp. 452.
[122]See also mathematical appendix part B.

Figure 10: Equilibria for labor distribution at T=3.0, σ=6



Source: Own graphic based on own simultations run with 1000 iterations, T=3.0, sigma=6, alpha=0.5, ny=0.1, my=0.5.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

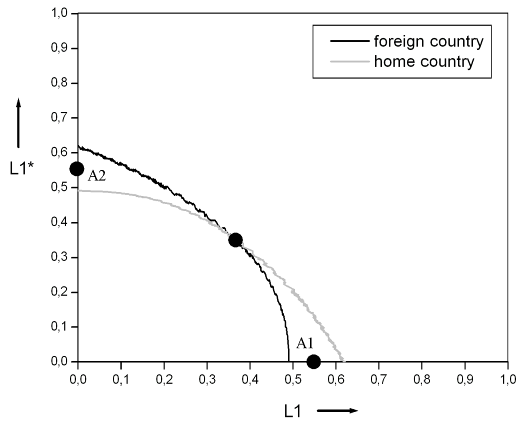
Figure 11: Equilibria for labor distribution at T=1.5, σ=6



Source: Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=6, alpha=0.5, ny=0.1, my=0.5.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

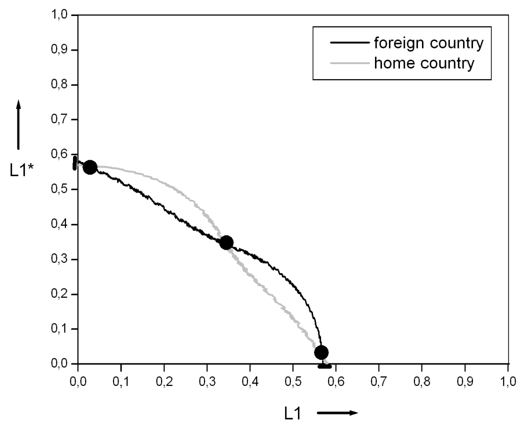
Figures 12 and 13 show the case for higher scale economies, $\sigma = 3$. As can be seen with quite high levels of transport costs of 3.0 there is still agglomeration at place (see figure 12) and no agglomeration occurs in case of very high transport costs (see figure 13), where still 5 equilibria exist.

Figure 12: Equilibria for labor distribution at T=3.0, σ=3



Source: Own graphic based on own simulations run with 1000 iterations, T=3.0, sigma=3, alpha=0.5, ny=0.1, my=0.5.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

Figure 13: Equilibria for labor distribution at T=5.0, σ=3



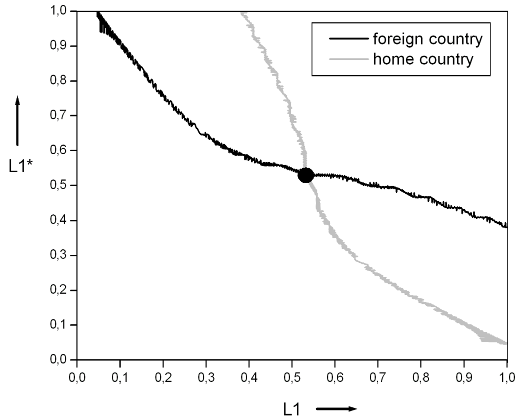
Source: Own graphic based on own simulations run with 1000 iterations, T=5.0, sigma=3, alpha=0.5, ny=0.1, my=0.5.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

4.7 The case of a lower share of inter-sectoral inputs for services

What if the services sector primarily receives intermediate inputs from its own sector than from the industrial sector? This is the case for several services like post and telecommunications or financial intermediation, for example. Modeling this situation, inter-sectoral inputs for services are set to zero. Only intra-sectoral inputs are thus important for the services sector, the input share is α. The assumption taken before that import of services is costless is being dropped here. The idea behind is that in this modeling framework services are more highly demanded as inputs due to the higher importance of intra-sectoral inputs for services and per se for industries' products such that the transport of services from another country might cause more costs compared to the case of modeling fewer intra-sectoral inputs for services. The price indices, expenditures and wages for services will alter, they are shown in the mathematical appendix part C.

The resulting equilibria will be shown with the following graphs.[123]

Figure 14: Equilibria for labor distribution at T=4.0, $\mu=\frac{2}{3}$

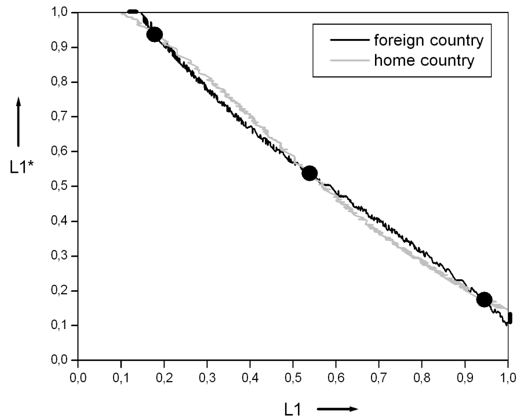


Source: Own graphic based on own simulations run with 1000 iterations, T=4.0, sigma=4, alpha=0.5, ny=0.1, my=0.66.
Note:The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2= services; countries: home and foreign.

From figure 14 one can see that in case of high transport costs industries and services will be distributed in each country following the consumers' preferences for industrial and services' products. There is no agglomeration existent.

[123]Note that figures 14 to 16 just give approximations because several outliers emerged during the simulations. They were discarded from drawing the curvatures. Increasing the number of iterations run should deliver smoother curves.

Figure 15: Equilibria for labor distribution at T=2.2, μ=$\frac{2}{3}$

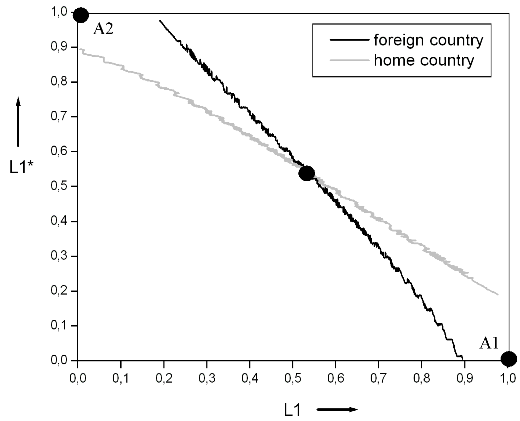


Source: Own graphic based on own simulations run with 1000 iterations, T=2.2, sigma=4, alpha=0.5, ny=0.1, my=0.66.
Note:The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2= services; countries: home and foreign.

Figure 15 shows that at middle-high transport costs 5 equilibria emerge. In case industries and services were relatively unequally distributed in the beginning, the industrial sector would not become fully agglomerated in either country. Either foreign has only industry and home country has mostly services and some industry (point in the upper left side) or home country has only industry, foreign has mostly services and some industry (point in the lower right side). So, the industrial sector is still dispersed compared to services. This might be explained by transport costs involved in making up services' wages here, in this modeling framework. If transport costs are quite high, then wages might be not high enough for the services sector as to make working in the services sector more attractive than working in the industrial sector. So, both countries would keep industrial goods' production. Only with decreasing transport costs, agglomeration tendencies will change (see the next figure), due to changing prices and wages. Figure 15 also shows that in case industries and services were relatively equally distributed in the beginning, the sectors would become relatively dispersed across countries, staying close to consumers' preferences.

In case of low transport costs–see figure 16–the same tendencies for agglomeration as in the Krugman/Venables (1996) model will occur. Basically, equilibria are possible where industries are exclusively agglomerated in foreign country and services in home (point A2) or industries are fully agglomerated in home and services in foreign country (point A1). A third equilibrium lies close to consumers' preferences in manufacturing goods.

Figure 16: Equilibria for labor distribution at T=1.5, $\mu = \frac{2}{3}$



Source: Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=4, alpha=0.5, ny=0.1, my=0.66.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2= services; countries: home and foreign.

Obviously, forward and backward linkages are at work which can be described in a manner known from Krugman's models. The greater importance of intra-sectoral inputs not only for the industrial sector, but here also for the services' sector makes it more advantageous for firms locating close to own sector's firms because they can thus receive cheaper intermediate goods. If in the beginning home specialized in industry and foreign in services, and home considered producing services, as well, then home would have to import services from foreign country. Transport costs involved in importing services in this model setting would increase the price index for services, thus production would become more expensive. Then real wages will decline and workers would not want to work in services in home country; the equilibrium of home country specializing in industry and foreign country in services would be preserved. So far, this was just the forward linkage. The backward linkage effect comprises that fewer workers want to move to the services sector in home country, expenditures shrink, thus fewer services firms would want to localize there.

As has been seen in the chapters before, with the modeling of fewer **intra-sectoral** inputs received for the services sector and imports of services being less dependent on transport costs a clear message on services sector's fewer agglomeration could be gained. Here, fewer **inter-sectoral** inputs used for producing services will generate the results known from New Economic Geography models where generally full agglomeration of a sector in one country, only, would be achieved. Transport costs would have to be quite low, then.

4.8 Conclusion

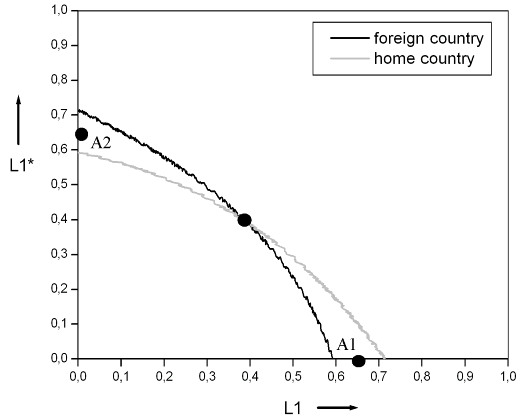
Taking account of services and certain characteristics (fewer intra-sectoral inputs, imported services less dependent on transport costs), this study shows that New Economic Geography modeling would point to agglomeration tendencies of both industrial and services sectors, however the modeling indicates that agglomeration of services would be less intensive. This is what can be shown by Empirics and is found in reality: services are less agglomerated. The mechanism behind is that with decreasing transport costs production costs for both sectors would decrease. However, the price index for the services sector will become smaller than for the industrial sector since no services inputs are assumed to be used for services production. Thus, assuming that in the beginning services were localized in foreign country and industries in home country, firms would want to produce more services in home country. Services sector's real wages would increase, workers would want to work in the services sector, too. More workers moving to a region would increase expenditures on services products, which is an incentive for services' firms to move close to workers, as well. Thus, both countries will have services' production, services are less agglomerated. In practise–as has been shown descriptively–this services sector might be the retail trade sector (selling activities to consumers) which does not use a lot of intermediate products of its own sector and per se transport costs should not play a big role for this service since retailing activities need to be in the proximity of the consumer, so less trade of retailing activities will be the case. And retail trade is not being agglomerated a lot. The same is true for sale and repair of motor vehicles, hotels' and restaurants' services and public administration.

This study could be enhanced by using a different approach of modeling product differentiation. The ideal variety approach would be an interesting alternative modeling procedure. In this approach consumers and firms would show a demand only for certain product variants, those they prefer to receive. Utility would not increase with the number of product variants but with the preferred product variant(s) met.

4.9 Appendix of Graphics

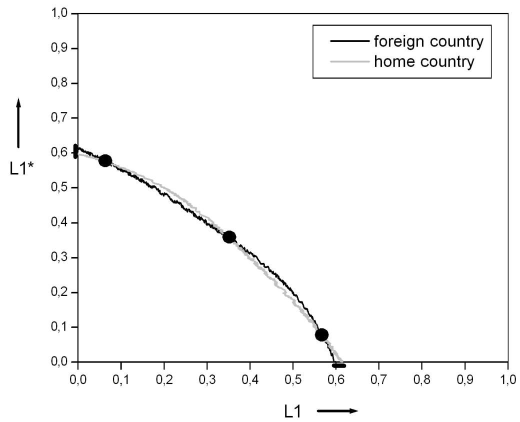
Graphics 17-19 display equilibria for the case of a consumption share for industrial goods of μ=$\frac{1}{2}$.

Figure 17: Equilibria for labor distribution at T=1.5, μ=$\frac{1}{2}$



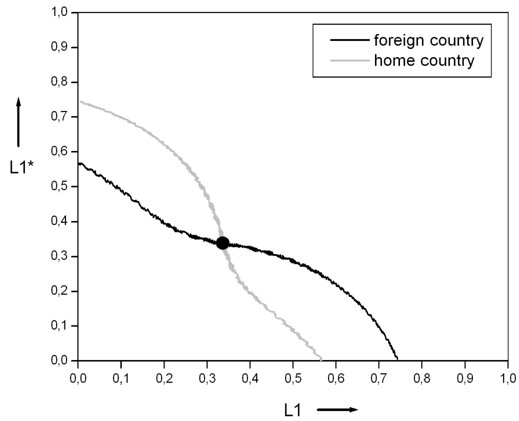
Source: Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=4, alpha=0.5, ny=0.1, my =0.5. Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

Figure 18: Equilibria for labor distribution at T=2.2, μ=$\frac{1}{2}$



Source: Own graphic based on own simulations run with 1000 iterations, T=2.2, sigma=4, alpha=0.5, ny=0.1, my=0.5. Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

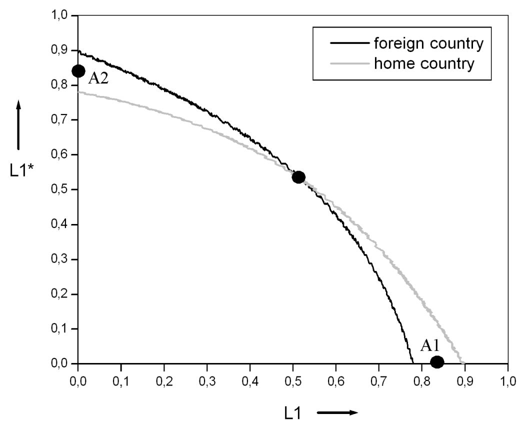
Figure 19: Equilibria for labor distribution at T=4.0, μ=$\frac{1}{2}$



Source: Own graphic based on own simulations run with 1000 iterations, T=4.0, sigma=4, alpha=0.5, ny=0.1, my=0.5.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

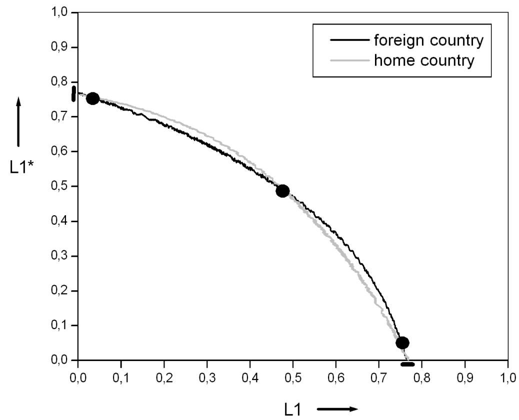
Graphics 20-22 display equilibria for the case of a consumption share for industrial goods of μ=$\frac{2}{3}$.

Figure 20: Equilibria for labor distribution at T=1.5, μ=$\frac{2}{3}$



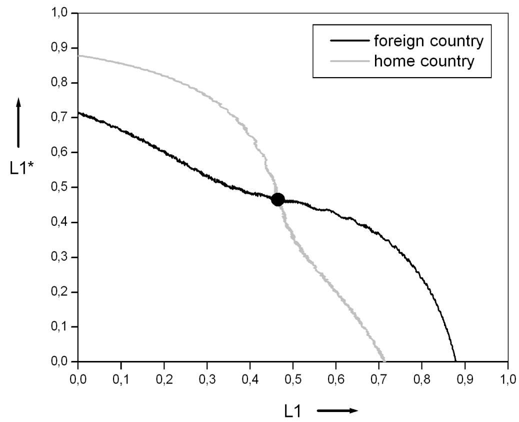
Source: Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=4, alpha=0.5, ny=0.1, my=0.66.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

Figure 21: Equilibria for labor distribution at T=2.2, $\mu=\frac{2}{3}$



Source: Own graphic based on own simulations run with 1000 iterations, T=2.2, sigma=4, alpha=0.5, ny=0.1, my=0.66.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

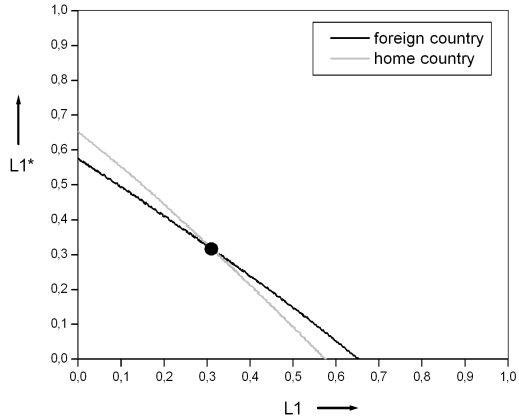
Figure 22: Equilibria for labor distribution at T=4.0, $\mu=\frac{2}{3}$



Source: Own graphic based on own simulations run with 1000 iterations, T=4.0, sigma=4, alpha=0.5, ny=0.1, my=0.66.
Note: The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

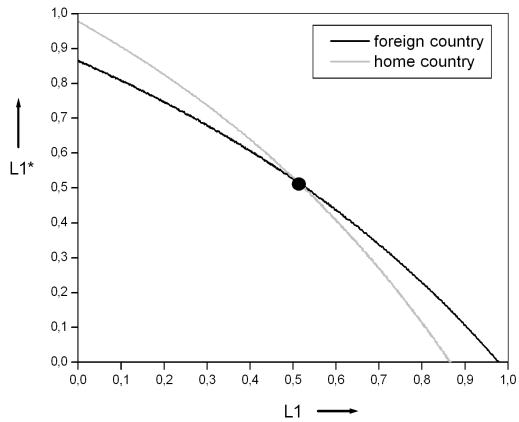
Graphics 23 and 24 display equilibria for the case of a lower range of difference between intra-sectoral and inter-sectoral linkages. Here, $\alpha = 0.3$ and $\nu = 0.2$ for the cases of consumption shares $\mu{=}\frac{1}{3}$ and $\mu{=}\frac{2}{3}$.

Figure 23: Equilibria for labor distribution at T=1.5, $\mu{=}\frac{1}{3}$, α=0.3, ν=0.2



Source:Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=4, alpha=0.3, ny=0.2, my=0.33.
Note:The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

Figure 24: Equilibria for labor distribution at T=1.5, $\mu{=}\frac{2}{3}$, α=0.3, ν=0.2



Source:Own graphic based on own simulations run with 1000 iterations, T=1.5, sigma=4, alpha=0.3, ny=0.2, my=0.66.
Note:The curves depict for a given employment (L) of one sector x in country d the employment of sector x in country c given that wages for both sectors of country c are equal; sector 1=industry, sector 2=services; countries: home and foreign.

4.10 Mathematical Appendix

A

Lagrange optimization:
Just look at two variants of goods. The optimization problem becomes:

$min\ p_1 m_1 + p_2 m_2$
s.t. $M = m_1^\rho + m_2^\rho$

The Lagrange function is:
$Ł = p_1 m_1 + p_2 m_2 + \lambda(M - m_1^\rho - m_2^\rho)$

First order conditions are:

1. $\frac{\delta Ł}{\delta m_1} = p_1 - \lambda \rho m_1^{\rho-1} =!0$
2. $\frac{\delta Ł}{\delta m_2} = p_2 - \lambda \rho m_2^{\rho-1} =!0$

$\Rightarrow \frac{p_1}{m_1^{\rho-1}} = \lambda\rho$ and $\frac{p_2}{m_2^{\rho-1}} = \lambda\rho$
$\Rightarrow \frac{p_1}{m_1^{\rho-1}} = \frac{p_2}{m_2^{\rho-1}}$
q.e.d.

B

The Amoroso-Robinson relation describes a relation between marginal revenue, the price and the price elasticity. It starts from the fact that in equilibrium marginal costs equal marginal revenue, so one can model the profit maximizing price of a firm:[124]

$\frac{\delta TC(i)}{\delta q(i)} = \frac{\delta R(i)}{\delta q(i)}$, with i=1,2 indicating the sector.

It is known from equations (39) and (40) that marginal costs are:
$C(i) * c$.
Marginal revenue is the derivation of $p(i) * q(i)$ by $q(i)$:
$p(i)$.

Now, having monopolistic competition it is assumed that a firm receives a mark-up on marginal revenue, that is $p(i) * \rho$.
Further, it is:

[124]See Perloff (2001), pp. 346.

$C(k) = w(k)^{\beta_k} * G(k)^{\alpha} * G(j)^{\nu}$, with k one sector and j the other sector.

Thus one can write:
$p(k) = w(k)^{\beta_k} * G(k)^{\alpha} * G(j)^{\nu} * c * \frac{\sigma}{\sigma-1}$ using from equation (28) that $\rho = \frac{\sigma-1}{\sigma}$. Since $0 < \rho < 1$, one can see that the price of a product variant (term on the left) is bigger than its marginal costs (term on the right side times $\frac{1}{\rho}$).

C

Assuming that intra-sectoral inputs but no inter-sectoral inputs exist for services, the price indices G_2, expenditures E_2 and nominal wages w_2 for both home and foreign country will be determined as follows:

$$G_{h2} = (L_{h2} * w_{h2}^{(1-\beta_2\sigma)} * G_{h2}^{-\alpha\sigma} + L_{f2} * w_{f2}^{(1-\beta_2\sigma)} * G_{f2}^{-\alpha\sigma} * T^{1-\sigma})^{\frac{1}{1-\sigma}} \tag{75}$$

$$G_{f2} = (L_{f2} * w_{f2}^{(1-\beta_2\sigma)} * G_{f2}^{-\alpha\sigma} + L_{h2} * w_{h2}^{(1-\beta_2\sigma)} * G_{h2}^{-\alpha\sigma} * T^{1-\sigma})^{\frac{1}{1-\sigma}}. \tag{76}$$

$$E_{h2} = (w_{h2} * L_{h2} + w_{h1} * L_{h1})(1-\mu) + \frac{\alpha * w_{h2} * L_{h2}}{\beta_2} \tag{77}$$

$$E_{f2} = (w_{f2} * L_{f2} + w_{f1} * L_{f1})(1-\mu) + \frac{\alpha * w_{f2} * L_{f2}}{\beta_2}. \tag{78}$$

$$w_{h2} = (\beta_2 * (G_{h2}^{\sigma-1} * E_{h2} + G_{f2}^{\sigma-1} * E_{f2} * T^{1-\sigma}))^{\frac{1}{\beta_2\sigma}} * G_{h2}^{\frac{-\alpha}{\beta_2}} \tag{79}$$

$$w_{f2} = (\beta_2 * (G_{f2}^{\sigma-1} * E_{f2} + G_{h2}^{\sigma-1} * E_{h2} * T^{1-\sigma}))^{\frac{1}{\beta_2\sigma}} * G_{f2}^{\frac{-\alpha}{\beta_2}}. \tag{80}$$

In contrast to the main modeling of this study assuming no intra-sectoral inputs to exist for services, here transport costs are involved in importing services, as can be seen from equations (75)-(76) and (79)-(80). Further explanations can be inferred from chapter 4.3

4.11 Technical Appendix

```
#include <oxstd.h>
#include <oxdraw.h>
#include <oxprob.h>
#import  <maximize>

main()
{

decl i;
decl l;

decl Lx=zeros(1000,1);
decl Lz=zeros(1000,1);
decl La=zeros(1000,1);

for (l=1; l<=1000; l++)
{
La[][0]=l/1000;

decl T=1.5;
decl s=4;
decl a=0.5;
decl m=2/3;
decl n=0.1;
decl b1=1-a-n;
decl b2=1-n;

decl wi1=zeros(1000,1);
decl wi2=zeros(1000,1);
decl wa1=zeros(1000,1);
decl wa2=zeros(1000,1);
wi1[0][0]=3;
wi2[0][0]=3;
wa1[0][0]=3;
wa2[0][0]=3;
decl gi1=zeros(1000,1);
decl gi2=zeros(1000,1);
decl ga1=zeros(1000,1);
decl ga2=zeros(1000,1);
gi1[0][0]=5;
gi2[0][0]=5;
ga1[0][0]=5;
ga2[0][0]=5;

decl gi1x=zeros(1000,1);
decl gi2x=zeros(1000,1);
decl ga1x=zeros(1000,1);
decl ga2x=zeros(1000,1);
```

```
decl wi1x=zeros(1000,1);
decl wi2x=zeros(1000,1);
decl wa1x=zeros(1000,1);
decl wa2x=zeros(1000,1);

decl Ei1=zeros(1000,1);
decl Ei2=zeros(1000,1);
decl Ea1=zeros(1000,1);
decl Ea2=zeros(1000,1);

decl wi1alt=zeros(1000,1);
decl wi2alt=zeros(1000,1);
decl wa1alt=zeros(1000,1);
decl wa2alt=zeros(1000,1);

decl L=zeros(1000,1);
decl w=zeros(1000,1);
decl Lx=zeros(1000,1);
decl Lix=zeros(1000,1);

decl Li=zeros(1000,1);

Li[0][0]=0.95;

for (i=1; i<1000; i++)
{

gi1x[i][0]=(Li[i-1][0]*(wi1[i-1][0]^(1-b1*s))*(gi1[i-1][0]^(-a*s))*(gi2[i-1][0]^(-n*s))+La[i-1][0]*(wa1[i-
1][0]^(1-b1*s))*(ga1[i-1][0]^(-a*s))*(ga2[i-1][0]^(-n*s))*(T^(1-s)))^(1/(1-s));
gi2x[i][0]=((1-Li[i-1][0])*wi2[i-1][0]^(1-b2*s)*gi1[i-1][0]^(-n*s)+(1-La[i-1][0])*wa2[i-1][0]^(1-
b2*s)*ga1[i-1][0]^(-n*s)*(T^(1-s)))^(1/(1-s));
ga1x[i][0]=(La[i-1][0]*(wa1[i-1][0]^(1-b1*s))*(ga1[i-1][0]^(-a*s))*(ga2[i-1][0]^(-n*s))+Li[i-1][0]*(wi1[i-
1][0]^(1-b1*s))*(gi1[i-1][0]^(-a*s))*(gi2[i-1][0]^(-n*s))*(T^(1-s)))^(1/(1-s));
ga2x[i][0]=((1-La[i-1][0])*wa2[i-1][0]^(1-b2*s)*ga1[i-1][0]^(-n*s)+(1-Li[i-1][0])*wi2[i-1][0]^(1-
b2*s)*gi1[i-1][0]^(-n*s)*(T^(1-s)))^(1/(1-s));

Ei1[i][0]=((wi1[i-1][0]*Li[i-1][0]+wi2[i-1][0]*(1-Li[i-1][0]))*m)+((a*wi1[i-1][0]*Li[i-1][0]+n*wi2[i-
1][0]*(1-Li[i-1][0]))/b1);
Ei2[i][0]=((wi2[i-1][0]*(1-Li[i-1][0])+wi1[i-1][0]*Li[i-1][0])*(1-m))+((n*wi1[i-1][0]*Li[i-1][0])/b2);
Ea1[i][0]=((wa1[i-1][0]*La[i-1][0]+wa2[i-1][0]*(1-La[i-1][0]))*m)+((a*wa1[i-1][0]*La[i-1][0]+n*wa2[i-
1][0]*(1-La[i-1][0]))/b1);
Ea2[i][0]=((wa2[i-1][0]*(1-La[i-1][0])+wa1[i-1][0]*La[i-1][0])*(1-m))+((n*wa1[i-1][0]*La[i-1][0])/b2);

wi1alt[i][0]=wi1[i-1][0];
wi2alt[i][0]=wi2[i-1][0];
wa1alt[i][0]=wa1[i-1][0];
wa2alt[i][0]=wa2[i-1][0];
```

```
wi1x[i][0]=((b1*((gi1[i-1][0]^(s-1))*Ei1[i][0] + (ga1[i-1][0]^(s-1))*Ea1[i][0]*(T^(1-
s))))^(1/(s*b1)))*(gi1[i-1][0]^(-a/b1))*(gi2[i-1][0]^(-n/b1));
wi2x[i][0]=((b2*((gi2[i-1][0]^(s-1))*Ei2[i][0] + (ga2[i-1][0]^(s-1))*Ea2[i][0]))^(1/(s*b2)))*(gi1[i-1][0]^(-
n/b2));
wa1x[i][0]=((b1*((ga1[i-1][0]^(s-1))*Ea1[i][0] + (gi1[i-1][0]^(s-1))*Ei1[i][0]*(T^(1-
s))))^(1/(s*b1)))*(ga1[i-1][0]^(-a/b1))*(ga2[i-1][0]^(-n/b1));
wa2x[i][0]=((b2*((ga2[i-1][0]^(s-1))*Ea2[i][0] + (gi2[i-1][0]^(s-1))*Ei2[i][0]))^(1/(s*b2)))*(ga1[i-1][0]^(-
n/b2));

wi1[i][0]=wi1x[i][0];
wi2[i][0]=wi2x[i][0];
wa1[i][0]=wa1x[i][0];
wa2[i][0]=wa2x[i][0];

gi1[i][0]=gi1x[i][0];
gi2[i][0]=gi2x[i][0];
ga1[i][0]=ga1x[i][0];
ga2[i][0]=ga2x[i][0];

if (fabs(wi1[i][0]-wi1alt[i][0])<0.001)
if (fabs(wi2[i][0]-wi2alt[i][0])<0.001)
break;

if (fabs(wi2[i][0]-wi1[i][0])<0.001)
break;

if ((wi1[i][0])>(wi2[i][0]))
Li[i][0]=Li[i-1][0]+0.001;
else
Li[i][0]=Li[i-1][0]-0.001;

if ((fabs(Li[i][0]-Li[i-1][0]))>0.002)
Lx[l-1][0]=10;
else
Lx[l-1][0]=Li[i][0];
}

Lz[l-1][0]=Lx[l-1][0];
}

println("");
println(Lz[][0]); println("");
}
```

5 A Panel Co-integration Analysis of Industrial and Services Sectors' Agglomeration in the European Union

Summary

This study empirically investigates the development of industrial and services sectors' agglomeration patterns in the European Union. New dynamic panel data estimation techniques will be employed in order to cope with non-stationarity of variables. The driving forces of agglomeration are derived from Traditional Trade Theory, New Trade Theory and the New Economic Geography. Static panel data analysis reveals that New Trade Theory's and New Economic Geography's assumptions can explain industrial concentration in the EU best. However, scale economies are only important for across industries' variation in agglomeration, not within. For services sectors' agglomeration results show that intermediate goods intensity matters only for within and not across industries' variation in agglomeration, but this result appears to be not very robust. Some evidence for intra-sectoral trade explaining equalizing economic structures for services sectors is given. Employing dynamic panel OLS it can be shown that intermediate goods' intensity and therewith New Economic Geography's arguments are able to explain industrial and services sectors' agglomeration in the EU.

5.1 Introduction

Research on New Economic Geography has been quite extensive over the last 20 years. The workhorse model of New Economic Geography by Krugman (1991 b) dealt with the endogeneity inherent in the process of agglomeration. Manufacturing firms would want to locate closer to a larger demand, in order to realize scale economies and save transport costs. Demand in turn would localize close to manufacturing firms because then consumers (producers) can buy cheaper goods (inputs).

Krugman's model has been enhanced by several scholars. Forslid and Ottaviano (2003), for example, considered skill heterogeneity of workers. They can show that agglomeration increases in the region where more highly skilled workers are available. This is due to highly skilled workers possessing higher purchasing power, which forms an incentive for firms to localize in this region, too. Firms will make profits and are able to pay higher wages for workers, which in turn makes workers move to this region. A circular process arises. Martin and Ottaviano (2001) investigated the relationship between growth and agglomeration incorporating innovation processes into their model. Agglomeration fosters growth since in a region where many firms are located in, innovation becomes cheaper –making use of knowledge spillovers, for example– and increasing innovations will lead to a higher level of growth. On the other hand the sector having benefited from innovations will expand, other firms will move close because of increasing returns, thus leading to agglomeration.

The empirical literature so far tried to disentangle reasons for agglomeration, which might lie in Marshallian type causes, that is labor availability, knowledge spillovers and input-output linkages between firms (see Ellison, Glaeser and Kerr (2010) for example). Further, the influences of scale economies, factor intensity or intermediate goods intensity for agglomeration have been investigated (see Amiti (1998, 1999), Brülhart (2001), Midelfart-Knarvik et al. (2000), for example). Another piece of research wanted to directly verify the importance of New Economic Geography (Davis and Weinstein (1999, 2003)). Davis and Weinstein could prove the existence of what Paul Krugman (1980) termed the home market effect: countries will specialize in that good that has a high domestic demand and will export that good. The high level of demand will make firms clustering together in order to benefit from increasing returns to scale and lower transport costs. As Redding (2010) and Brakman, Garretsen (2009) point out, however, more work needs to be done in Empirics, like discriminating between different agglomeration forces or using micro data for evaluating the agglomeration effects explained by Krugman.

In my investigation I will follow this call, though not making use of micro data. I will take a look on industrial and services sectors' agglomeration in the European Union making use of a panel data set from the EU KLEMS data base applying adequate panel data estimation methods. Non-stationarity issues will be addressed, panel unit roots and co-integration tests will be conducted and dynamic OLS regression for co-integrating variables will be applied. To the best of my knowledge, non-stationarity properties of regression variables have not been considered adequately in Empirics on New Economic Geography so far. They are, however, essential in order to gain valid estimation results.

So, the main contribution of this paper is to address econometric issues not having been given much attention to in the New Economic Geography literature so far: non-stationarity issues calling for dynamic panel data analysis.

5.2 Literature Review

Taking a look at studies on industrial and services' agglomeration one can find that there is fewer work being done on services. The reasons for this might be lower data quality and availability for services as well as problems related to defining services. Services are known to be mostly non-tradable since they have to be produced and consumed in one place and cannot be stored (see Copeland and Mattoo (2008)).

Summarizing work on industrial agglomeration for the EU, most studies found that agglomeration increased over time. Brülhart and Torstensson (1998) show that specialization in the EU increased beginning with the 1980s. They find that increasing returns to scale industries tend to localize, and industries localizing do so primarily in central EU countries. Brülhart (2001) finds evidence for an increasing level of industrial agglomeration in the EU from 1972 to 1996. Especially labor intensive industries show the highest increase in agglomeration. Amiti (1998, 1999) found that scale economies and intermediate goods intensity (representing the importance of New Trade Theory's and New Economic Geography's arguments in explaining agglomeration) significantly influenced agglomeration in the EU from 1968-1990.

Taking a look at services sectors' agglomeration, Jennequin (2008) found that services sectors got concentrated in the EU although concentration is only moderate from 1986 onwards. He can show that business and financial services are the most agglomerated sectors. Midelfart-Knarvik et al. (2000) investigated services' concentration in the EU considering only five services sectors. They find that services sectors are highly agglomerated compared to industrial sectors. Financial services, insurance, business, communication and real estate activities are the sectors that are the most concentrated over time and also those that deagglomerated most between 1982 and 1995. Transport services are the most dispersed services over time; in turn this sector shows the highest increase in agglomeration over time. The authors see changes in demand as a reason for the increasing developments. Both demand for final consumption and for intermediate goods would have risen.

Three other studies are worthwhile noting, which give information on the variation in agglomeration explained, or have only very recently been published and therewith point to the relevance of investigating agglomeration issues.
Kim (1995) runs a regression for explaining localization of industries in the US by plant size (addressing scale economies) and resource intensity (addressing Traditional Trade Theory's arguments). He uses twenty industries and 5 time periods (1880, 1914, 1947, 1967 and 1987) in his sample. Kim can show that plant size explains within industry variation in agglomeration and raw material intensity is able to explain across industry variation in agglomeration.
Some very recent research focuses on co-localization of industries, clarifying the issue which industries locate next to each other. In their rigorous study Ellison, Glaeser, Kerr (2010) investigate co-agglomeration patterns and its causes for US manufacturing industries. The authors want to test for the relative importance of natural advantages and Marshallian externalities for industrial agglomeration with a cross-section analysis for 1987. They find that input-output-linkages are most important among the Marshallian externalities. However, shared natural advantages were overall most important within their regressions. The authors point to the need of investigating Marshallian externalities for services and assume that input-output-linkages should be important in that sector.
Another study deals with non-stationarity issues within an agglomeration context. Zheng (2010) employs co-integration analysis investigating dynamic externalities for Tokyo. Therefore, he makes use of time series data. Zheng found out for the Tokyo metropolitan area that knowledge spillovers among firms in one industry explain total factor productivity growth in manufacturing, finance, trade and overall industry. Further, he defines network dynamic externalities which are knowledge spillovers that result from the agglomerated area via transportation networks.[125] There exist co-integration relationships between network dynamic externalities and total factor productivity in manufacturing, finance, wholesale and retail trade and overall industries. Knowledge spillovers resulting from the diversity of industries are important for total factor productivity in the services sector, only.

5.3 Methodology

In the following, procedures for panel unit root and co-integration tests will be briefly discussed. In the end it should be possible to figure out the most appropriate test for investigation of either industrial or services agglomeration. Issues of size and power of tests will be addressed. Furthermore, dynamic panel OLS and fully modified OLS will be briefly explained.

[125] See Zheng (2010), p. 130.

5.3.1 Panel Unit Root tests

The analysis of non-stationarity in panel data required the development of new unit root tests coping with both the time series and cross-section dimension of the data. Testing for non-stationarity and co-integration benefits from adding the cross-section dimension to time series because the data base thus increases and the power of testing and estimation will be enhanced. [126] The tests from Levin, Lin, Chu (2002), Im, Pesaran, Shin (2003), Choi (2001), Maddala, Wu (1999) and Breitung (2000) will be explained in the following.

The different models start with considering a stationary autoregressive process of first order, that is:

$$y_{it} = \rho_i y_{it-1} + u_{it} \tag{81}$$

where $-1 < \rho_i < 1$ is the autoregressive parameter, y is the variable of interest, i is the number of cross sections, t is the number of time points and u_{it} is the error term. Now, a unit root exists when $|\rho_i| = 1$. For the following tests, however, only positive autocorrelation will be tested for, that is $\rho_i = 1$ (where $0 < \rho_i \leq 1$).

Levin, Lin and Chu (2002) (LLC) test the hypothesis that each individual time series contains a unit root against the alternative that each time series is stationary. The authors start with the model:

$$y_{it} = \rho_i y_{it-1} + z'_{it}\gamma_i + u_{it} \tag{82}$$

where z_{it} is a deterministic component and could be zero, one, the fixed effects or fixed effects plus time trend and γ_i is a vector of coefficients. Further, it is assumed that the u_{it} are iid$(0, \sigma_u^2)$ that is independent and identically distributed with mean 0 and variance σ_u^2 and $\rho_i = \rho$ for all i. Equation (82) can also be written as:

$$\Delta y_{it} = \delta y_{it-1} + z'_{it}\gamma_i + u_{it} \tag{83}$$

with $\Delta y_{it} = y_{it} - y_{it-1}$ that is taking $-y_{it-1}$ on both sides of the equation having $\delta = \rho - 1$. The hypotheses which are being tested for are:

$H_0 : \delta = 0$ versus $H_{alternative} : \delta < 0$.

[126] A comprehensive review on panel unit root tests can be found in Baltagi and Kao (2000) or Baltagi (2009).

This would mean $\rho = 1$ under the null.
The authors employ a three-step procedure to get their test-statistic: first, estimating separate ADF-regressions (therefore including lags of Δy into the regression) for each individual, getting orthogonalized residuals and standardizing these residuals, second, estimating the ratio of long-run to short-run standard deviations for each individual, and third, computing the panel test statistics. The adjusted test statistic is given by:[127]

$$t^\star_\delta = \frac{t_\delta - N\widetilde{T}\widehat{S}_N \widehat{\sigma}_{\widetilde{\varepsilon}}^{-2} STD(\widehat{\delta})\mu^\star_{m\widetilde{T}}}{\sigma^\star_{m\widetilde{T}}} \tag{84}$$

where $\sigma^\star_{m\widetilde{T}}$ and $\mu^\star_{m\widetilde{T}}$ are the standard deviation and mean adjustment, N is the number of cross sections, $\widetilde{T}$ is the average number of observations per individual in the panel, $\widehat{S}_N$ is the estimator of the average of the ratio of long-run to short-run standard deviation[128], $\widehat{\sigma}^2_{\widetilde{\varepsilon}}$ is the estimated variance of the error term, $STD(\widehat{\delta})$ is the standard error of $\widehat{\delta}$ and t_δ is the conventional t-statistic for testing $\delta = 0$. $t^\star_\delta$ is asymptotically normally distributed, N(0,1). The authors can show via Monte Carlo simulations that generally the power of their test is higher than the power of a standard DF-test (for N=1 and T varying) if a panel with moderate sizes is being taken for analysis (that is N between 10 and 250 and T between 25 and 250).[129] Size distortions get lower with increasing N in case of including individual specific effects and time trends or none of these two elements to the regression framework. Power is lower for smaller T when including both individual specific effects and time trends into the model compared to just including individual effects or considering none of these two deterministic elements. However, this should not lead one to just consider running tests of the hypothesis without any deterministic elements because the unit root test will be inconsistent if such an element does exist in real data but is not taken account of in the estimation.[130] The LLC test is criticized for being valid only in case there is no cross sectional correlation present and for the formulation of hypotheses referring to identical individuals.[131] Drawing a conclusion, for my study making use of a rather small panel of N=20 and T=11 in case of industrial agglomeration and N=13 and T=36 in case of services sectors' agglomeration, the LLC test appears to be not too powerful. At least power increases applying the test in case of services' agglomeration.

[127] See Levin, Lin, Chu (2002), p. 8.
[128] To derive this estimate, kernel-based techniques are used. They are necessary for removing time trends. In fact, a truncation lag parameter has to be determined, however, it is data dependent, that is where kernel methods come into use.
[129] See Levin, Lin, Chu (2002), pp. 15-17.
[130] See Levin, Lin, Chu (2002), p. 5.
[131] See Levin, Lin, Chu (2002), p. 18.

Im, Pesaran and Shin (2003) (IPS) use a test based on averaging individual unit root test statistics. The authors use ADF-tests like the one in equation (83) including additional lags of Δy. They test the hypothesis that each series in the panel contains a unit root against the alternative that some (so not necessarily all) of the individual series have unit roots whereas others have not , so a less restrictive testing than the LLC test did:

$H_0 : \delta_i = 0$ for all i versus $H_{alternative} : \delta_i < 0$ for at least one i.

A standardized test statistic is:[132]

$$t_{IPS} = \frac{\sqrt{N}(\bar{t} - N^{-1}\sum_{i=1}^{N} E(t_{T_i}))}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(t_{T_i})}} \tag{85}$$

which converges to N(0,1) as T and N $\rightarrow \infty$. $E(t_{T_i})$ and $Var(t_{T_i})$ are the mean and the variance of t with T varying across groups i and $\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{T_i}$ is the mean of individual test statistics. Running Monte Carlo simulations, Im, Pesaran, Shin can show that when there is no serial correlation then their test has higher power and smaller size distortions compared to the LLC test even for small T. However, when errors are serially correlated then T and N need to be sufficiently large, furthermore, the order of ADF-regressions becomes important. The power of the IPS test increases the higher is the order of ADF-regressions.[133] So, for my study the IPS test seems to be more appropriate than the LLC test because of gains in power. However, as Im, Pesaran, Shin point out, one has to be careful with the interpretation of test results. A rejection of the null hypothesis does not mean that the null of unit roots is rejected for all individuals but for just some of them.[134]

Breitung (2000) generally follows the LLC test procedure.[135] However, he uses a different transformation for Δy and y, adjusting for time trends in computing orthogonalized residuals.[136] Therefore, no kernel methods are needed. His test is asymptotically normally distributed. Monte Carlo simulations display that his test attains a much higher power than LLC or IPS tests.[137]

Choi and Maddala/Wu propose a Fisher test combining p-values from unit root

[132] See Im, Pesaran, Shin (2003), p. 59.
[133] See Im, Pesaran, Shin (2003), p. 67-72.
[134] See Im, Pesaran, Shin (2003), p. 73.
[135] Formal notations follow LLC, except for the differences briefly talked about here.
[136] See Breitung (2000), p. 171.
[137] See Breitung (2000), pp. 173-174.

tests for each cross section i. Formally this is:[138]

$$P = -2\Sigma_{i=1}^{N} ln p_i. \tag{86}$$

p_i is the p-value from any individual unit root test for i and P is distributed as χ^2 with 2N degrees of freedom as $T_i \to \infty$ for all N. The hypotheses are:

$H_0 : \rho_i = 1$ for all i versus $H_{alternative} : \rho_i < 1$ for at least one i.

Out of Choi's (2001) proposed tests, the Z-test appears to be the one that has highest power in relation to size, also outperforming the IPS test.[139] However, Choi's test considerably gains in power only as N increases. Formally the Z-test is:[140]

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i). \tag{87}$$

$Z \Rightarrow N(0,1)$ as $T_i \to \infty$ and $N \to \infty$. $\Phi(\cdot)$ denotes the standard normal cumulative distribution function. For my study, including intercept and trend, and N being quite small, the quality of Choi's test can be seen comparable to the quality of IPS' test.

Maddala and Wu (1999) find that for high values of T and N (50-100) the Fisher-test dominates the IPS test as size distortions are smaller at comparable power.[141] For small T and N, however, IPS and LLC seem to be preferable over Fisher-tests.

When I test for unit roots in the following, p-values for the Fisher-test will be gained by using ADF- and Phillips-Perron individual unit root tests.

Summarizing, for the setup of my study keeping track of the sizes of panels, the Breitung test appears to be the best test having a high power, followed by IPS.

5.3.2 Panel Co-integration tests

The Kao (1999) and Pedroni (2004) tests will be briefly explained in the following.[142] These tests are based on the Engle-Granger (1987) test. There, I(1)-variables are regressed on each other, then the resulting residual is being checked for stationarity. The residual being I(0) will indicate co-integration.

[138] See Choi (2001), p. 253.
[139] See Choi (2001), pp. 257-268.
[140] See Choi (2001), p. 253.
[141] See Maddala and Wu (1999), pp. 638-644.
[142] See also Baltagi and Kao (2000) or Baltagi (2009) for a summary on these tests' procedures.

Kao developed four DF- and one ADF-test testing the null hypothesis of no co-integration. He starts with the regression:

$$w_{it} = \alpha_i + \beta x_{it} + e_{it} \tag{88}$$

where w is the dependent, x the independent variable, α is the intercept, and e the error term and w and x are assumed to be integrated of order 1, that is I(1). The estimated residuals, needed for the ADF-test statistic are:[143] [144]

$$\hat{e}_{it} = \rho \hat{e}_{it-1} + \sum_{j=1}^{p} \varphi_j \Delta \hat{e}_{it-j} + \nu_{it}. \tag{89}$$

ν_{it} is the disturbance term, and 1 to p lags of the first difference of estimated residuals $\sum_{j=1}^{p} \varphi_j \Delta \hat{e}_{it-j}$ are included in the regression. The null of no co-integration is $H_0 : \rho = 1$. The ADF-test is formally given as:[145]

$$t_{ADF} = \frac{t_\rho + \frac{\sqrt{6N}\hat{\sigma}_\nu}{2\hat{\sigma}_{0\nu}}}{\sqrt{\frac{\hat{\sigma}^2_{0\nu}}{2\hat{\sigma}^2_\nu} + \frac{3\hat{\sigma}^2_\nu}{10\hat{\sigma}^2_{0\nu}}}} \tag{90}$$

where $t_\rho = \frac{(\hat{\rho}-1)\sqrt{\sum_{i=1}^{N}(e_i' Q_i e_i)}}{s_\nu}$, $Q_i = I - X_{ip}(X_{ip}' X_{ip})^{-1} X_{ip}'$, X_{ip} is the matrix of observations on the p regressors $\Delta \hat{e}_{it-j}$, $\hat{\sigma}^2_\nu$ is the estimated variance, $\hat{\sigma}^2_{0\nu}$ is the estimated long-run variance employing a kernel estimator and $s^2_\nu = \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\nu}^2_{it}$. The asymptotic distribution of ADF converges to a standard normal distribution N(0,1). Kao finds out that for small T (T=10) and N=15 or 20 all of the tests have quite low power (ranging from 0.017 to 0.375).[146] In case of an increasing σ he finds that the ADF-test outperforms all his other tests. For my case, based on the sample sizes comparing results of Kao's Monte Carlo simulations, the ADF-test seems to be most adequate and in case of an increasing variance it would be the best choice, as has been stated before.

Pedroni proposed eleven tests, allowing for heterogeneous coefficients for explanatory variables across cross-sections (in contrast to Kao, where coefficients do not differ across individuals).[147] He tests the null of no co-integration using residuals from a regression of I(1) variables like it is done by Kao (see equation (89) for example). He separates his work in two classes of test statistics.[148] First, pooling residuals across

[143] See Kao (1999), pp. 9.
[144] DF-tests are not mentioned here for reasons of lucidity.
[145] See Kao (1999), p. 10.
[146] See Kao (1999), pp. 15-22.
[147] I will not present the formal notation here for reasons of lucidity.
[148] See Pedroni (2004), pp. 603-604.

the within dimension of the panel, the panel statistics, second, pooling across the between dimension, the group statistics. The standardized statistic is asymptotically normally distributed. Running Monte Carlo simulations Pedroni shows that for low N and low T (N=20 and T starting with 20) the group-rho, panel-v and panel-rho tests have quite lower power than the panel-t and group-t tests. Power increases when T gets larger. With higher N the panel-v and panel-rho tests have the highest power.[149] Considering the sizes of tests is also important. In that context, Pedroni explains that when the group-rho statistic rejects the null hypothesis, one could be confident about then having found a co-integration relationship, since the group-rho statistic is the most conservative test in terms of empirical size.[150]

5.3.3 Estimation in Panel Co-integrating Frameworks

Estimating long-run relationships of co-integrating variables the literature proposes using for example Fully Modified OLS (FMOLS) or Dynamic OLS (DOLS).[151]

Stock and Watson (1993) demonstrate via Monte-Carlo simulations that the DOLS estimator is preferable over other estimators. The authors explain that for obtaining the DOLS-estimator one has to regress the dependent variable onto the explanatory variables, leads and lags of their first differences and a constant using either OLS or GLS [152]. This procedure would be valid only for I(1)-variables with a single co-integrating vector. Adding several lags and leads into the regression framework reduces the bias of the DOLS estimator.[153] Formally the DOLS-estimator can be obtained by running the regression:[154]

$$w_{it} = \alpha_i + x_{it}^{'}\beta + \Sigma_{j=-q}^{q} c_{ij}\Delta x_{it+j} + \dot{\nu}_{it} \tag{91}$$

where $\Sigma_{j=-q}^{q} c_{ij}\Delta x_{it+j}$ comprises the leads and lags of the first difference of x, and $\dot{\nu}_{it}$ is the disturbance term. $\hat{\beta}_{DOLS}$ has the same limiting distribution as the FMOLS estimator.

The FMOLS estimator is given by[155]:

$$\hat{\beta}_{FMOLS} = [\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_i)(x_{it}-\bar{x}_i)^{'}]^{-1} \times [\sum_{i=1}^{N}(\sum_{t=1}^{T}(x_{it}-\bar{x}_i)\hat{w}_{it}^{+} - T\hat{\Delta}_{\varepsilon u}^{+})] \tag{92}$$

[149] See Pedroni (2004), pp. 613-615.
[150] See Pedroni (2004), pp. 614-615.
[151] See also Baltagi and Kao (2000).
[152] See Stock and Watson (1993), p. 784.
[153] See Kao, Chiang (2000), p. 216.
[154] See Kao, Chiang (2000), p. 188
[155] See Kao, Chiang (2000), pp. 186-187.

where $\hat{w}_{it}^{+}$ is a transformation of w_{it} in order to correct for endogeneity underlying in OLS, $\overline{x_i}$ is the mean over time of x_{it} and $\hat{\Delta}_{\varepsilon u}^{+}$ is the correction term for serial correlation. If assumptions of the model hold then $\sqrt{N}T(\hat{\beta}_{FMOLS} - \beta) \Rightarrow N(0, 6\Omega_{\epsilon}^{-1}\Omega_{u,\epsilon})$, with Ω as the covariance matrix.
Kao and Chiang (2000) demonstrate via Monte Carlo simulations that the DOLS estimator is superior to FMOLS and OLS in both homogenous and heterogenous panels.

Summarizing, in the following, estimation via dynamic OLS will be taken into account for long-run relationships because it is superior to FMOLS.

5.4 Empirical Analysis

The empirical analysis is based on data taken from the EU KLEMS database (2008). EU KLEMS is a data collection project funded by the European Commission and is conducted by the OECD, several research institutes and universities in the EU. The sample period taken covers the years 1970-2005 for 14 European countries, 20 industries and 22 services sectors.[156] Data on explanatory variables for Italy (that is labor compensation, capital compensation, intermediate inputs, value added, gross output as volume and as value) were missing in the EU KLEMS database. Therefore I decided to take data for explanatory variables for Italy from the OECD STAN database. Further, values given in national currency for Denmark, Sweden and the UK were converted to values in euros, using the respective exchange rates on January 4th 1999.[157] Next, all values for explanatory variables for all countries were deflated using the price index for gross output (1995=100).

The empirical analysis consists of the following steps. First, measurement of industrial and services sectors' agglomeration and further explanatory variables will be addressed. Second, industrial and services sectors' agglomeration shall be explained employing both static and dynamic panel data analysis. A sensitivity analysis will be given in the final subchapter.

5.4.1 Measurement and tendencies of agglomeration

Measurements for agglomeration differ over the literature. Some authors employ absolute measures of agglomeration (like Aiginger and Leitner (2002) or Aiginger and Pfaffermayr (2004)), others use relative ones (see for example Amiti (1998, 1999) or Kim (1995)). Relative measures of agglomeration have the advantage that they

[156]Countries included in the sample, as well as industrial and services sectors are listed in the appendix.
[157]See ECB, exchange rate statistics.

allow for a comparison of an industry's importance (in terms of employment, value added, exports etc.) in a given country to the importance of a country in relation to the whole EU. Hoover (1936) was the first to employ the Gini coefficient, a relative measure, for analyzing concentration of US manufacturing. Krugman (1991 a) made use of this measure using relative employment shares. The same procedure will be undertaken here. Therefore, data on employment (*numbers of persons engaged*) was extracted from the EU KLEMS database. For getting a Gini coefficient, first the Balassa index needs to be computed as

$$B_{ij} = \frac{\frac{e_{ij}}{e_i}}{\frac{e_j}{E}}. \tag{93}$$

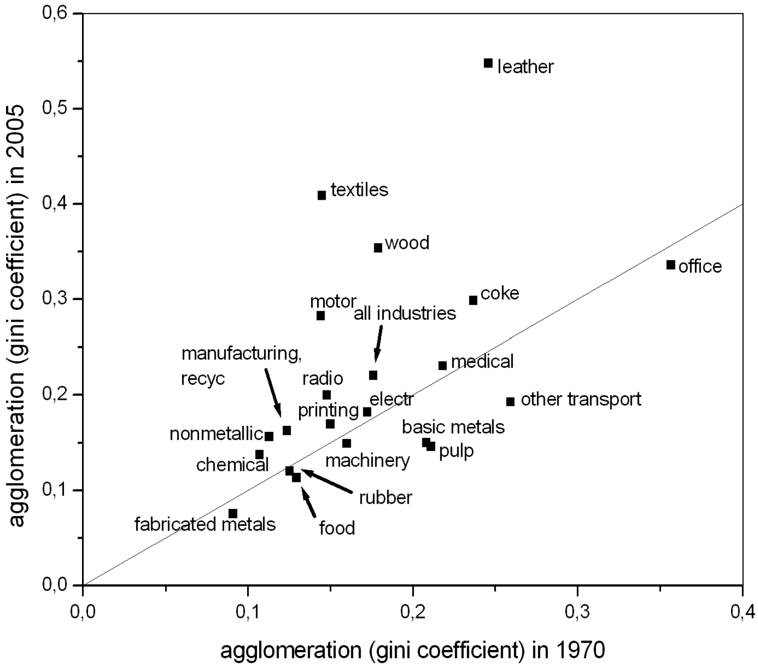
e_{ij} denotes an industry i's employment in a country j, e_j denotes total manufacturing employment in country j, e_i denotes total industry i's employment in the EU and E denotes total manufacturing employment in the European Union. Substituting the index s for the index i, yields the same procedure for services. Ranking the Balassa index in descending order, constructing a Lorenz-curve by plotting the cumulative of the numerator on the vertical axis and the cumulative of the denominator on the horizontal axis (cumulating over countries for calculation of $gini_{it}$ –that is the Gini for industrial agglomeration– or of $gini_{st}$ –that is the Gini for services' agglomeration), then taking twice the area within a 45 degree line and the Lorenz-curve yields the Gini coefficient.[158]

Theses indices were calculated for both industries and services sectors.[159] The main results and tendencies for agglomeration shall be summarized in the following.

[158]See Amiti (1998, 1999).

[159]See chapter 2 and 3 in this dissertation.

Figure 25: Industrial agglomeration

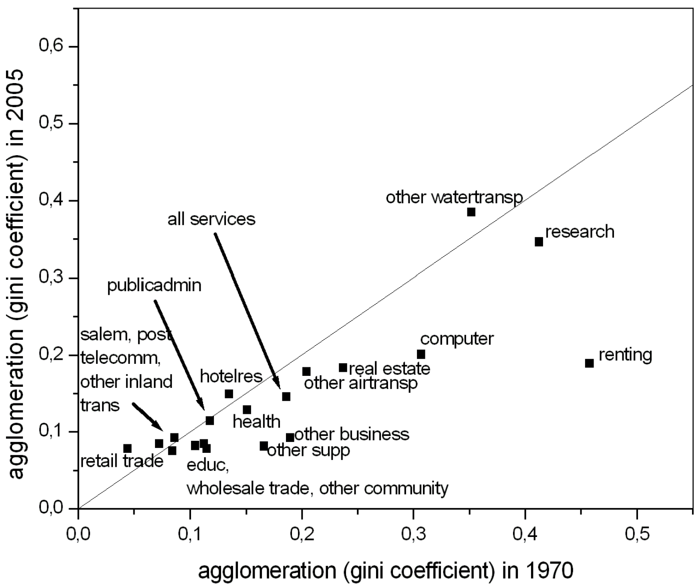


Source: Own graphic based on own calculations using EU KLEMS data (2008) and OECD STAN data. Note: The following abbreviations for industries are taken: food= food, beverages, tobacco; textiles=textiles, textile products; leather=leather, footwear; wood=wood, wood products; pulp=pulp, paper, paper products; printing=printing, publishing; basic metals=basic metals; fabricated metals=fabricated metals; nonmetallic=non-metallic mineral products; coke=coke, refined petroleum, nuclear fuel; rubber=rubber, plastics, plastics products; machinery=machinery equipment; motor=motor vehicles, trailers, semitrailers; other transport=other transport equipment; manufacturing, recyc=manufacturing nec. recycling; chemical=chemical industry; office=office, accounting, computing machines; electr=electrical machinery apparatus; radio=radio, tv, communication equipment; medical=medical, precision, optical instruments.

Figure 25 shows that among the most agglomerated industries in 2005 were the leather and footwear industry, textiles and textile products and wood and wood products. These are also the industries which experienced the highest increase in agglomeration from 1970 to 2005. Motor vehicles, trailers and semitrailers also experienced an enormous increase in agglomeration. Leather and textiles belong to the labor intensive industries as classified by the OECD. The Balassa-Index for these industries is especially high for countries like Greece, Italy, Portugal or Spain.[160] One could argue now that labor intensive industries got agglomerated in these countries because of lower labor costs, supporting Heckscher-Ohlin theory's arguments. Results, however, indicated that New Economic Geography's assumptions explain industrial agglomeration in the EU best. Also, for labor intensive industries intermediate goods' intensity and therewith New Economic Geography's assumptions were best in explaining agglomeration trends.

[160]See chapter 2 of this dissertation.

Figure 26: Services sectors' agglomeration



Source: Own graphic based on own calculations using EU KLEMS data (2008).
Note: The following abbreviations for services sectors are taken: salem=sale, maintenance and repair of motor vehicles and motorcycles, retail sale of fuel; wholesale trade=wholesale trade and commission trade, except of motor vehicles and motorcycles; retail trade=retail trade, except of motor vehicles and motorcycles; repair of household goods; hotelres=hotels and restaurants; other inland trans=other inland transport; other watertransp=other water transport; other airtransp=other air transport; other supp=other supporting and auxiliary transport activities, activities of travel agencies; post, telecomm=post and telecommunications; real estate=real estate activities; renting=renting of machinery and equipment; computer=computer and related activities; research=research and development; other business=other business activities; publicadmin=public admin and defense, compulsory social security; educ=education; health=health and social work; other community=other community, social and personal services.

Taking a look on services' agglomeration it can be seen that water transport is highly agglomerated both in 2005 and 1970, which is not a big surprise since these services need to be located next to the river or sea and depend on actively used waterways. Research and development activities are also highly agglomerated pointing to the need of high-skilled labor, other industries' or services' products or other supportive materials. Among the most dispersed services are other inland transport both in 2005 and 1970 and in particular retail trade. Retail trade, however, experienced a rather large increase in agglomeration of about 76 percent over the time period 1970-2005.[161] One could have argued before that the dispersion of retail trade was in favor of consumers' needs, but there is a tendency for clustering over time evident. Financial intermediation is still quite dispersed in 2005 although it records a 46 percent increase in agglomeration over time.[162] It can be expected that financial services will become more and more clustered, particularly in the highly active business districts.

[161]See chapter 3 of this dissertation.
[162]This is not shown in the graph, since data are only available from 1995 onwards; see chapter 3 of this dissertation instead.

5.4.2 Trade theories, New Economic Geography and explanatory factors

The aim of this study is to find out if agglomeration can be explained by several trade theories' and the New Economics Geography's assumptions. Adequate measures for representing Heckscher-Ohlin theory, New Trade Theory and the New Economic Geography have to be developed. Authors like Amiti (1998, 1999), Brülhart (2001) or Midelfart-Knarvik (2000) offer a guide in doing so. Deriving explanatory factors in the following resembles the procedure of earlier work of mine (see chapters 2 and 3 of this dissertation).
Only the notation for industries will be shown, for services one has to substitute the index s for i.

For addressing Heckscher-Ohlin theory I will employ the following measure as is done in Amiti (1998, 1999):

$$fact_{it} = |\frac{w_{it}L_{it}}{VA_{it}} - \frac{\overline{w_t L_t}}{\overline{VA_t}}|. \tag{94}$$

$w_{it}L_{it}$ denotes labor compensation of employees in industry i at time t and VA_{it} is gross value added at current basic prices at time t in industry i. A higher value of *fact* should lead to a higher level of agglomeration because then either an industry's labor or capital intensity is quite high which according to Heckscher-Ohlin theory will lead to countries getting specialized in products that need the factor relatively intensively that the country is well endowed with.

New Trade Theory shall be modeled as follows:

$$scale_{it} = \frac{\frac{w_{it}L_{it}+Cap_{it}+Int_{it}}{Q_{it}}}{Q_{it}}. \tag{95}$$

$w_{it}L_{it}$ again denotes labor compensation at time t for industry i, Cap is capital compensation, Int is intermediate inputs at current purchasers' prices and Q is gross output as a volume index (1995=100). This measure shall represent scale economies over time. As *scale* increases, the lower will be scale economies, because then an industry would have to bear higher unit costs per given output. The higher are scale economies, the higher should be agglomeration because then firms would rather tend to cluster than serving markets from single locations because firms would want to reap off benefits of scale economies through localization (see Krugman (1998)).

New Economic Geography shall be modeled by the following measure as is done in Amiti (1998, 1999):

$$intermediate_{it} = \frac{P_{it}Q_{it} - VA_{it}}{P_{it}Q_{it}}. \tag{96}$$

$P_{it}Q_{it}$ is gross output at current basic prices in industry i at time t and VA is gross value added at current basic prices. The higher is intermediate goods intensity, the higher can linkages between upstream and downstream firms expected to be and the higher should be agglomeration (see Amiti (1999)). This is exactly one of the core messages of New Economic Geography (see for example Krugman/ Venables (1995)). With lowering transport costs upstream firms may want to locate closer to downstream firms because they can save transport costs that way. On the other hand downstream firms will want to locate closer to upstream firms because they can thus receive cheaper inputs for their production.

5.4.3 Explaining Industrial Agglomeration

First, static panel analysis' results will be presented. The logarithm of all of the variables is taken such as to better interpret percentage changes in variables. Formally, I estimate:

$$lngini_{it} = \alpha_i + \beta_1 lnfact_{it} + \beta_2 lnscale_{it} + \beta_3 lninterm_{it} + u_{it} \tag{97}$$

that is *lngini* is regressed on the logarithms of factor intensity, scale economies and intermediate goods intensity, u_{it} is the disturbance term. Ordinary least squares (OLS), fixed-effects (FE), random-effects (RE) and between (BE) estimation will be conducted.

As can be seen in table 39, OLS points to New Trade Theory's and New Economic Geography's arguments being important for explaining industrial agglomeration in the EU. However, scale economies' influence basically explains across industry variation in agglomeration, as can be seen by BE-estimates. FE- and RE-estimators display that New Trade Theory's arguments are not important in explaining industrial agglomeration. Heckscher-Ohlin theory's assumptions appear not to be important, anyway. A Hausman test pointed to the difference in FE and RE coefficients not being systematic, thus preferring FE over RE estimation.
Overall, I can confirm results by Amiti (1999). Additionally, we learn that scale economies are able to explain across industry variation in agglomeration only and not within an industry over time. This contrasts Kim (1995) who found scale economies to be important for within industry variation in agglomeration. His result, however, might be due to the fact that scale economies have been made more and more use of over time by firms in former times (his sample ends at 1987), whereas in recent times (my sample ranges from 1995 to 2005) there is less variation in scale economies over time existing, instead scale economies vary across industries.

Table 39: Static panel data analysis–industries

Variable	OLS	FE	RE	BE
lnfact	-0.0528	-0.0046	-0.0048	-0.0825
	(-0.62)	(-0.52)	(-0.54)	(-0.67)
lnscale	-0.3187	0.0476	0.0305	-0.3426
	(-3.28)	(1.33)	(0.90)	(-2.91)
lninterm	1.6128	1.5942	1.5101	1.7617
	(2.73)	(3.34)	(3.39)	(2.50)
const	-2.0915	-0.9316	-1.0126	-2.1911
	(-7.06)	(-3.43)	(-3.52)	(-5.57)
N	220	220	220	220
R^2	0.4178	0.2513		0.4507
R^2 overall		0.0732	0.0954	0.4149
R^2 between		0.0705	0.0929	0.4507
R^2 within		0.2513	0.2497	0.1122
sigma u		0.4563	0.3799	
sigma e		0.0543	0.0543	
rho		0.9860	0.9800	

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: t-stats in brackets are calculated with robust standard errors, for OLS clustered, for BE bootstrapped.

In the following panel unit root tests will be conducted. Results show that the null of panel unit roots is rejected for all of the four variables using the Levin, Lin, Chu test. Only the Breitung test suggests that every variable is non-stationary. Overall, *lngini*, *lnfact* and *lnscale* might be considered non-stationary, it is not so clear if *lninterm* is non-stationary. As has been explained in chapter 5.3.1 Breitung's test results are most important here, indicating non-stationarity of variables.

Table 40: Panel unit root tests–industries

test	statistic			
	variables			
	lngini	lnfact	lnscale	lninterm
Levin, Lin Chu	-5.9837***	-6.5455***	-1.8635**	-7.6495***
Breitung	2.3966	-0.8451	4.1649	-1.2074
Im, Pesaran, Shin	-0.0901	-0.9669	1.4707	-1.3883*
ADF-Fisher-Chi-square	45.6754	54.9315*	28.6555	58.6944**
PP-Fisher-Chi-square	75.8498***	44.7039	34.414	70.9994***

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: *** significant at 1 percent level, ** significant at 5 percent level, * significant at 10 percent level. Including individual effects and individual linear trends. Automatic selection of maximum lags. Automatic selection of lags based on SIC. Newey-West bandwidth selection using Bartlett kernel. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution.

Next, results for co-integration tests are provided. Seven out of eleven tests by

Table 41: Panel co-integration tests–industries

test	**Panel v**	**Panel rho**	**Panel PP**	**Panel ADF**
	statistic			
Pedroni residual co-integration	-1.8213	4.6396	-0.9548	-0.6772
	weighted statistic			
Pedroni residual co-integration	-1.8624	4.1436	-3.4945***	-2.6289***
test	**Group rho** *statistic*	**Group PP**	**Group ADF**	
Pedroni residual co-integration	5.6672	-8.3065***	-3.9636***	
test	**ADF** *statistic*			
Kao residual co-integration	-2.565***			

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: *** significant at 1 percent level, ** significant at 5 percent level, * significant at 10 percent level. Null hypothesis: no co-integration. Pedroni: Deterministic intercept and trend included, Kao: no deterministic trend. Pedroni: Automatic lag selection using SIC with a max lag of 0, Kao: automatic 2 lags by SIC with a max lag of 2. Newey-West bandwidth selection with Bartlett kernel.

Pedroni do not reject the null of no co-integration. The group-rho statistic does not support co-integration. The Kao test rejects the null of no co-integration. So, evidence is less clear on whether there is co-integration among regression variables or not.

As a result, the following estimation output by dynamic panel OLS can be interpreted only with caution:

$$lngini_{it} = -0.9564 - 0.0059 * lnfact_{it} + 0.0405 * lnscale_{it} + 1.6129 * lninterm_{it} \quad (98)$$

where $lninterm$ and the constant are significant at the 5 percent level, $N = 217$, $R^2 overall = 0.087$, $R^2 between = 0.081$, $R^2 within = 0.265$. Lags and leads of order 1 of first differences of co-integrated explanatory variables are included.

Taking into account the variables' dynamics does not seem to alter the basic result that New Economic Geography's arguments bear a lot of significant power in explaining industrial agglomeration in the European Union. A one percent increase in intermediate goods' intensity increases industrial agglomeration by 1.61 percent.

5.4.4 Explaining Services Sectors' Agglomeration

Static panel data analysis will be presented first. The following equation will be estimated:

$$lngini_{st} = \alpha_s + \beta_1 lnfact_{st} + \beta_2 lnscale_{st} + \beta_3 lninterm_{st} + u_{st} \qquad (99)$$

where *lngini* is regressed on the logarithms of factor intensity, scale economies and intermediate goods intensity and u_{st} is the error term.

Investigating services sectors' agglomeration I get the following regression results:

Table 42: Static panel data analysis–services

Variable	OLS	FE	RE	BE
lnfact	0.1084	-0.0014	0.0017	0.1404
	(1.23)	(-0.08)	(0.09)	(0.99)
lnscale	0.2335	0.2396	0.2344	0.2857
	(2.13)	(3.01)	(3.00)	(1.24)
lninterm	-0.0904	0.5466	0.5069	-0.0916
	(-0.25)	(2.40)	(2.37)	(-0.13)
const	-1.8216	-1.4550	-1.4929	-1.6805
	(-3.14)	(-5.07)	(-5.24)	(-1.69)
N	468	468	468	468
R^2	0.2506	0.2667		0.3138
R^2 overall		0.0011	0.0025	0.2503
R^2 between		0.0019	0.0006	0.3138
R^2 within		0.2667	0.2662	0.1042
sigma u		0.4126	0.3387	
sigma e		0.1215	0.1215	
rho		0.9203	0.8861	

Source: Own calculations based on EU KLEMS data (2008).
Note: t-stats in brackets are calculated with robust standard errors, for OLS clustered, for BE bootstrapped.

OLS points to only a little significance of explanatory variables. New Trade Theory's arguments are important, however, the estimate does not show the expected sign. FE- and RE-estimators point to New Economic Geography's assumptions being important in explaining agglomeration. Intermediate goods' intensity, however, is less important than in the case of industrial agglomeration. Heckscher-Ohlin theory's arguments are not important anyway. BE-estimates are not significant at all. A Hausman test pointed to preferring FE- over RE-estimates. Summarizing, intermediate goods intensity is only important for explaining within services' sectors variation in agglomeration and not across sectors.

The positive sign for scale economies might indicate that intra-sectoral trade influences agglomeration tendencies for services. The reasoning behind is that in case of a heterogenous good increasing liberalization will make consumers getting access to a greater variety of products, intra-sectoral trade increases, economic structures across countries equalize.

Table 43: Panel unit root tests–services

test	statistic			
	variables			
	lngini	lnfact	lnscale	lninterm
Levin, Lin Chu	-2.7084***	-1.4575*	1.3016	1.3052
Breitung	1.14	-0.8115	1.7232	0.8567
Im, Pesaran, Shin	-1.6922**	-1.7413**	2.96	2.0622
ADF-Fisher-Chi-square	35.2456	43.7653**	15.9805	15.7504
PP-Fisher-Chi-square	28.2727	37.2823*	21.7274	15.8946

Source: Own calculations based on EU KLEMS data (2008).
Note: *** significant at 1 percent level, ** significant at 5 percent level, * significant at 10 percent level. Including individual effects and individual linear trends. Automatic selection of maximum lags. Automatic selection of lags based on SIC. Newey-West bandwidth selection using Bartlett kernel. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution.

Looking at unit root tests, the Breitung test is the only test pointing to all of the four variables being non-stationary. As has been seen before, this test's results are most indicative for non-stationarity here. The logs of scale and interm are non-stationary most clearly, non-stationarity of $lngini$ and $lnfact$ is not so clear, however.

Table 44: Panel co-integration tests–services

test	**Panel v**	**Panel rho**	**Panel PP**	**Panel ADF**
	statistic			
Pedroni residual co-integration	-1.7726	3.2757	2.486	1.672
	weighted statistic			
Pedroni residual co-integration	-1.4444	2.5092	1.2285	0.4089
test	**Group rho**	**Group PP**	**Group ADF**	
	statistic			
Pedroni residual co-integration	3.5458	1.9721	0.9417	
test	**ADF**			
	statistic			
Kao residual co-integration	-3.6072***			

Source: Own calculations based on EU KLEMS data (2008).
Note: *** significant at 1 percent level, ** significant at 5 percent level, * significant at 10 percent level. Null hypothesis: no co-integration. Pedroni: Deterministic intercept and trend included, Kao: no deterministic trend. Pedroni: Automatic lag selection using SIC with a max lag of 7, Kao: automatic 1 lag by SIC with a max lag of 9. Newey-West bandwidth selection with Bartlett kernel.

Conducting co-integration analysis shows that none of the Pedroni tests would suggest co-integration, whereas only the Kao test does. So, in the case of services sectors' agglomeration only with great caution on interpretation can a co-integration estimation be conducted.

Running dynamic panel OLS delivered the following results:

$$lngini_{st} = -1.4324 + 0.014 * lnfact_{st} + 0.2394 * lnscale_{st} + 0.5308 * lninterm_{st} \quad (100)$$

with *lnscale*, *lninterm* and the constant being significant at the 5 percent level, $N = 465$, $R^2overall = 0.005$, $R^2between = 0.000$, $R^2within = 0.3$. Lags and leads of order 1 of first differences of co-integrated explanatory variables are included.

So, intermediate goods intensity seems to be important in explaining services' agglomeration. The influence, however, is not as strong as has been the case for industrial agglomeration (see chapter 5.4.3). Here, a one percent change in intermediate goods' intensity increases services' agglomeration by 0.53 percent. The coefficient for scale economies bears a positive sign indicating intra-sectoral trade being able to explain agglomeration of services.

5.4.5 Sensitivity Analysis

To check for robustness of results the following analysis was conducted. In addition to the Gini coefficient I calculated the Krugman (1991 a) index of concentration for measuring agglomeration. This index has been further elaborated by Midelfart-Knarvik et al. (2000) and is denoted as:

$$K_{i,t} = \sum_{c=1}^{C} |\frac{e_{ic,t}}{e_{i,t}} - \frac{1}{I-1}\sum_{i=1}^{I-1}(\frac{e_{ic,t}}{e_{i,t}})|. \quad (101)$$

It measures the deviation of employment in industry i in country c as a share of employment of industry i in the EU from the mean of these employment shares for the other (I-1) industries. Formalizing this measure for services, the index s has to be substituted for i. The same trends for agglomeration for both industries and services as in case of taking the Gini coefficient apply.[163] Regression results taking the Krugman index can be found in table 45.

As can be seen, robustness checks employing FE estimation give evidence for the high explanatory power of New Economic Geography's arguments for industrial agglomeration. For services' agglomeration, New Economic Geography's assumptions

[163] See chapters 2 and 3 in this dissertation.

do not seem to have any explanatory power. The coefficient for scale economies does not bear the expected sign. The positive sign might indicate intra-sectoral trade to be able to explain agglomeration in the services sector.

Table 45: Sensitivity analysis

	agglomeration	
	FE	FE
Dependent Variable	Krugman-I industries	Krugman-I services
lnfact	0.0012	0.0277
lnscale	0.0941*	0.2418**
lninterm	2.2022**	0.5081
const	-0.1152	-0.9723**
N	220	468
R^2 within	0.288	0.242
R^2 between	0.046	0.021
R^2 overall	0.05	0.041

Source: Own calculations based on EU KLEMS data (2008) and OECD STAN data.
Note: ** denotes significance at a 5 percent level, * denotes significance at a 10 percent level. Standard errors are robust.

5.5 Conclusions

The analysis revealed that New Economic Geography's assumptions are best in explaining both within and across industry variation in industrial agglomeration. New Trade Theory's arguments are only able to explain across industry variation in industrial agglomeration. As concerns services sectors' agglomeration New Economic Geography's assumptions are only important for within services sectors' variation. That is intermediate goods intensity matters for agglomeration of a given sector over time but not in explaining between services sectors' variation. This result, however, appears not to be robust. Regression results point to the fact that intra-sectoral trade can explain agglomeration tendencies in the services sector, with increasing liberalization and returns to scale, sectors would become more deagglomerated. I further found non-stationarity and co-integration relationships between agglomeration and explanatory variables (although some of the relationships are not very strong). Taking account of co-integrating relationships between variables applying panel dynamic OLS regression I can show the importance of New Economic Geography's arguments for explaining both industrial and services sectors' agglomeration in the EU, though intermediate goods' intensity is less important for services' agglomeration than is the case for industrial agglomeration. For future research, various co-integration relationships between variables could be checked for, applying the Johansen procedure for example. Further, Marshallian externalities, that is variables capturing an adequate pool of labor or knowledge spillovers (input-output linkages are already addressed in my modeling by intermediate goods' intensity) could be added to the regression framework. Besides, as theoretical models by Krugman, for example, suggest, prices, expenditures, wages and transport costs play an important role in determining agglomeration. Getting data on transport costs for several industrial and services' sectors is not an easy task, though.

5.6 Appendix

Industries included in analysis:

1.Food, beverages, tobacco; 2.Textiles, textile products; 3.Leather, footwear; 4.Wood, wood products; 5.Pulp, paper, paper products; 6.Printing, publishing; 7.Basic metals; 8.Fabricated metals; 9.Non-metallic mineral products; 10.Coke, refined petroleum, nuclear fuel; 11.Rubber, plastics, plastics products; 12.Machinery equipment; 13.Motor vehicles, trailers, semitrailers; 14.Other transport equipment; 15.Manufacturing nec. recycling; 16.Chemical industry; 17.Office, accounting, computing machines; 18.Electrical machinery apparatus; 19.Radio, TV, communication equipment; 20.Medical, precision, optical instruments

Services sectors included in analysis:

1.Sale, maintenance and repair of motor vehicles and motorcycles, retail sale of fuel; 2.Wholesale trade and commission trade, except of motor vehicles and motorcycles; 3.Retail trade, except of motor vehicles and motorcycles; repair of household goods; 4.Hotels and restaurants; 5.Other inland transport; 6.Other water transport; 7.Other air transport; 8.Other supporting and auxiliary transport activities, activities of travel agencies; 9.Post and telecommunications; 10.Financial intermediation, except insurance and pension funding; 11.Insurance and pension funding, except compulsory social security; 12.Activities related to financial intermediation; 13.Real estate activities; 14.Renting of machinery and equipment; 15.Computer and related activities; 16.Research and development; 17.Other business activities; 18.Public admin and defense, compulsory social security; 19.Education; 20.Health and social work; 21.Other community, social and personal services; 22.Private households with employed persons

Countries included in analysis:

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, UK

Table 46: List of industries' and services' ISIC codes

Industry / Service	ISIC Rev. 3 Code
Total manufacturing	D
Food, beverages and tobacco	15t16
Textiles and textile	17t18
Leather, leather and footwear	19
Wood and of wood and cork	20
Pulp, paper and paper	21
Printing, publishing and reproduction	22
Coke, refined petroleum and nuclear fuel	23
Chemicals and chemical	24
Rubber and plastics	25
Other non-metallic mineral	26
Basic metals	27
Fabricated metal	28
Machinery, nec	29
Office, accounting and computing machinery	30
Electrical machinery and apparatus, nec	31
Radio, television and communication equipment	32
Medical, precision and optical instruments	33
Motor vehicles, trailers and semi-trailers	34
Other transport equipment	35
Manufacturing, nec; recycling	36t37
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50
Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
Retail trade, except of motor vehicles and motorcycles; repair of household goods	52
Hotels and restaurants	H
Transport and storage	60t63
Other Inland transport	60
Other Water transport	61
Other Air transport	62
Other Supporting and auxiliary transport activities; activities of travel agencies	63
Post and telecommunications	64
Financial intermediation	J
Financial intermediation, except insurance and pension funding	65
Insurance and pension funding, except compulsory social security	66
Activities related to financial intermediation	67
Real estate activities	70
Renting of machinery and equipment and other business activities	71t74
Renting of machinery and equipment	71
Computer and related activities	72
Research and development	73
Other business activities	74
Public admin and defense; compulsory social security	L
Education	M
Health and social work	N
Other community, social and personal services	O
Private households with employed persons	P

6 Final Conclusions, Policy Implications and Outlook

New Economic Geography experienced a wave of intensive investigation over the past 20 years. Its models offer a comprehensive framework in analyzing the localization of firms in space. Considering tendencies of agglomeration in the European Union is of strong current interest for politics as well as academic research. Ongoing, increasing integration raises the question whether industries get as much agglomerated in the EU as has been the case for the US. The problem is that with its common currency the euro area might not be able to adequately react in case of asymmetric shocks. If European countries, however, are getting more and more specialized, vulnerability to asymmetric shocks might increase.

Throughout this dissertation agglomeration and specialization tendencies of both industries and services sectors in the European Union, the driving forces behind and dynamic developments have been investigated. Explanatory factors have been derived from two trade theories, that is Heckscher-Ohlin theory and New Trade Theories and the New Economic Geography. Adequate econometric methods have been chosen, especially non-stationarity issues have been addressed. It has been shown that agglomeration is a dynamic process which can be understood by different trade theories' explanations. In fact, New Economic Geography's arguments are important in explaining industrial agglomeration and countries' specialization in industries in the European Union, whereas for services its explanatory power appears to be weaker. Instead, Traditional Trade Theory's arguments, i.e. consideration of factor availability and quality, tend to play a role in explaining services' agglomeration.

In the first part of the investigation it could be shown that industrial agglomeration in the European Union increased by about 25 percent over the time from 1970 to 2005. Increasing agglomeration can be especially found for labor intensive or low-technology industries like textiles, leather and footwear, wood and motor vehicles. Countries' specialization, however, remained rather low. Two European core countries, Germany and France, and three peripheral countries, Ireland, Greece and Portugal display high increases in specialization. Regression results indicate that New Trade Theory's and New Economic Geography's assumptions can explain industrial agglomeration best. Heckscher-Ohlin type arguments, however, did not appear to be significant, they might explain agglomeration in research and medium-low technology industries to a little extent. Regarding countries' specialization, New Economic Geography's assumptions are the best explanatory force. Specialization is negatively influenced by growing liberalization over time and declining trade costs. This is in accordance with the model of Krugman and Venables (1995). Liberalization in the EU seems to have proceeded so far and trade costs have declined so much that specialization in the EU becomes less. Suppliers settle down in both core and peripheral regions again, dispersion among countries occurs. The investigation undertaken in this dissertation appears to be the first one that considers stationarity properties of variables in studying agglomeration and specialization issues. Results indicate that New Economic Geography's assumptions are best in explaining specialization in the EU. For the EU as a whole the effect of adjusting to the long-run equilibrium state of specialization could be disentangled which is about 63-79 percent within the next period. Further valid co-integration relationships and error correction regressions could be established for Denmark, France, Germany, Spain and Sweden, only. These countries' adjustment rates are lower than the European average. So these countries economies' react more slowly in coming back to the long-run equilibrium state of specialization than the European Union on average. This might be a valuable new insight for regional, structural, economic and social politics of the European Union's member countries. The results mean that Denmark, France, Germany, Spain and Sweden would need a longer time to recover, to come back to their long-run equilibrium of specialization, if specialization deviated from its long-run equilibrium.

In a next chapter it could be shown that services sectors' agglomeration decreased continuously in the European Union over 1970 to 2005. Only retail trade, water transport and financial intermediation except insurance and pension funding got more agglomerated. The analysis allowed for a special consideration of Greece. Results show that Greece specialized in sale, retail trade activities, hotels and restaurants, transport and storage, public administration and education. This means, for example, that out of Greece's total services' employment a large share of workers is employed in the branch of public administration compared to the employment share of Greece within the EU. I argued that this kind of specialization made Greece vulnerable to asymmetric shocks, especially seen during the current debt crisis of the EU. The Greek economy made itself dependent on a well functioning tourism and cherished a big public sector employing a lot of workers. As can be further shown, factor intensity bears some explanatory power, so obviously, services agglomerate due to availability and/or quality of labor or capital inputs. New Economic Geography's arguments are important in explaining services' agglomeration, however, their importance is weaker than has been the case for industrial agglomeration. In particular, intermediate goods' intensity appears to be important for explaining within variation of services' agglomeration. Further, as concerns the influence of scale economies, intra-sectoral trade appears to be able to explain equalizing economic structures for services. However, this is not the case for every services sector. Employing stationarity tests of variables and dealing with co-integration in services' agglomeration is new to the literature. I can show that factor intensity is influencing agglomeration of wholesale trade and intermediate goods' intensity is important in explaining agglomeration of public administration, defense and compulsory social security.

Taking account of findings from the previous chapter, that is fewer importance of intermediate goods' intensity for services' agglomeration, agglomeration tendencies for both an industrial and a services' sector have been investigated in the Krugman/ Venables (1996) model. Results show that industries and services agglomerate, however, services do so to a lower extent. This corresponds to empirical findings: services are less agglomerated in reality. The modeling is built on the following assumptions: intra-sectoral input for services is zero and so are transport costs importing services from another country. The mechanism behind is that with decreasing transport costs production costs for both sectors would decrease. However, the price index for the services sector will become smaller than for the industrial sector since no services inputs are assumed to be used for services production. Thus, assuming that in the beginning services were localized in foreign country and industries in home country, firms would want to produce more services in home country. Services sector's real wages would increase, workers would want to work in the services sector, too. More workers moving to a region would increase expenditures on services products, which is an incentive for services' firms to move close to workers, as well. Thus, both countries will have services' production, services are less agglomerated. The data show that activities of sale and repair of motor vehicles, retail trade, hotels and restaurants and public administration are services which on the one hand are not agglomerated that much and on the other hand suffice the assumptions of low intra-sectoral input for services and transport costs being negligible for services' imports. The last assumption is fulfilled since these services are hardly traded over countries, so transport costs per se can be assumed not to be important.

In the last part, static and dynamic panel data analysis has been conducted for investigating both industrial and services sectors' agglomeration. New Trade Theory's arguments are only important for across industry variation of industrial agglomeration whereas New Economic Geography's arguments explain both within and across industry variation. For services' agglomeration New Economic Geography's arguments are only able to explain within services' variation in agglomeration but their importance is less robust. Some evidence for intra-sectoral trade explaining equalizing economic structures for the services sector is given. Further, panel unit root and co-integration tests were computed. Panel dynamic OLS revealed that New Economic Geography's assumptions are best in explaining both industrial and services sectors' agglomeration, though their importance for explaining services' agglomeration is weaker than for industries' agglomeration.

The following policy implications can be given. The analysis has shown that Heckscher-Ohlin type arguments are not able to explain agglomeration trends for industries. However, they can explain services' agglomeration. Obviously, services' localization tends to depend on factor availability and/ or quality. Therewith, it remains an important task for politics to influence especially availability and quality of the relatively immobile factor labor in the European Union in order to handle agglomeration and specialization processes. Labor's qualities could be improved by taking care of people's education. Having a highly qualified labor force increases the competitiveness of European member countries making localization of productive activity more attractive for firms.
Further, the analysis revealed that certain European countries have a tendency to take more time in coming back to their long run equilibrium state of specialization. Their adjustment is slower than for the European Union as a whole. If some deviations occurred, then it is important to know for politicians in regional, structural, economic and social politics that recovery of economic structures for Denmark, France, Germany, Spain and Sweden would need a longer time. Accordingly, adequate supportive politics could be conducted in order not to hurt the regeneration processes of these economies.
It has been shown that a strong specialization on services related to the branches of tourism and public services existed for the Greek economy. I argued that this made the Greek economy vulnerable to asymmetric shocks which seems to be supported by the current debt crisis. Becoming less dependent on the tourism sector and restructuring the public sector is an important task that needs to be achieved for the future.
Overall, intermediate goods' intensity has been proven to be an important factor in influencing agglomeration of both industries and services. So, making access to inputs or outputs between firms either more easy or more difficult, politics could to some extent manage agglomeration and specialization tendencies in the EU. This might be achieved through means of taxation or influencing the infrastructure, for example.

There is ample scope for future research in agglomeration and specialization in the EU. A higher disaggregation of industries for example would allow for a more detailed analysis of agglomeration patterns. Also, through regional data analysis localization patterns of firms within a country could be detected. Since agglomeration of European industries increases considerably over time and can be expected to increase even further, the probability for asymmetric shocks to occur is and remains quite high. So, it would be interesting to model asymmetric shocks in a framework of growing agglomeration in the European Union. In addition, the New Eastern European member countries of the EU could be included into analysis. That way it could be possible to evaluate adverse effects due to asymmetric shocks in a potentially enlarged European Monetary Union. Co-agglomeration patterns between industries and services raise much of the current interest of New Economic Geography literature and offer a lot of potential for future research (see Ellison, Glaeser, Kerr (2010)). Theoretical modeling for explaining services' agglomeration could be further enhanced using the ideal variety approach for modeling product differentiation. Finally, several further econometric analyses could be conducted like checking for various co-integration relationships among variables.

There is far more questions that are still open concerning firms' localization. What lies ahead is an area of research which Ottaviano (2011) describes as "new New Economic Geography". It refers to combining heterogenous firms' activity which is currently very intensively investigated in the trade literature, with agglomeration patterns. Ottaviano mentions some unanswered questions that still need to be resolved like *Do better firms locate in denser areas or do clusters provide themselves environments which make firms become better?* or *Do better workers select into denser areas or do denser areas make workers become better?*. After all, the growing integration of economies, not only in the EU, but also in the Asian, African or Latin-American countries, calls for clarifying many more issues on where and why demand and supply will localize. As with the growing strength of the Chinese economy another important question would be, for example, how Chinese import competition influences firms' localization in the EU.
It is very easy to see: The New Economic Geography is flourishing and gaining influence in research.

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Eidesstattliche Erklärung

Ich versichere an Eides Statt, dass ich die eingereichte Dissertation *Essays on Industrial and Services Sectors' Agglomeration in the European Union–An Empirical and Theoretical Assessment of the New Economic Geography with a Special Focus on Non-stationarity Issues* selbstständig verfasst habe. Anderer als der von mir angegebenen Hilfsmittel und Schriften habe ich mich nicht bedient. Alle wörtlich oder sinngemäß den Schriften anderer Autorinnen und/oder Autoren entnommenen Stellen habe ich kenntlich gemacht.

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"Services Sectors' Agglomeration and its Interdependence with Industrial Agglomeration in the European Union", cege discussion paper No. 107, July 2010

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International Conference on Policy Modeling, Ottawa, June 2009
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