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Productivity convergence across industries and regions in Norway and Sweden

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Foreword

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Göran Hallin,
Head of Unit

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Abstract

Output per worker is radically unevenly distributed across space. Several authors have asked why the differences between countries are so large and hypothesized that differences in social infrastructure provide an answer. However, differences in output per worker also vary considerably when comparing spatial units at lower levels of resolution, without substantial variation in the social infrastructure. The purpose of this paper is to discuss possible reasons for regional differences based on data for the Scandinavian Peninsula at a spatial resolution almost equivalent to the European NUTS 3. Since Norway and Sweden are considered to be particularly egalitarian and homogeneous societies, differences in broad measures of social infrastructure can hardly be invoked as substantially important determinants of productive performance. Instead, we investigate the role played by industrial structure. We find strong productivity convergence between Norwegian regions and weak divergence between Swedish ones. For Norway, there is convergence in primary production, manufacturing and services. For Sweden, there is divergence, except in the primary sector. The effect of the industry structure on the spatial distribution of productivity appears to be small in magnitude, but is qualitatively important at least for one time period. The data cover 5-year intervals from 1980 to 2000 for Norway and from 1985 for Sweden.

JEL classification: O41, O57, R11

Key words:
Productivity convergence, comparative study, European regions.

1 Introduction[1]

The comparative analysis of productive performance across regions has in particular been related to questions concerning economic growth. Are less productive regions eventually catching up with more productive ones, and if so, how quickly and for what reasons? The present paper extends this kind of analysis to the counties of Norway and Sweden in the last two decades of the twentieth century.[2] To the extent that the past provides guidance for the future, we may come closer to an idea of what to expect for the first decade of this century. Moreover, we believe the comparative perspective to be useful for identifying important research questions through detecting similarities and differences across national borders that ought to be explained.

The results of regional convergence studies have often been interpreted in terms of the one-sector neoclassical growth model, following the research by Barro and Sala-i-Martin (1991).

On the other hand, several authors argue that studying why countries appear to converge based on the one-sector model is misleading, since this is too narrowly focused on the role of diminishing returns to capital interpreted in either a narrow (physical) or broad sense (physical and human). Comparing regions or countries, output per worker may converge in some sectors and diverge in others. The net effect depends on the balance between these opposing effects and changes in the industry structure over time. Hence, the role played by the changing industry structure in the process of economic growth should be integrated in the analysis (see, e.g., Bernard and Jones,1996, Kongsamut et al, 2001, Caselli and Coleman, 2001, Carluer and Gaullier, 2001). In this paper, information on productivity in different sectors is used to examine the role played by changing industry structure in the convergence process.

The paper is organized in 6 sections. The two main types of convergence are presented in Section 3 and the first type, sigma-convergence, is investigated. The other type, beta-convergence, is analyzed in Sections 4 and 5. Section 6 concludes. First, however, we take a look at the regional output per worker in different regions, based on the Norwegian and Swedish data for the terminal year in our sample, year 2000.

[1] *The authors acknowledge helpful comments and valuable suggestions from Kent Eliasson at the Swedish Institute for Growth Policy Studies (ITPS), Robert A. Nakosteen, University of Massachusetts at Amherst, and seminar participants at the conference of European Regional Science Association 2003. The authors thank Åsa Sjödin at ITPS for excellent assistance.*

[2] *In European studies, Norway and Sweden have been excluded, probably since the harmonized GDP at the regional level that is commonly used has not been available for these countries.*

2 The Scandinavian Peninsula

The units of analysis are confined to the 43 counties on the Scandinavian Peninsula, 24 Swedish and 19 Norwegian ones. The county level approximately corresponds to the NUTS 3 level, used by the European Community (see Appendix A for more details on regional classifications). The number of Swedish counties has been reduced on two occasions within the time period considered, and we have chosen to stick to the original division into 24 counties (there are now 21, exactly corresponding to NUTS 3). We use data for 1980 and later. The regional data are based on information from Statistics Sweden and Statistics Norway. Details on these data and sources are found in Appendix B.

Comparisons across the national border are not innocuous. Therefore, we have used two different conversion factors to see how robust the rankings are when comparing all 43 counties. The normal procedure for international comparisons of productive performance is to use Purchasing Power Parities (PPPs). The PPPs are taken from the OECD-Eurostat PPP program, and are for 1999, which at the time of writing is the latest published benchmark year. Expressed in 1999 U.S. Dollars, the PPPs for Gross Domestic Product (GDP) are 9.246 NOK/USD and 9.640 SEK/USD. The other conversion factor is simply the market exchange rate. Also in this case expressed in 1999 U.S. Dollars, the exchange rates used are 7.807 NOK/USD and 8.274 SEK/USD.[3] Readers reluctant to make international comparisons, could concentrate on the figures for each country.

A striking feature is that the top performers in each country, Stockholm and Oslo, have an output per worker almost double that of the regions with the poorest performance, Gotland and Finnmark. This appears most clearly in Table 1, presenting the relative performance (country average equals 100).[4] Another striking feature, apparent from Table 2, is the predominantly poor performance for Norwegian counties. It may come as a surprise to some readers that, on average, productivity appears to be higher in the Swedish regions than in the Norwegian regions, since Norwegian productivity at the national level has consistently been ranked higher since 1975. Using PPPs, the GDP per worker in 2000 was 59275 USD for Norway and only 52760 USD for Sweden. However, the Norwegian figure includes oil activities on the continental shelf. According to these data, the mainland performance is much more modest, only 43747 USD.[5]

[3] *Source: U.S. Department of Labor, Bureau of Labor Statistics, Office of Productivity and Technology, http://stats.blv.gov/fls/flsgdp.pdf, July 29, 2003.*

[4] *For Norway, the country average is defined excluding the oil activities off-shore.*

[5] *The level of productivity excluding activities on the continental shelf is possibly sensitive to how the data are classified. This is another reason for caution when making comparisons across the border.*

Table 1 Labor productivity, year 2000. Relative performance (country averages equal 100).

Norway			Sweden		
Code	**County**	**Labor productivity**	**Code**	**County**	**Labor productivity**
NOR	Norway	100	SWE	Sweden	100
ØFO	Østfold	93	STH	Stockholm	117
AKH	Akershus	108	UPP	Uppsala	96
OSL	Oslo	127	SML	Södermanland	92
HED	Hedmark	88	ÖGL	Östergötland	97
OPP	Oppland	84	JÖN	Jönköping	92
BSK	Buskerud	94	KRO	Kronoberg	93
VFO	Vestfold	94	KAL	Kalmar	89
TLM	Telemark	96	GOT	Gotland	81
AAG	Aust-Agder	97	BLE	Blekinge	96
VAG	Vest-Agder	92	KRI	Kristianstad	89
ROG	Rogaland	99	MLM	Malmöhus	99
HOR	Hordaland	97	HAL	Halland	88
SFJ	Sogn og Fjordane	92	GOB	Göteborg och Bohus	103
MOR	Møre og Romsdal	96	ÄLV	Älvsborg	91
STR	Sør-Trøndelag	94	SKA	Skaraborg	89
NTR	Nord-Trøndelag	86	VML	Värmland	92
NOL	Nordland	89	ÖRE	Örebro	95
TRO	Troms	83	VML	Västmanland	98
FIN	Finnmark	83	KOP	Kopparberg	91
			GVL	Gävleborg	93
			VNL	Västernorrland	95
			JML	Jämtland	86
			VSB	Västerbotten	92
			NOB	Norrbotten	95

Table 2 Labor productivity, year 2000. All counties are ranked according to the level of labor productivity measured in 1999 Purchasing Power Parities.

Labor productivity			**Labor productivity**		
County	PPPs	USD	County	PPPs	USD
Stockholm	63942	74498	Skaraborg	48705	56746
Oslo	56987	67490	Akershus	48387	57306
Göteborg och Bohus	56638	65989	Halland	48125	56071
Malmöhus	54260	63218	Jämtland	46859	54595
Västmanland	53850	62740	Gotland	44598	51961
Östergötland	53234	62023	Rogaland	44387	52568
Uppsala	52548	61223	Hordaland	43623	51664
Blekinge	52380	61028	Aust-Agder	43560	51589
Örebro	52259	60887	Møre og Romsdal	43247	51218
Norrbotten	52254	60881	Telemark	43038	50971
Västernorrland	52098	60699	Buskerud	42436	50258
Kronoberg	50888	59290	Sør-Trøndelag	42115	49878
Gävleborg	50757	59136	Vestfold	42066	49820
Värmland	50624	58981	Østfold	41710	49398
Jönköping	50418	58742	Vest-Agder	41289	48899
Västerbotten	50413	58736	Sogn og Fjordane	41208	48803
Jönköping	50418	58742	Vest-Agder	41289	48899

Since the price level appears to be rather similar in the two countries as measured by PPPs with the base year 1999, the ranking of the counties according to productive performance does not change considerably if market exchange rates are used. (Akershus move up from 25^{th} to 22^{nd} and Rogaland from 29^{th} to 28^{th}). The higher *levels* reflect the higher price level in Norway and Sweden as compared to the U.S., about 18 and 17 percent, respectively.

To put the figures in perspective, the top-ranked county, Stockholm, had about the same productivity (PPPs) as Belgium (63999 USD), whereas the last, Finnmark, had a somewhat higher productivity than Korea (33046 USD).

In the next section, we take a look at what happened to convergence between the Norwegian and the Swedish regions during the 1980s and 1990s. Has the spread between leaders and laggards visible in Tables 1 and 2 been narrowing or widening?

3 Sigma-convergence

There are two main types of convergence discussed in the literature: beta-convergence (β-convergence) and sigma-convergence (σ-convergence). Beta-convergence means that lagging regions grow faster than leading regions, which implies a negative relationship between initial productivity and the productivity growth rate. Properly speaking, this concept corresponds to what is known as absolute beta-convergence. When the relationship is made conditional on other covariates, it is referred to as conditional beta-convergence. Sigma-convergence might be a more intuitive concept closer to what is understood by convergence in common parlance. Sigma-convergence simply means that the spread, or dispersion, is reduced over time. The spread might be measured by the coefficient of variation or, more common in the economic literature, the standard deviation of the logarithms. Both have the virtue of being independent of scale. Hence, for measuring sigma-convergence it is the quality of the spatial distribution of data that is of importance, not the comparability of productivity over time. At least for the Norwegian data, the data provider has put in more effort into securing cross-sectional validity than comparability over time (see Sørensen, 1994, p.3). It can be noted that sigma-convergence implies absolute beta-convergence, but not the other way around, although in practical applications it will be hard to find any cases where the two are not interchangeable. For a discussion of this, see Sala-i-Martin (1996). We study sigma-convergence in this section and beta-convergence in Section 4 (absolute) and 5 (conditional).

As pointed out by Sørensen (2001) comparative studies of sectorial productivity based on international data, like, e.g., Bernard and Jones (1996), should not take place if robust conversion factors for making data internationally comparable are not available. A posteriori, it appears that manufacturing in the 1970s and 1980s, i.e. the time period considered by Bernard and Jones, is sensitive to the choice of base year while other production sectors and the aggregate turn out to be more robust. A priori, however, we do not know how robust the conversion factors are. This problem of comparability is less serious when we look at regions within small countries where the regional price differences can be expected to be small. In particular, by looking at this sort of spatial data we may provide a more robust answer to whether manufacturing productivity has converged.[6] Let us therefore concentrate on one country at a time.

[6] *The difficulties concerning international comparisons of productivity were discussed in more detail at an OECD expert workshop on the topic in 1996. Some of the papers are available at http://www1.oecd.org/dsti/sti/stat-ana/prod/measurement.htm . Sørensen (2001) is another useful reference.*

Since manufacturing in particular turns out to be sensitive to the choice of convergence factors for comparing international data, we start out by looking at sigma-convergence related to manufacturing between regions. Let us first consider the 19 NUTS 3 regions in our Norwegian sample. The productivity measure used is value added per worker, deflated by the national GDP deflator (see Appendix B for details). Some summary statistics for the Norwegian sample, with county data pooled over the four time periods, are provided in Table 3.

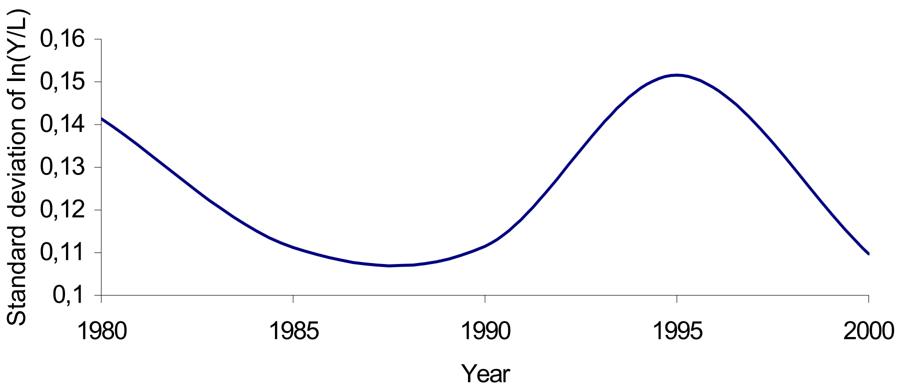
Table 3 Summary Statistics for the Norwegian Sample. County data pooled over four time periods: 1980-1985, 1985-1990, 1990-1995 and 1995-2000.

Variable		Mean	Std dev	Min	Max
Initial productivity	Aggregate	11,720	0,773	10,365	12,790
	Primary	11,281	0,888	8,818	13,339
	Manufacturing	11,938	0,761	10,547	13,084
	Services	11,673	0,789	10,330	12,804
Productivity growth rate	Aggregate	0,098	0,045	0,031	0,169
	Primary	0,103	0,067	-0,135	0,335
	Manufacturing	0,096	0,047	0,011	0,185
	Services	0,098	0,047	0,025	0,168
Number of observations: 76					

Note: Initial productivity is given in natural logs. The statistics are based on the sample of 19 counties over the four time periods.

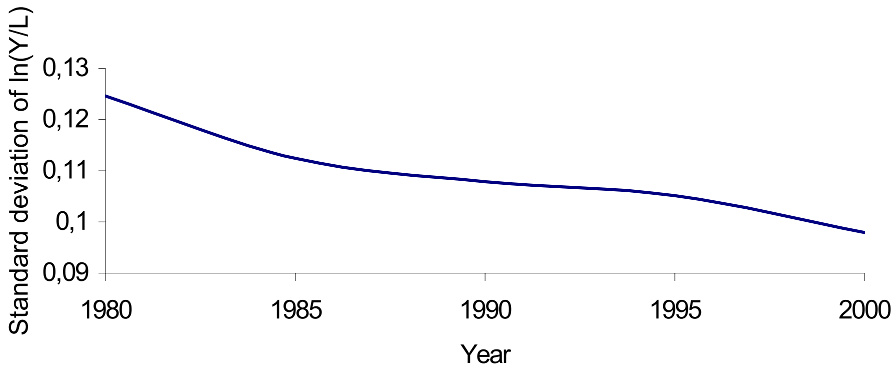
The graph in Figure 1 shows the standard deviations of the natural logarithms of regional labor productivity in Norwegian manufacturing. Note that the dispersion fell in the 1980s, which is the opposite of what Bernard and Jones (1996) believed to have found in the OECD data. The data exhibit sigma convergence in the first and last period, sigma divergence in the third period, whereas there is basically no change in the second period.

Figure 1 Regional labor productivity dispersion in Norwegian manufacturing



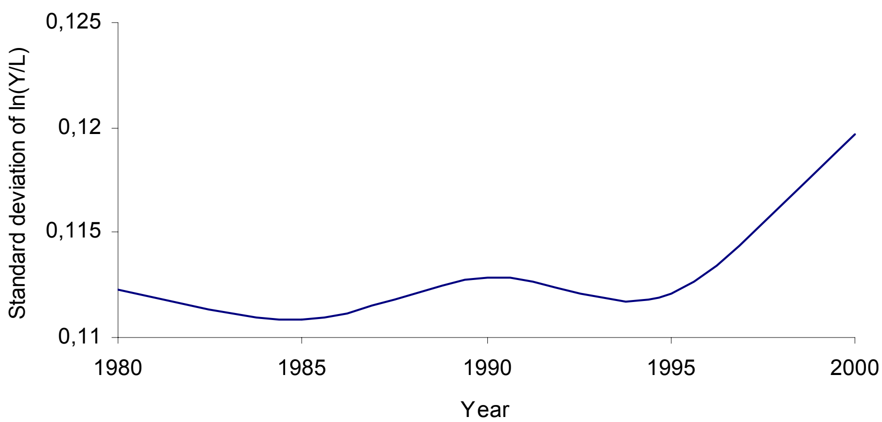
When we aggregate across industries, the almost perfect log-linear relationship in Figure 2 emerges. Now, sigma-convergence appears to have taken place in all periods, even in the third one.

Figure 2 Regional labor productivity dispersion for total Norwegian production



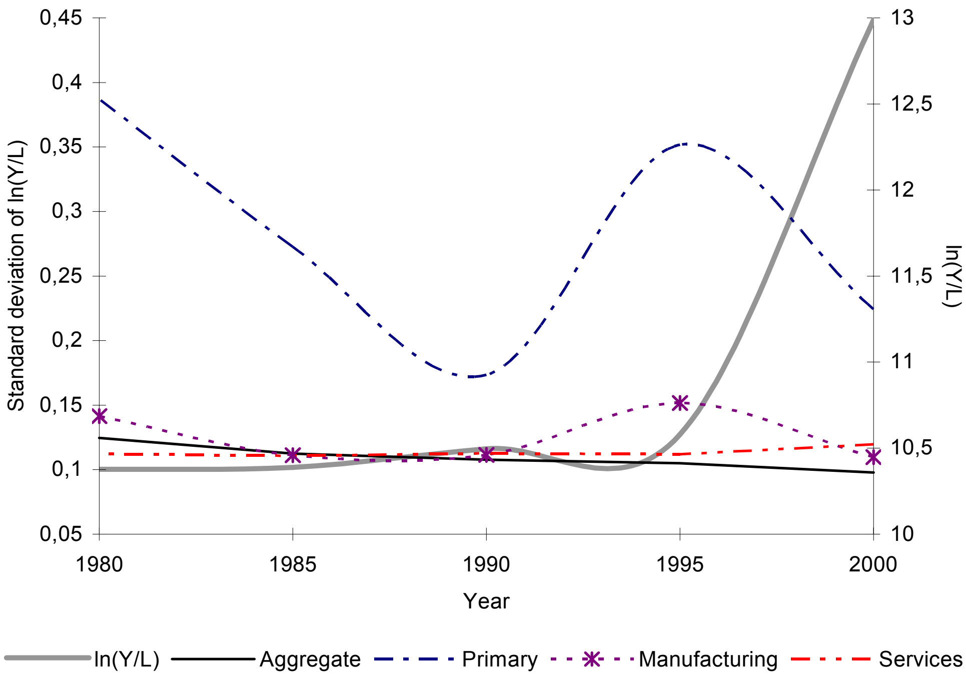
The explanation may be found in Figure 3, showing the sigma-conversion curve for services. In the first period, both manufacturing and services exhibit convergence and contribute to aggregate convergence. From the second period onwards however, services move in the opposite direction of manufacturing. In the second and fourth period, services exhibit divergence, whereas manufacturing exhibits convergence. Apparently, manufacturing dominates and leads to overall convergence. In the third period, we seem to have exactly the opposite situation. This time, the converging services seem dominate and lead to overall convergence.

Figure 3. Regional labor productivity dispersion in Norwegian services



This counter cyclical movement of services and manufacturing over time might well be an interesting regularity. It is also shown in Figure 4 with common scale, where some other data series are added. The standard deviations for the substantially less important agricultural sector are included. The log of aggregate output per worker ln(Y/L) is also provided in Figure 4 (right scale). Observe that manufacturing divergence coincides with the decline in overall productivity represented by the dip in the ln(Y/L) curve in the 1990-1995 period, whereas divergence in the service sector appears to be correlated with rising overall productivity (the second and the last period).

Figure 4 Regional labor productivity dispersion for Norwegian production sectors (left axis) and total output per worker (right axis).

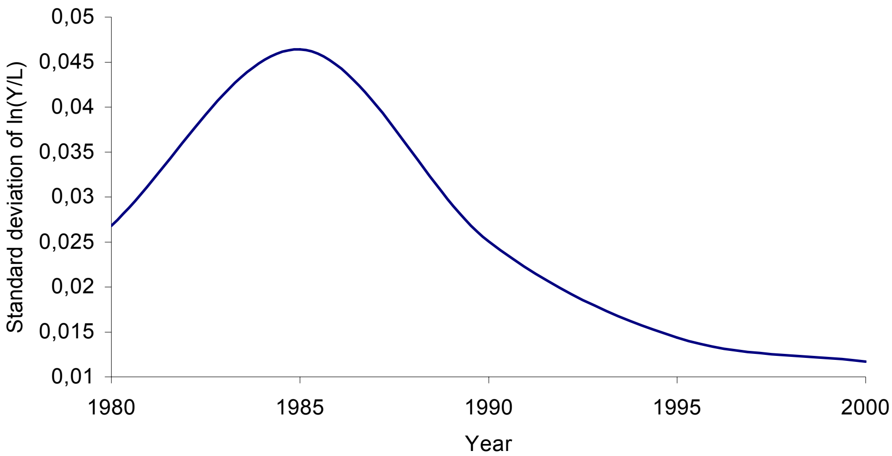


The interpretation offered so far is dangerously simplistic, however, since it fails to take industry composition into account. We could commit the classical fallacy of composition if we did not recognize that overall convergence might appear even when no convergence takes place at the sectorial level. In fact, this is what Carluer and Gaullier (2001), henceforth (CG), find for French data 1982-1992.

Following the procedure used by CG, the curve in Figure 5 is based on hypothetical productivity where the actual regional productivity for each sector is replaced by the national productivity for that sector. The sectorial productivities are weighted by the actual industry structure in each region (the employment shares).

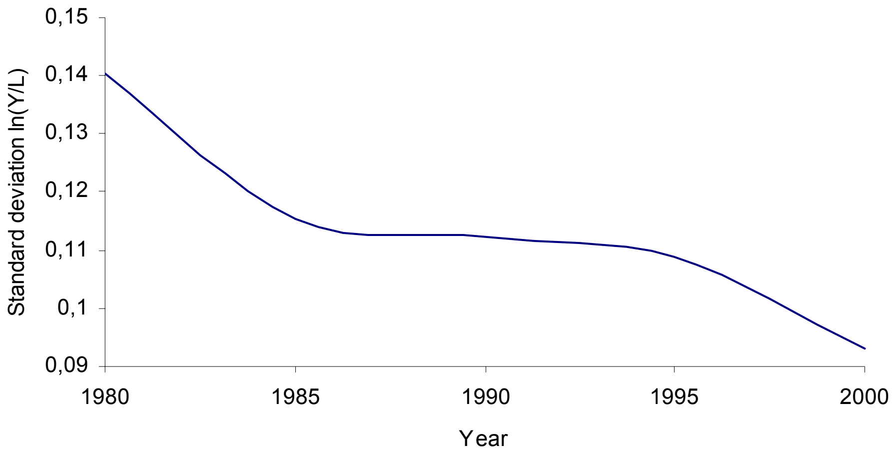
Interpreting this hypothetical measure is not straightforward and the criticism raised against the decompositions used for shift-share analysis could be valid here as well (see, e.g., Armstrong and Taylor, 1985, ch. 7.1). However, CG suggest that the figures reflect the effect of industry structure. From Figure 5, it appears that the relocation between sectors alone would have led to convergence after 1985. The change in standard deviations over time is very small, though, so basically the impact of changing structure seems to be negligible (observe the scale on the vertical axis).

Figure 5 Hypothetical regional labor productivity dispersion in Norway, based on sectoral productivity at the national level, weighted by the actual industry structure in each region.



CG compute a second hypothetical productivity measure where they try to control for the change in industry structure. They use the regional industry structure in the first period for all subsequent periods. The corresponding hypothetical convergence curve for Norwegian data is illustrated in Figure 6. The picture is very much in line with what we saw in Figure 2, showing the real figures, both in a qualitative and quantitative sense. Hence, contrary to the French case, compositional effects appear not to be qualitatively important and the convergence between regions seems to be driven by sector-specific developments – we refer to this as the intra-industry effect. However, we observe that compositional effects (the inter-industry effects) modify the sigma-convergence curve presented in Figure 6, and contribute to the smooth line in Figure 2.

Figure 6 Hypothetical regional labor productivity dispersion in Norway, based on sectorial productivity for each region, weighted by the actual industry structure in 1980.



Let us now turn to Sweden. Figure 7 shows the regional dispersion in income per capita (age 20-64) for the 24 Swedish counties in the same period as for Norway from 1980 to 2000. The income data are based on gross income, including taxable government transfers (source: Statistics Sweden) and are similar to the data used in other regional convergence studies for Sweden (see Persson, 1997, and Gustavsson and Persson, 2001).

Looking at Figure 7, convergence appears to be less smooth than in the Norwegian case, and is partially reversed in the last period. Note also that the spatial distributions are very compressed and that the distribution is fairly stable over time (observe the small scale on the vertical axis).

Do the differences between Norway and Sweden have any connection with industry composition? To address the issue of possible effects on productivity caused by industry structure, we must use other data, since the income data are not available at the sectorial level. However, we do have appropriate data on the wage costs per worker for the period 1986-2000, which could be used as a proxy variable for labor productivity (see Appendix B for details).[7] Table 4 presents some summary statistics for this dataset and shows that there is not much sample variation for Sweden.

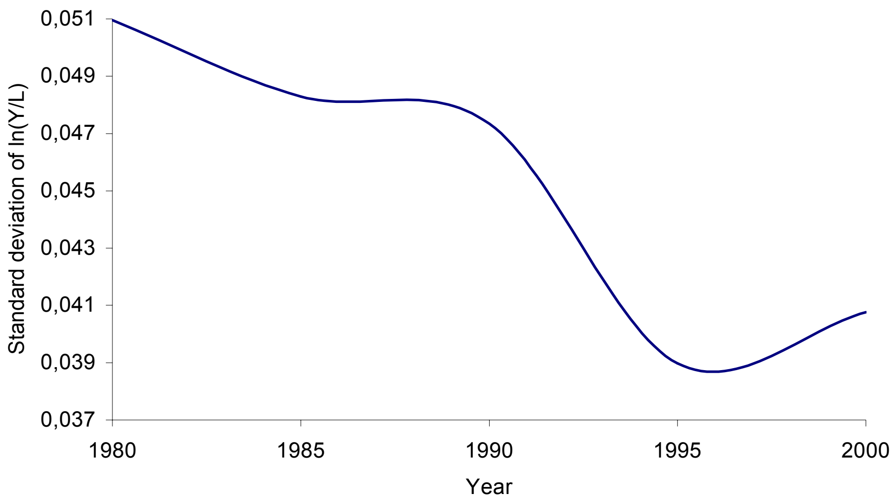
[7] *Under Cobb-Douglas and price taking, e.g., wage costs per worker would be a perfect proxy for labor productivity up to a multiplicative constant (see McCann, 2001, Appendix 6.2).*

Table 4 Summary Statistics for the Swedish Sample. County data pooled over three time periods: 1986-1990, 1990-1995 and 1995-2000.

Variable		Mean	Std dev	Min	Max
Initial productivity	Aggregate	11,957	0,107	11,715	12,250
	Primary	11,076	0,339	10,264	11,720
	Manufacturing	12,075	0,101	11,864	12,330
	Services	11,942	0,096	11,807	12,234
Productivity growth rate	Aggregate	0,020	0,003	0,013	0,031
	Primary	0,035	0,015	-0,015	0,072
	Manufacturing	0,019	0,010	-0,005	0,052
	Services	0,019	0,005	0,006	0,032
Number of observations: 72					

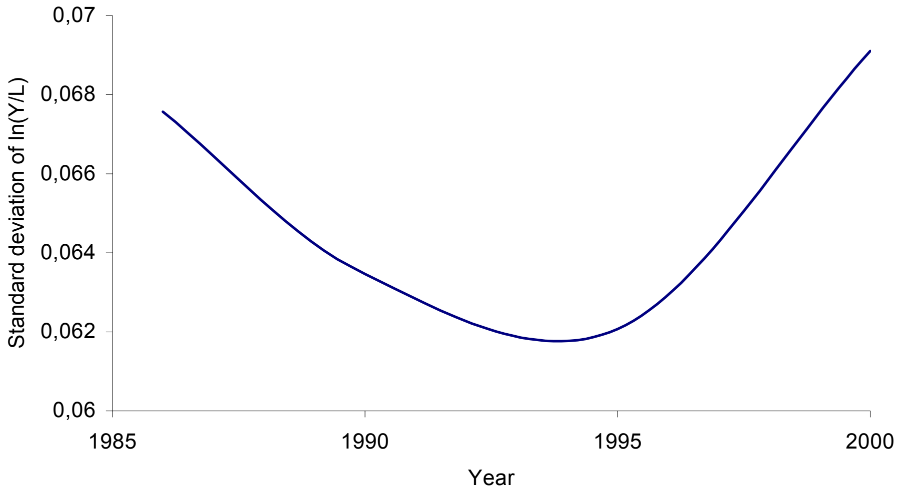
Note: Initial productivity is given in natural logs. The statistics are based on the sample of 24 counties over the three time periods.

Figure 7 Regional income dispersion in Sweden



There is no qualitative difference between the main message conveyed by Figure 7 and Figure 8, based on the wage cost data. Sigma-convergence is replaced by sigma-divergence in the last period and the spatial distributions are compressed for both data sets, although even more for income data than wage cost data.

Figure 8 Regional labor productivity dispersion for total Swedish production



Turning from the aggregate to different sectors, Figure 9 and Figure 10 reveal that sigma-divergence appears to have taken place at the sectorial level for all periods, not only the last. In particular, note that the aggregate sigma-convergence between 1990 and 1995 apparent in both Figure 9 and 10, cannot be driven by a corresponding convergence within manufacturing or industries.

The explanation must be sought in the change in industry structure. Convergence between regions is possible if industries with more regional productivity dispersion are crowded out by industries with less, even though dispersion increases within each industry. This is exactly what CG found for the French regions in the period 1982-1992.

Figure 9 Regional labor productivity dispersion in Swedish manufacturing

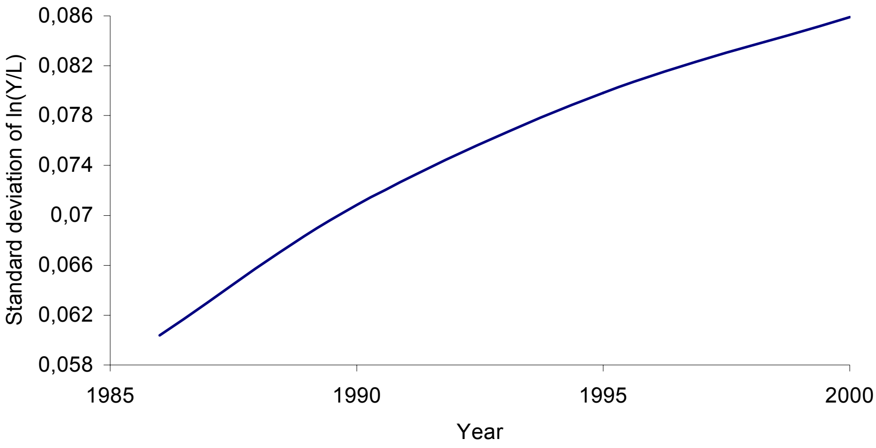
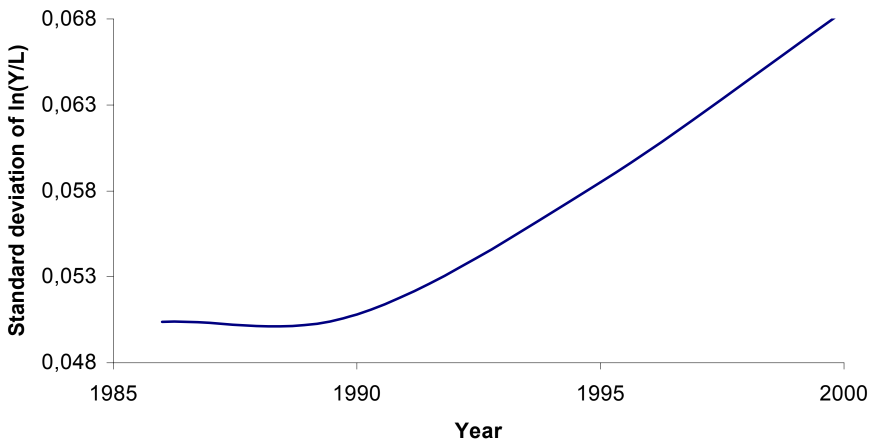


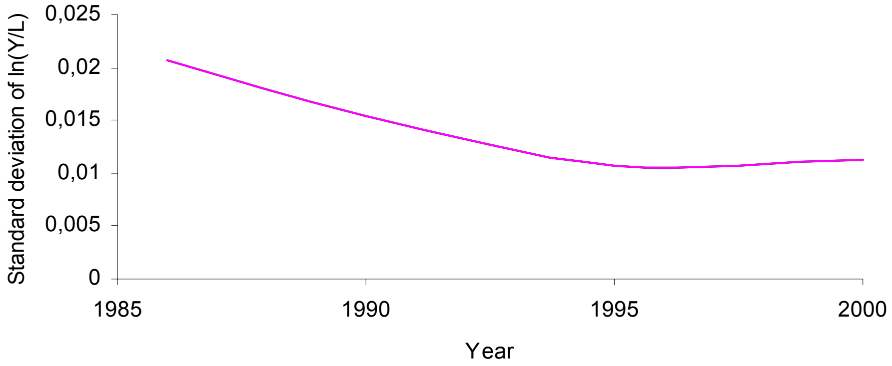
Figure 10 Regional labor productivity dispersion in Swedish services



Following the same procedure as when looking at the Norwegian regions, we have computed hypothetical productivity measures for each region.

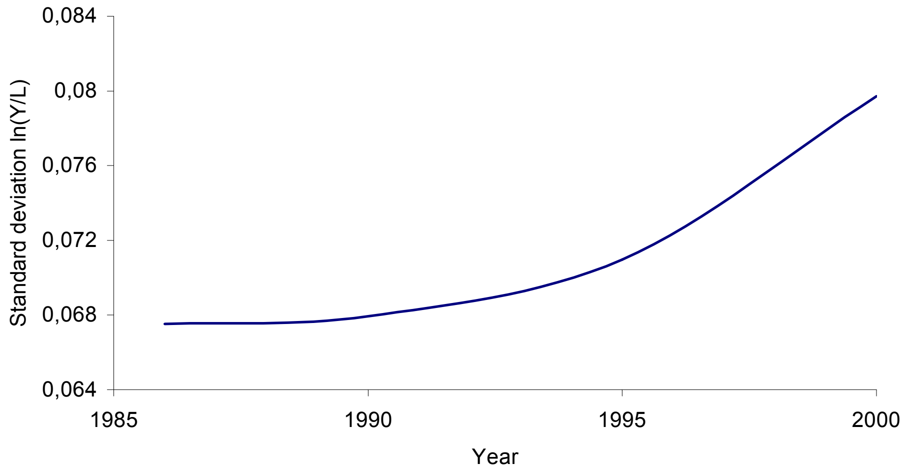
The effect of changing industry structure is illustrated in Figure 11. Comparing with the Norwegian case (Figure 5), we see that in a qualitative sense, there is no difference. A changing industry structure contributes to convergence in the 1985-1995 period and to the later divergence. The magnitudes of change are small, as they were in the Norwegian case.

Figure 11 Hypothetical regional labor productivity dispersion in Sweden, based on sectorial productivity at the national level, weighted by the actual industry structure in each region.



In Figure 12, we controll for a changing industry structure by fixing the structure to 1986. Figure 12 is comparable to Figure 6 (the Norwegian case).

Figure 12 Hypothetical regional labor productivity dispersion in Sweden, based on sectoral productivity for each region, weighted by the actual industry structure in 1986.



Once more, objections could be raised against this construction since sectorial productivity is not independent of industry structure, but Figure 12 is suggestive as an approximation of what could be expected if there had been no sectorial relocation from 1986 to 2000. Observe that there would have been divergence in all periods. In contrast to the Norwegian case, the magnitudes of change are small, and this is the reason why changing industry structure – the inter-industry effect – is of importance in the Swedish case (see Figure 11). Both the intra-industry and the inter-industry effects are small, and thus the latter effect can dominate and lead to overall regional convergence between 1986 and 1995.

For Sweden, it seems that relocation between sectors adds to productivity convergence across regions, except in the last period. Intra-industry relocation adds to the divergence in all periods, apparently in contradiction with the neoclassical prediction based on diminishing returns to capital. The inter-industry effect dominates the intra-industry effect, resulting in sigma-convergence from 1986 to 1995. However, let us emphasize that the changes are very small, and much smaller than what we found for Norwegian regions, where the intra-industry effect is consistent with the neoclassical prediction and totally dominates the inter-industry effect. Hence, Sweden and Norway appear to be rather different. If appropriate data had been available for Sweden for earlier periods, it would have been interesting to see if Sweden was subject to the same convergence process as we see for Norway, but at an earlier stage.

One possible objection against the above statement about the inconsistency between Swedish data and neoclassical theory, is the fact that we have not made any provision for heterogeneous labor or any other of the potentially important qualifying determinants suggested by neoclassical theory. Could it be that sectorial divergence is in fact replaced by convergence, if we control for labor quality or other possibly conditioning determinants? This will be investigated in Section 5, but first, we will discuss the other convergence concept found in the literature in more detail: beta-convergence.

4 Absolute beta-convergence based on cross section data

From a methodological point of view, we take the analysis in this Section one step further by using regression analysis rather than graphical presentations. If we assume the neoclassical growth model to be basically right, we may find the speed of convergence from the parameter estimates. We may also include an arbitrary number of covariates and control for quality differences of labor, differences in capital stocks or other potential important independent variables, provided that we have the appropriate data.

Let us start by looking at simple cross sections of the data. The dependent variable is average labor productivity growth over a specified time period and the natural logarithm of initial labor productivity is the only regressor. This kind of setup is referred to as Barro-regressions in the literature after Barro (1991). More formally, the model to be estimated is

$$\frac{1}{T}\ln\left(\overline{y}_{i,T} / \overline{y}_{i,0}\right) = \alpha + \beta \ln \overline{y}_{i,0} + \varepsilon_i \,. \qquad (1)$$

Here, the left side is the average growth rate, α and β are the parameters to be estimated, and ε_i is an error term. If the estimated β is negative, we say that the data exhibits absolute beta-convergence (which helps explain the peculiar notion ‘beta-convergence’). We will be looking at Sweden and Norway separately.

Let us first average over the longest time span possible for both datasets. This means 1986-2000 for Sweden and 1980-2000 for Norway. The model has been estimated by Ordinary Least Squares (OLS).

Table 4 presents the results for the Swedish sample. The model has been estimated for four different sets of data. The first column presents the results based on aggregate data for each region. The following columns give the results based on sectorial data for each region, the primary, secondary (manufacturing) and tertiary (services) sectors.

From Table 5, it is evident that the model does not perform well, except for the primary sector where the data exhibit absolute convergence. The lack of convergence for the aggregate data is also fairly evident from the scatterplot in Figure 13, where each datapoint is represented by the corresponding three-letter county-code from Table 1.[8] Observe that the most and least productive counties in 2000 (Table 1) were also the most and least productive in the initial year, 1986. Stockholm, Göteborg and Bohus, Malmöhus and Västmannland are on the right hand side in the plot, while Gotland, Jämtland and Halland are to the left. Note also that Stockholm is not only most productive, but also has the highest productivity growth followed by Kronoberg and Blekinge (at the top in the plot). It is important to realize, though, that he growth rate differences are very small (observe the vertical scale – differences are only visible in the third decimal). If we were to fit a trend line through the plot, it would be almost horizontal, indicating no relationship between the two variables.

Table 5 OLS Results, Barro-regressions for Sweden. Dependent variable: Average productivity growth rate, 1986-2000

Independent variables	**Aggregate**	**Primary**	**Secondary**	**Tertiary**
$\ln \overline{y}_{i,0}$	-.000	-.024	.012	.017
	(.004)	(.005)	(.011)	(.008)
Constant	.024	.187	-.069	-.099
	(.028)	(.033)	(.083)	(.055)
Observations	24	24	24	24
R-Squared	.000	.482	.051	.181

Note: Standard errors in the parenthesis below estimates.

[8] *We observe that Stockholm is an outlier, and indeed, rerunning the regression without Stockholm considerably improves the fit and the precision of the estimated beta.* R *Squared increases to .134, the point estimate for beta becomes -.007 with standard the error .004.*

Figure 13 Convergence across Swedish counties 1986-2000

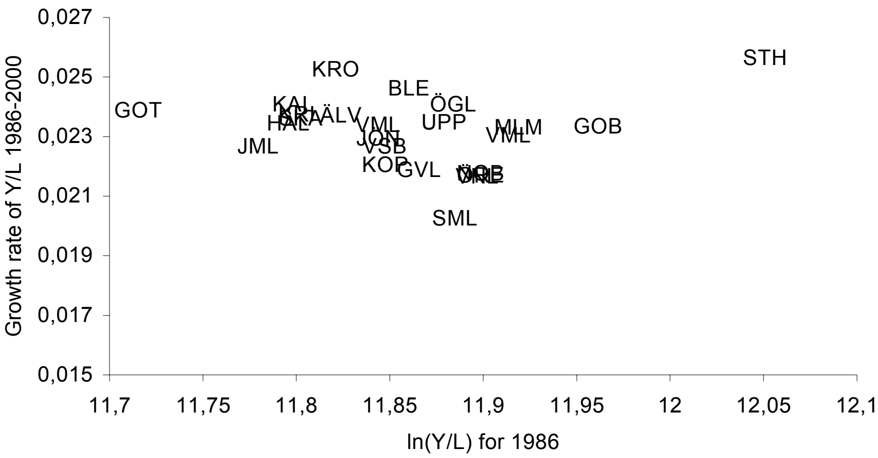


Table 6 presents the results for the Norwegian counties, to some extent comparable to the results for Sweden presented in Table 4. As for Sweden, the data for the primary sector give the best fit and exhibit absolute convergence. In addition, the convergence between the Norwegian counties is much stronger than between the Swedish ones. Also for services, there is a certain similarity in the sense of the model not explaining much of the variation in growth rates for any of the samples. For Norway, the convergence parameter estimate is not significant.

Table 6 OLS Results, Barro-regressions for Norway. Dependent variable: Average productivity growth rate, 1980-2000

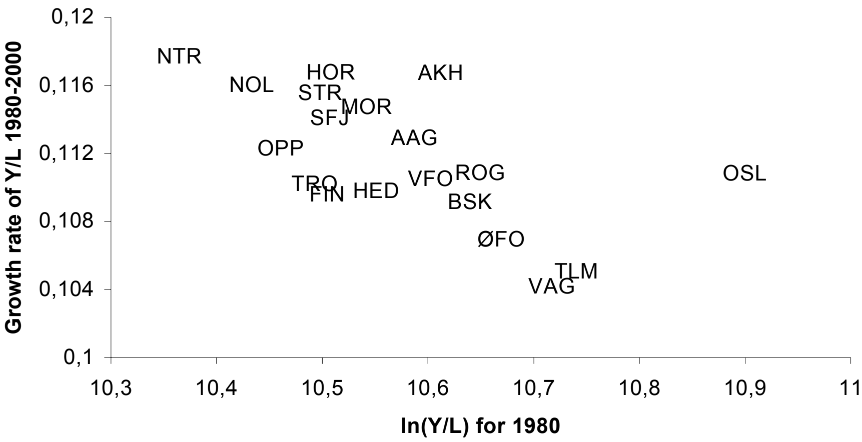
Independent variables	**Aggregate**	**Primary**	**Secondary**	**Tertiary**
$\ln \overline{y}_{i,0}$	-.020	-.049	-.022	-.005
	(.006)	(.007)	(.006)	(.007)
Constant	.319	.609	.347	.167
	(.064)	(.067)	(.070)	(.071)
Observations	19	19	19	19
R-Squared	.384	.758	.405	.034

Note: Standard errors in the parenthesis below estimates.

The model performs much better for the Norwegian than for the Swedish sample, as far as manufacturing and the aggregate are concerned. A reasonably large part of the growth rate variation is explained by variation in initial productivity and the convergence parameter estimates are highly significant and indicate convergence. This conclusion does not come as a surprise, since Figure 1 and Figure 2 showed sigma-convergence between the terminal years, 1980 and 2000, for manufacturing and the aggregate, but the regression analysis confirms the reduced dispersion to be sufficiently large to conclude.

Aggregate convergence is also fairly evident from the scatterplot in Figure 14. Once more, we have used three-letter codes identifying each point. Since Stocholm was far to the right in the previous plot, Oslo is far to the right here. However, Oslo appears to be more in line with neoclassical economic theory in the sense that productivity growth is not high. If we look to the far left, Nord-Trøndelag had the lowest productivity in 1986. But consistent with theory, Nord-Trøndelag is also the top-growing county. Hence, the gap between Nord-Trøndelag and Oslo has been reduced in the period. Comparing Figure 14 to Table 1 we note that Nord-Trøndelag has moved up the ranking and left more slow-growing Finnmark, Troms and Oppland behind. It is also interesting to note that the counties ranked next to Oslo in 1980, are also those with the slowest growth, consistent with the neoclassical prediction. By the year 2000, Telemark, Vest-Agder and Østfold, ranked 2nd, 3rd and 4th in 1980, place 7th, 12th and 10th.

Figure 14 Convergence across Norwegian counties 1980-2000



In order to study stability over time, it may be of some interest to look at each individual time period. In Table 7, results from this exercise are presented for Sweden. Aggregate data exhibits beta-convergence in the first period and beta-divergence in the last. In the 1990-95 period, the point estimate suggests convergence, but the standard error is large and the point estimate is not significant. If this sequence is compared to the graph showing sigma-convergence followed by sigma-divergence (Figure 8), we observe the tight empirical correspondence between the two convergence-concepts and we understand why the *linear* regression for the 1986-2000 period fails when the sigma-curve is U-shaped. Although Figure 8 also shows sigma-convergence in the 1990-1995 period, it is so small that it is essentially nil. This is reflected in the statistically insignificant beta-estimate.

Looking at the primary sector, we see that the data consistently exhibit beta-convergence, and the convergence seems to increase from period to period. For the other two sectors, the estimates of beta remain insignificant with the exception of the first period where the tertiary sector exhibits strong convergence.[9]

When we run separate regressions for each time period for Norway, we note that there is no sign of divergence in any sector or for the aggregate in any period (Table 8). Except for the primary sector, the model does not perform well for the two mid-term periods, 1985–1990 and 1990–1995.

Table 7 OLS Results, Barro-regressions for Sweden, different time periods. Dependent variable: Average productivity growth rate

Time period	Independent variables	Aggregate	Primary	Secondary	Tertiary
1986-1990	$\ln \bar{y}_{i,1986}$	-.013	-.014	.016	-.471
		(.006)	(.007)	(.020)	(.011)
	Constant	.109	.125	-.103	.050
		(.044)	(.046)	(.146)	(.078)
	Observations	24	24	24	24
	R-Squared	.168	.136	.027	.009
1990-1995	$\ln \bar{y}_{i,1990}$	-.008	-.021	-.022	.009
		(.006)	(.009)	(.026)	(.017)
	Constant	.079	.178	.184	-.044
		(.040)	(.056)	(.191)	(.122)
	Observations	24	24	24	24
	R-Squared	.086	.215	.033	.012
1995-2000	$\ln \bar{y}_{i,1995}$	.018	-.033	-.028	.010
		(.008)	(.012)	(.024)	(.017)
	Constant	-.115	.246	.235	-.055
		(.059)	(.077)	(.183)	(.130)
	Observations	24	24	24	24
	R-Squared	.200	.269	.056	.016

Note: Standard errors in the parenthesis below estimates.

[9] Also this time have we looked at what happens to the beta estimate based on aggregate data when we exclude Stockholm from the sample. It turns out that the estimate is not stable over time. Data exhibit convergence in the first period, followed by insignificant convergence and divergence. The estimates for the last two periods are not only imprecise but also very small.

Convergence seems to slow down for the primary sector as we move from 1980 to 2000. The convergence is very strong in the first two periods. In the first period, there also appears to be strong convergence in manufacturing, and this is even true for the last period. This is reflected in a relatively strong convergence for the aggregate in the same two periods. However, the parameter estimates are reasonable stable for the aggregate over time. For services, the model does not work well this time either.

Table 8 OLS Results, Barro-regressions for Norway, different time periods. Dependent variable: Average productivity growth rate

Time period	Independent variables	Aggregate	Primary	Secondary	Tertiary
1980-1985	$\ln \bar{y}_{i,1980}$	-.032	-.089	-.068	-.021
		(.016)	(.021)	(.021)	(.018)
	Constant	.494	1.047	.896	.375
		(.172)	(.215)	(.227)	(.196)
	Observations	19	19	19	19
	R-Squared	.138	.505	.383	.071
1985-1990	$\ln \bar{y}_{i,1985}$	-.023	-.083	-.023	-.017
		(.017)	(.016)	(.021)	(.019)
	Constant	.389	1.057	.391	.333
		(.196)	(.175)	(.244)	(.223)
	Observations	19	19	19	19
	R-Squared	.097	.619	.068	.044
1990-1995	$\ln \bar{y}_{i,1990}$	-.021	-.133	-.001	-.010
		(.017)	(.082)	(.038)	(.013)
	Constant	.307	1.641	.062	.162
		(.214)	(.966)	(.469)	(.155)
	Observations	19	19	19	19
	R-Squared	.079	.136	.000	.032
1995-2000	$\ln \bar{y}_{i,1995}$	-.032	-.123	-.067	-.003
		(.019)	(.024)	(.016)	(.017)
	Constant	.469	1.561	.910	.010
		(.237)	(.288)	(.208)	(.212)
	Observations	19	19	19	19
	R-Squared	.147	.618	.495	.002

Note: Standard errors in the parenthesis below estimates.

This could be the end of the story, but we would rather look at the regressions so far as further exploratory investigations of the data, complementing Section 3. The regressions have all been rather crude in at least two respects. First, the linear regression equation with one independent variable is far from the model implied by neoclassical growth theory. In this sense, the information provided by theory was not utilized. Second, the empirical information available was not efficiently utilized either, since the dataset permits panel estimation that would considerably increase the number of observations.

5 Beta-convergence based on panel data

In this Section, we will try to take better care of the information to see if this makes any difference to the results obtained in Section 3. The model to be estimated is now

$$\frac{1}{T}\ln\left(\overline{y}_{i,t} / \overline{y}_{i,t-T}\right) = \alpha_j - \frac{1-e^{-\beta_k T}}{T}\ln \overline{y}_{i,t-T} + \varepsilon_{i,t} . \quad (2)$$

This formulation is closer to theory, both with respect to functional form and by allowing convergence to be conditional, i.e, each county may have different steady states and even different convergence rates. However, we have not specified the conditioning covariates. Instead, we allow for fixed effects in a variable-coefficient model with time invariant parameters that may vary from one unit to another (see Hsiao, 1986, p.130). This is reflected in the indexation of the two parameters, α and β. We have used index $j = 1, 2, ...J$ and $k = 1, 2, ...K$ where $J, K \leq I$, and I is the number of counties. We have estimated equation (2) for different *J*s corresponding to NUTS 0 (J = 1), NUTS 2 (J = 8 for Sweden and 5 for Norway), and NUTS 3 (J = 24 for Sweden, 19 for Norway).[10] Hence, we allow for as many fixed effects as there are counties, at most. We have also estimated equation (2) for different *K*s other than K equal to 1. For both samples, the model has been estimated for K corresponding to NUTS 3 (K = 24 for Sweden, 19 for Norway) with J restricted to being equal to K.

One reason for the shortcut that the use of fixed effects and differing convergence rates represents, is the lack of appropriate data on conditioning variables. We do, e.g., not have data on investment in physical capital for the Swedish counties.[11] Another reason is that there is that as yet, there is no settled consensus on what the appropriate conditioning variables should be. A hundred have been suggested in the literature and few appear to be robust (see Levine and Renelt, 1994, Sala-i-Martin, 1998, and Florax et al., 2001). The approach here may be seen as a way of testing for conditional convergence that minimizes the data requirements. However, estimating (2) is by no means a perfect substitute for structural form estimation, since we have not imposed the restrictions between parameters implied by a specific functional form for the underlying technology. Although this issue is hardly mentioned in the literature, it is not obvious that convergence rate estimates obtained from fixed-effect reduced form models are robust to different specifications of the underlying technology. Extensions in this direction are topics for ongoing work by the authors and will be reported in a later paper.

[10] *The old county division we are using is, strictly speaking, not completely equivalent to NUTS 3 for Sweden (see Section 2 and Appendix A).*
[11] *This problem is not specific for Swedish counties, but pertains to most available regional datasets.*

Equation (2) has been estimated based on the pooled cross sections over the available time periods. For Norway, this means that the number of observations is increased fourfold from 19 to 76, and for Sweden threefold from 24 to 72. We have used dummy variables to catch the fixed effects, and the model has been estimated by Nonlinear Least Squares (NLS). The panel data approach to convergence was pioneered by Islam (1995).

Let us first look at the model *without* fixed effects. The results are presented in Table 9.[12]

Observe that a negative beta here according to the specification in equation (2) means *divergence*. Hence, the data exhibit divergence, except for the primary sector. Observe also that the estimated beta now directly gives the rate of convergence. The data tell us that the counties' aggregate productivities drift apart at an average annual rate of 1.8 per cent, approximately the same as for services (tertiary sector) at 1.9 percent. The speed of divergence is even stronger in manufacturing (the secondary sector) at 3 per cent. Only for agriculture, does there appear to be convergence at a rate of 2.7 per cent a year.[13] This is basically the same model as the one estimated in the preceding section, however, now taking full advantage of the panel structure by increasing the number of observations from 24 to 72. This gives us much sharper estimates, as can be seen comparing Table 5 and Table 9.

Table 9 NLS Results, panel data for Swedish counties. Dependent variable: Average productivity growth rate

Parameter	**Aggregate**	**Primary**	**Secondary**	**Tertiary**
Convergence rate	-.018	.027	-.030	-.019
	(.002)	(.006)	(.005)	(.003)
Constant	-.116	.200	-.221	-.128
	(.015)	(.032)	(.043)	(.023)
Observations	72	72	72	72
R Square	.427	.281	.166	.255

Note: Standard errors in the parenthesis below estimates.

[12] *We have also tried OLS on the linear equation used in the previous section, now using the panel data. However, NLS on the non-linear equation gives lower standard errors and a better fit and is therefore preferred.*

[13] *Excluding Stockholm is not of any significat importance at this stage; the speed of divergence in manufacturing is not altered whereas for services, it falls slightly to 1.8 per cent and for the aggregate to 1.7 per cent. For agriculture, the speed of convergence increases to 3 per cent.*

Now, also taking full advantage of the panel structure of the Norwegian data, without fixed effects, we obtain the results presented in Table 10. We find convergence for all sectors as well as the aggregate, and convergence is strong. Aggregate productivity is converging at an annual rate of 6.5 per cent.

When we introduce fixed effects, there is a substantial incrase in the number of parameter estimates. The conventional procedure is to allow the constant term to vary, but impose a common convergence rate for all units. Let us start by looking at Sweden. If we use dummy variables for each NUTS 2 region in order to allow the constant terms to vary between (but not within) the 8 NUTS 2 regions, the estimated beta measures only convergence within each of the 8 regions. The results are reported in Table C.1.S in Appendix C. Here, we only mention that there is no sign of convergence within the NUTS 2 areas. The convergence rate is estimated to -0.3 per cent, hence the divergence. Although close to zero, the estimate seems precise (*t*-value equals –16.73). The fit is not good, however. The adjusted *R* Square is 0.040 compared to -0.103 when only dummies are regressors. If we let *all* Swedish counties have different constant terms, the estimated rate of convergence is –2.1 per cent. Now, the estimate measures convergence to their own steady state or long run dynamic equilibrium. The results are reported in Table C.2.S in Appendix C. This time the fit is reasonable good, the adjusted *R* Square is 0.501 compared to -0.336 when only dummies are regressors.

Table 10 NLS Results, panel data for Norwegian counties. Dependent variable: Average productivity growth rate

Parameter	Aggregate	Primary	Secondary	Tertiary
Convergence rate	.065	.070	.069	.065
	(.004)	(.009)	(.005)	(.004)
Constant	.727	.749	.774	.729
	(.028)	(.064)	(.035)	(.034)
Observations	76	76	76	76
Adjusted *R* Square	.867	.573	.830	.820

Note: Standard errors in the parenthesis below the estimates.

Introducing dummy variables to capture county specificity for both constant terms and rates of convergence is like running separate regressions for each county with only three observations, one for each time period. To make the presentation lighter, we have only reported the rates of convergence for aggregate productivity in Table 11. A more detailed presentation of the results is found in Appendix C, Table C.3.S. For Kronoberg, Halland, Kopparberg, Västernorrland, Jämtland and Norrbotten, the estimated convergence rate is very inaccurate and not significantly different from zero at any reasonable level of significance. For the remaining 18 counties, the estimates are reasonably precise and all suggest divergence, for Stockholm as much as at an annual rate of 3.3 per cent.

Table 11 NLS Results, panel data for Swedish counties with county-specific effects. Dependent variable: Average productivity growth rate

County	Convergence rate	County	Convergence rate
Stockholm	-.033	Göteborg och Bohus	-.031
	(.006)		(.007)
Uppsala	-.021	Älvsborg	-.023
	(.008)		(.008)
Södermanland	-.025	Skaraborg	-.022
	(.008)		(.008)
Östergötland	-.028	Värmland	-.016
	(.007)		(.009)
Jönköping	-.017	Örebro	-.028
	(.009)		(.007)
Kronoberg	-.010	Västmanland	-.031
	(.011)		(.007)
Kalmar	-.018	Kopparberg	-.011
	(.009)		(.011)
Gotland	-.023	Gävleborg	-.029
	(.008)		(.007)
Blekinge	-.026	Västernorrland	-.013
	(.007)		(.011)
Kristianstad	-.018	Jämtland	-.001
	(.009)		(.015)
Malmöhus	-.031	Västerbotten	-.018
	(.007)		(.009)
Halland	-.012	Norrbotten	.003
	(.011)		(.017)
Observations: 72			
Adjusted R Square: .497			
Unadjusted R square: .830			

Note: Standard errors in the parenthesis below the estimates.

Table 12 NLS Results, panel data for Swedish counties – parsimonious fixed effects. Dependent variable: Average productivity growth rate

Group of counties	Parameters	Aggregate	Primary	Secondary	Tertiary
STH/GOB/VML/MLM	Constant	-.220	-.007	-.308	-.166
		(.025)	(.083)	(.097)	(.058)
	Rate of convergence	-.030	-.007	-.040	-.024
		(.002)	(.012)	(.011)	(.007)
GVL/ÖRE/ÖGL	Constant	-.202	.359	.520	.315
		(.031)	(.202)	(.097)	(.109)
	Rate of convergence	-.028	.057	.080	.045
		(.004)	(.040)	(.019)	(.018)
BLE/SML/GOT/ÄLV/SKA/UPP	Constant	-.132	.214	-.284	-.111
		(.002)	(.068)	(.082)	(.060)
	Rate of convergence	-.020	.031	-.037	-.017
		(.003)	(.013)	(.009)	(.008)
VSB/KRI/KAL/JÖN/VML	Constant	-.106	.224	.394	.327
		(.029)	(.076)	(.114)	(.081)
	Rate of convergence	-.017	.031	.058	.047
		(.004)	(.014)	(.020)	(.014)
VNL/HAL/KRO/KOP/JML/NOB	Constant	-.022	.323	.426	-.080
		(.032)	(.060)	(.089)	(.068)
	Rate of convergence	-.006	.048	.063	-.013
		(.004)	(.011)	(.016)	(.009)
Observations		72	72	72	72
Adjusted R Square		.609	.364	.009	-.007

Note: Standard errors in the parenthesis below the estimates.

If we look at the estimates for both constant terms and rates of convergence, five groups of counties emerge with rather similar parameter estimates within each group. To reduce the number of parameters, we have reestimated the model with five dummies representing these five groups. The results for this more parsimonious representation are given in Table 12.

We observe that although counties diverge within each of the 5 groups as far as aggregate productivity is concerned, the results are more mixed for individual sectors. For agriculture there is convergence between counties within 4 groups out of 5, for manufacturing there is convergence within 3 out of 5, and for services there is convergence for only 2 out of 5. It is interesting that although there is strong convergence for each sector within the second and the fourth group of counties, there is still divergence for the aggregate. Hence, structural change seems to dominate and lead to divergence in spite of intra-industry convergence.

The evidence presented for Sweden indicates that the question asked at the end of Section 2, must be answered with a no: there is nothing to suggest that the introduction of variables that could control for differences in labor quality or physical capital would make any difference to the conclusion that the counties diverge. If control variables would have altered the conclusion, introducing fixed effects as we have done here, ought to change the sign on the estimated rate of convergence.

What about the Norwegian counties? Once more, we start out only allowing the constant term to vary between units. First, we consider the fixed effects for each NUTS 2 region. We find conditional convergence at 6.5 per cent (t-value 17.778 and the adjusted R square equal to 0.862 with the adjusted R square equal to -0.054 with NUTS 2 dummies as only regressors). More details are found in Appendix C, Table C.2.N.

When we allow county specific constant terms, the results do not change considerably. With two decimals, all constant terms are equal to 0.74, except for Akershus and Oslo at 0.75. The rate of convergence is estimated at 6.6 per cent (details are found in Table C.2.N in Appendix C). Although this may seem high when compared to the Swedish case exhibiting divergence, it is by no means uncommon. Fuente (2002), e.g., reports an estimated convergence rate for labor productivity equal to 12. 7 per cent, based on panel estimation with fixed effects, using data on 17 Spanish regions for 1955-1991.

Allowing both constant terms and rates of convergence to be county specific, the estimated convergence rates range from 5.4 per cent for Sogn og Fjordane to 7.9 per cent for Troms, with the constant terms estimated to 0.639 and 0.832. This simply suggests that the two counties converge at a somewhat different speed towards somewhat different steady states. The county specific convergence rates are all presented in Table 13 (more results in Table C.3.N, Appendix C). We observe that we can explain about 86 per cent of the sample variation in the growth rate.

Table 13 NLS Results, panel data for Norwegian counties with county-specific effects. Dependent variable: Average productivity growth rate

County	Convergence rate	County	Convergence rate
Østfold	.069	Rogaland	.072
	(.021)		(.021)
Akershus	.071	Hordaland	.064
	(.020)		(.019)
Oslo	.066	Sogn og Fjordane	.054
	(.021)		(.019)
Hedmark	.067	Møre og Romsdal	.069
	(.021)		(.021)
Oppland	.066	Sør-Trøndelag	.066
	(.020)		(.020)
Buskerud	.072	Nord-Trøndelag	.063
	(.021)		(.019)
Vestfold	.058	Nordland	.066
	(.020)		(.020)
Telemark	.061	Troms	.079
	(.021)		(.022)
Aust-Agder	.059	Finnmark	.070
	(.020)		(.023)
Vest-Agder	.062		
	(.021)		
Observations: 76			
Adjusted R square: .778			
Unadjusted R square: .858			

Note: Standard errors in the parenthesis below the estimates.

We have estimated the model for each sector. Now, there are no problems with convergence of the iteration process, as experienced when we tried to run the model on the Swedish data. The model performs reasonably well for each sector. The adjusted R square are, e.g., .479 for primary sector data, .737 for manufacturing and .697 for services. The estimation results are found in appendix C: Table C.5.I-III. Here, we are content in observing that the parameter estimates for different sectors pertaining to the same county are rather different. This clearly indicates that there is a potential need to cater for different technology in different sectors, and not simply assume away sectorial heterogeneity, as is commonly done in convergence studies. Sectorial heterogeneity also has implications for the functional form of the aggregate regional production structure and is of consequence when attempting to extract information on the parameters representing the underlying technology from the estimated growth equation.

6 Concluding discussion

The main conclusion is that the Norwegian and the Swedish counties do not share a common pattern of labor productivity convergence. There is no sign of convergence between the Swedish counties, whereas there is strong evidence of convergence between the Norwegian counties. In fact, for Sweden there appears to have been divergence: Counties with low productivity in 1986 remained so by the year 2000, and the gaps had been widening, not only in absolute but also in relative terms.

A decomposition into effects caused by changing industry structure on the one hand, and intra-industry, or sectorial, productivity development on the other hand, suggests that if it were not for relocation between sectors, the divergence between Swedish counties would have been even greater. Hence, the change in industry composition appears to have acted as a stabilizing factor.

Although the divergence between Swedish counties is significant in a statistical sense, and appears to have taken place at an annual rate of 1.8 per cent, it is important to emphasize that the differences in productivity growth are small.[14] The compressed spatial distribution is also valid for separate industries, except primary production. In particular, manufacturing productivity growth appears to be unusually equal across Swedish regions as compared to other countries, whereas large differences for services seem to be an unusual feature for Norway. The small growth rate differentials in Sweden combined with rather large differences in initial productivity is just another way of saying that there is no convergence. Indeed, the Swedish data are consistent with increasing returns to scale and inconsistent with constant returns to scale (as assumed in the neoclassical growth model).[15]

The main conclusion for Norway is that the counties exhibit strong absolute convergence during the sample period. The rate of convergence is estimated at 6.5 per cent per year, using panel data with 5-years intervals. This means that it takes about 10 years to close the gap between initial productivity and the productivity we would expect along the long-run equilibrium path. About three quarters of the gap should be closed by the end of the sample period and close to 85 per cent by the end of this decade.[16]

Changes in industrial composition appear to have contributed to convergence in 1985-2000, just as it did for Sweden over the same time period. However, this is

[14] *Measured by the standard deviation of logarithms, the average over the three time periods covered by the sample, is only 0.07. To put this figure into perspective, compare it to 0.11 for the Norwegian sample or 0.09 for France (on average over 1982-1992, CG, Tableau 1).*

[15] *The standard deviations for primary, manufacturing and services are, on average, 0.28, 0.07 and 0.06. The corresponding figures for Norway are 0.28, 0.13 and 0.11 and for France, 0.34, 0.14 and 0.05.*

[16] *This does not mean that three quarters of the gap between the bottom and the top county should be closed by 2000, although the data are consistent with all counties moving towards the same long-run equilibrium path. How much is closed depends on how far the leading county, Oslo, is from the equilibrium.*

not a general feature we can expect for each period, as witnessed by the 1980-1985 period when industrial composition contributed to divergence.

The intra-industry convergence appears to be the substantially important factor behind the convergence found in the data. Hence, the convergence found in the data appears not to be only “Une convergence de façade”, to borrow the suggestive subtitle of the paper by CG describing France. In the Norwegian case, the data are consistent with genuine convergence created by diminishing returns to private production factors.

The regional data for sectors in Norway suggest a possible regularity. Productivity dispersion in manufacturing and services appear to move out of phase, thereby smoothing aggregate productivity dispersion. Structural change therefore plays two roles in shaping spatial aggregate distribution: Changes in industry size affect the spatial industry distribution, and changes in the relative size affect the weight of the industry in the aggregate.

The potential importance of industry structure suggests that considerable caution should be exercised doing convergence studies based on the one-sector growth model commonly used. A useful feature of our data is that, to a large extent, we can actually test for heterogeneity. Comparing parameter estimates across industries for separate counties based on the fixed effect, we may identify homogeneous groups.[17]

Closing this discussion, we would like to mention some issues on which we would like to see more research. First, more work could be done to verify the validity of data. At least three points are worth attention. 1) The possible influence of short-term fluctuations should be investigated to correct for measurement errors in both samples. 2) For the Swedish sample, some assessment of how well wage costs proxies for gross value added should be undertaken. 3) For the Norwegian sample, observing the low productivity levels in Table 2, we would feel more confident if the sensitivity to alternative definitions of continental shelf activities were investigated. Moreover, the data available have not been fully utilized: more disaggregated data can be obtained. This is possible along the industry dimension for both countries, and for Sweden, also along the spatial dimension. For Sweden, we do in fact have firm-level data making any spatial and sectorial aggregation possible. Cheshire and Carbonaro (1995) argue for the need of moving away from purely administrative units. Eliasson and Westerlund (2003) follow this up by using the same data as we have used for Sweden, to aggregate over 89 functional economic regions instead of the 24 counties. Other regional divisions between the municipal level and NUTS 2 could be considered to investigate how the estimates are affected by different spatial resolutions. Perhaps Exploratory Spatial Data Analysis (ESDA) could be used to endogeneously create new regional borders, thereby unveiling hidden spatial patterns.

[17] *This is not completely satisfying, since the estimates reflect both differences in the underlying technology and differences in investment rates and other omitted variables, potentially influencing steady state. However, if appropriate data on additional variables were available, it would in principle be possible to obtain estimates of the technology parameters.*

Appendix A

Regional classifications

Nomenclature of territorial units for statistics, better known for its French acronym NUTS (Nomenclature des unités territoriales statistiques), is a regional classification defined for the members of the European Community. As a non-member, Norway has formally no NUTS classification, but an equivalent classification has nonetheless been constructed by Statistics Norway.

The *official* regional classification used in Norway does not completely correspond to NUTS. It is called REGIN and has 5 levels. REGIN 1 is the whole country, REGIN 2 consists of 7 regions, REGIN 3 corresponds to the 19 counties, REGIN 4 consists of 90 regions, and REGIN 5 corresponds to the municipal level (see Hustoft et al., 1999).

Aggregating three of the seven REGIN 2 regions, we obtain the equivalent of NUTS 2 (5 regions). NUTS 3 is equal to REGIN 3 and REGIN 4 has been constructed to have a Norwegian equivalent to NUTS 4. Note that Statistics Norway made a classification in 1992 in connection with the membership application to the European Union, meant to be equivalent to NUTS 4. The classification comprised 49 regions and was approved by the Ministry of Local Government and Labour in 1993. A new classification was made in 1999, also meant to be equivalent to NUTS 4, this time comprising 90 regions (Eek et al., 1999). This may cause some confusion, but we do not need to go into this issue here since we will not go below the NUTS 3 level. More information on regional classifications for Norway (in both English and Norwegian) is available from Statistics Norway at www.ssb.no/emner/00/00/20/nos_c513/ .

Table A.1 Regional classifications at the county level and above for Norway'

REGIN 3/NUTS 3, county (*fylker*) division		REGIN 2, national districts (*landsdel*)		NUTS 2	
Code	County	**Code**	National district	**Code**	National district (EU)
1	Østfold	1	Oslo og Akershus (2+3)	1	Østlandet (1+2+3)
2	Akershus	2	Hedmark og Oppland (4+5)	2	Agder og Rogaland (4)
3	Oslo	3	Sør-Østlandet (1+6+7+8)	3	Vestlandet (5)
4	Hedmark	4	Agder og Rogaland (9+10+11)	4	Trøndelag (6)
5	Oppland	5	Vestlandet (12+14+15)	5	Nord-Norge (7)
6	Buskerud	6	Trøndelag (16+17)		
7	Vestfold	7	Nord-Norge (18+19+20)		
8	Telemark				
9	Aust-Agder				
10	Vest-Agder				
11	Rogaland				
12	Hordaland				
14	Sogn og Fjordane				
15	Møre og Romsdal				
16	Sør-Trøndelag				
17	Nord-Trøndelag				
18	Nordland				
19	Troms				
20	Finnmark				

Official regional classification in Sweden in principle consists of five levels; parishes, municipalities, counties, national districts, and the national level. Except for national districts, these regions also constitute official administrative jurisdictions. National districts correspond to NUTS 2 and counties to NUTS 3. In this study, we employ the latter subdivision according to the classification of counties prior to 1998 (24 counties). Table A.2 contains the relevant classification of counties and national districts. Details on changes in the official classification of regions in Sweden are provided in Statistics Sweden (2003).

Table A.2 Regional classifications at the county level and above for Sweden

County (län) division before 1997		NUTS 3, county (län) division after 1998			NUTS 2, national districts (riksområden)		
Code	**County**	**Code**	**NUTS code**	**County**	**Code**	**NUTS code**	**National district**
01	Stockholm	01	SE011	Stockholm	1	SE01	Stockholm (01)
03	Uppsala	03	SE021	Uppsala	2	SE02	Östra Mellansverige (03+04+05+18+19)
04	Södermanland	04	SE022	Södermanland	3	SE09	Småland med öarna (06+07+08+09)
05	Östergötland	05	SE023	Östergötland	4	SE04	Sydsverige (10+11)
06	Jönköping	06	SE091	Jönköping	5	SE0A	Västsverige (13+14)
07	Kronoberg	07	SE092	Kronoberg	6	SE06	Norra Mellansverige (17+20+21)
08	Kalmar	08	SE093	Kalmar	7	SE07	Mellersta Norrland (22+23)
09	Gotland	09	SE094	Gotland	8	SE08	Övre Norrland (24+25)
10	Blekinge	10	SE041	Blekinge			
11	Kristianstad	11	SE042	Skåne (11+12)			
12	Malmöhus	13	SE0A1	Halland			
13	Halland	14	SE0A2	Västra Götaland (14+15+16)			
14	Göteborg och Bohus	17	SE061	Värmland			
15	Älvsborg	18	SE023	Örebro			
16	Skaraborg	19	SE024	Västmanland			
17	Värmland	20	SE062	Dalarna (20)			
18	Örebro	21	SE063	Gävleborg			
19	Västmanland	22	SE071	Västernorrland			
20	Kopparberg	23	SE072	Jämtland			
21	Gävleborg	24	SE081	Västerbotten			
22	Västernorrland	25	SE082	Norrbotten			
23	Jämtland						
24	Västerbotten						
25	Norrbotten						

Appendix B

Data

Norway

We are using data on gross value added broken down on counties. The available data goes back to 1973 and have been published for 1976, 1980, 1983, 1986, 1990, 1992, 1993, 1995, 1997, 1998, 1999 and 2000. Unfortunately, data on employment are not available before 1980 and we have therefore used 1980 as our first year.

Although there have been minor changes in sources, operational definitions etc. throughout that reduce the comparability over time, the data for 1973, 1976, 1980, 1983 and 1986 were considered to be readily comparable by sources inside Statistics Norway (Schanke, 1989a and 1989b). The data for 1990 are somewhat special. The data were compiled at the request of the Norwegian Government in connection with the membership application to the European Union. The data were broken down on a finer territorial level (the old NUTS 3 equivalent – see Appendix A), but due to time pressure, some simplifications were done as far as the industrial breakdown was concerned and only the aggregate regional figures were published (Eek et al., op.cit).

Later, a database has been constructed for the whole 1973-1990 period (Sørensen, 1994). These data have two advantages. Efforts have been made to improve comparability, and additional information has been used to produce annual data. We have used the numbers on gross product and intermediate inputs from this database to compute gross value added.[18] However, as far as employment is concerned we have stuck to the years where original data are available, since the database provides no information on employment. Employment data for 1995 and 1990 have been obtained by intrapolation on the assumption that sectorial labor productivities have grown at constant county-specific rates between 1983 and 1986 (to obtain sectorial employment for each county in 1995) and between 1986 and 1992 (to obtain 1990 figures).

The national accounts went through a major revision in 1995. Norway was the first European country to implement the new international guidelines provided by the System of National Accounts (SNA 93) and the European System of National and Regional Accounts (ENS 95) (Fløttum et al., 2002). In addition, a new revision was undertaken in 1999. These efforts have led to improved quality and comparability in relation to the EU member states, and new consistent national data series have been constructed back to 1970. Unfortunately, this does not pertain to regional data.

[18] *In Ostbye and Westerlund (2003), we used aggregate gross value added from the database, but the sectorial distributions from the original data. The sectorial distribution in the original data turns out to be very different from the revised database.*

Data for 1992, 1993, 1995 and 1997 were all subject to the revision of 1995 (observe the long time lag – the 1992 figures were published in June 1996). Although continuous changes in sources and definitions make comparability between 1992, 1993, 1995 and 1997 less than perfect, these changes are assumed to be of minor importance compared to the change caused by the major 1995 revision which calls for caution when making comparisons with data prior to 1992. The most recent data for 1998, 1999 and 2000 were published in late spring 2003 and subject to the 1999 revision, which again calls for caution when making comparisons with figures before 1998.

Sweden

Regional production is proxied by the aggregated gross earnings of labor pertaining to work places located in the region. Gross earnings include all kinds of taxable income of labor. Data derive from the regional employers' mandatory reports to the National Tax Board. The classification of industries is based on SNI92 (Standard för svensk näringsgrensindelning 1992) corresponding to NACE rev. 1 (Nomenclature générale des Activités économiques dans la Communauté Européen). Data prior to 1994 have been recoded from the earlier classification SNI69, using the official key provided in MIS 1992:6 , Statistics Sweden (1992).

Appendix C

Additional regression results

Table C.1.S

Panel data for Swedish counties with NUTS2-specific constant terms

The A:s are county-specific constant terms. The numeration goes from 1 for Stockholm to 8 for Övre Norrland (the same ordering as in Table A.2). B is the rate of convergence. Estimation method: Nonlinear Least Squares.

```
Log of Likelihood Function =     313.482
Number of Observations =     72
```

Parameter	Estimate	Standard Error	t-statistic
A1	.187773E-02	.227908E-02	.823900
A2	-.455153E-03	.140347E-02	-.324305
A3	.130751E-02	.152706E-02	.856228
A4	.871094E-03	.163163E-02	.533878
A5	.653394E-03	.153285E-02	.426261
A6	-.168058E-04	.140304E-02	-.011978
A7	-.373641E-03	.180812E-02	-.206646
A8	-.514555E-03	.181182E-02	-.283999
B	-.269054E-02	.160798E-03	-16.7324

```
Sum of squared residuals = .696773E-03
Std. error of regression = .332564E-02
Variance of residuals = .110599E-04
```

Table C.1.N

Panel data for Norwegian counties with NUTS2-specific constant terms

The A:s are county-specific constant terms. The numeration goes from 1 for Østlandet to 5 for Nord-Norge (the same ordering as in Table A.1). B is the rate of convergence. Estimation method: Nonlinear Least Squares.

```
Log of Likelihood Function =     207.100
Number of Observations =     76
```

Parameter	Estimate	Standard Error	t-statistic
A1	.731236	.029335	24.9274
A2	.729766	.029543	24.7017
A3	.730565	.029346	24.8947
A4	.728160	.029375	24.7887
A5	.724827	.029214	24.8107
B	.065120	.366301E-02	17.7776

```
Sum of squared residuals = .019118
Std. error of regression = .016526
Variance of residuals = .273112E-03
```

Table C.2.S

Panel data for Swedish counties, county-specific constant terms

The A:s are county-specific constant terms. The numeration goes from 1 for Stockholm to 24 for Norrbotten (the same ordering as in Table A.2 and 5). B is the rate of convergence.

Estimation method: Nonlinear Least Squares.

```
Log of Likelihood Function =     347.599
Number of Observations =     72
```

Parameter	Estimate	Standard Error	t-statistic
A1	-.144353	.014237	-10.1393
A2	-.142403	.013922	-10.2289
A3	-.145096	.013904	-10.4355
A4	-.142060	.013928	-10.1993
A5	-.142027	.013856	-10.2504
A6	-.139729	.013841	-10.0953
A7	-.140183	.013781	-10.1718
A8	-.138568	.013620	-10.1740
A9	-.141234	.013894	-10.1654
A10	-.140483	.013782	-10.1935
A11	-.143431	.013982	-10.2585
A12	-.140583	.013775	-10.2055
A13	-.144335	.014063	-10.2638
A14	-.141094	.013821	-10.2085
A15	-.140651	.013780	-10.2068
A16	-.141797	.013864	-10.2280
A17	-.144216	.013935	-10.3495
A18	-.143607	.013973	-10.2773
A19	-.142981	.013865	-10.3122
A20	-.143411	.013877	-10.3348
A21	-.144240	.013949	-10.3402
A22	-.140948	.013751	-10.2499
A23	-.142436	.013863	-10.2747
A24	-.144366	.013966	-10.3368
B	-.021032	.170322E-02	-12.3485

```
Sum of squared residuals = .270098E-03
Std. error of regression = .239724E-02
Variance of residuals = .574676E-05
```

Table C.2.N

Panel data for Norwegian counties, county-specific constant terms

The A:s are county-specific constant terms. The numeration goes from 1 for Østfold to 19 for Finnmark (the same ordering as in Table A.1 and 5). B is the rate of convergence.
Estimation method: Nonlinear Least Squares.

Log of Likelihood Function = 210.737
Number of Observations = 76

Parameter	Estimate	Standard Error	t-statistic
A1	.735309	.032510	22.6178
A2	.746201	.032619	22.8761
A3	.751381	.033106	22.6964
A4	.731808	.032230	22.7060
A5	.730658	.032073	22.7810
A6	.737437	.032519	22.6771
A7	.734252	.032314	22.7224
A8	.735749	.032608	22.5632
A9	.736459	.032319	22.7872
A10	.732968	.032514	22.5429
A11	.739687	.032555	22.7208
A12	.739104	.032286	22.8926
A13	.733729	.032143	22.8268
A14	.738542	.032342	22.8352
A15	.736946	.032234	22.8625
A16	.732418	.031934	22.9355
A17	.734506	.032099	22.8825
A18	.731964	.032219	22.7183
A19	.727601	.032040	22.7093
B1	.065951	.394525E-02	16.7167

Sum of squared residuals = .017373
Std. error of regression = .017613
Variance of residuals = .310231E-03

Table C.3.S

Panel data for Swedish counties, county-specific parameters

The B:s are reported as county-specific convergence rates in Table 5 in the main text. The A:s are county-specific constant terms. The numeration goes from 1 for Stockholm to 24 for Norrbotten (the same ordering as in Table A.2 and 5). Estimation method: Nonlinear Least Squares.

Log of Likelihood Function = 371.495
Number of Observations = 72

Parameter	Estimate	Standard Error	t-statistic
A1	-.248137	.055360	-4.48228
A2	-.144576	.067980	-2.12674
A3	-.176198	.067576	-2.60742
A4	-.195657	.059751	-3.27456
A5	-.111207	.075105	-1.48070
A6	-.049920	.082957	-.601751
A7	-.111980	.071198	-1.57280
A8	-.156236	.062767	-2.48914
A9	-.182647	.059182	-3.08616
A10	-.116585	.071136	-1.63890
A11	-.229793	.057236	-4.01481
A12	-.072741	.081705	-.890285
A13	-.223989	.058225	-3.84696
A14	-.156975	.064063	-2.45034
A15	-.148529	.065728	-2.25973
A16	-.104272	.072986	-1.42866
A17	-.204937	.062257	-3.29179
A18	-.224156	.057232	-3.91659
A19	-.064930	.084324	-.770008
A20	-.205959	.060831	-3.38577
A21	-.083882	.083976	-.998878
A22	.012082	.108132	.111732
A23	-.114852	.072849	-1.57659
A24	.043514	.126543	.343863
B1	-.033157	.628559E-02	-5.27510
B2	-.021299	.834618E-02	-2.55199
B3	-.024827	.817113E-02	-3.03842
B4	-.027520	.712157E-02	-3.86426
B5	-.017190	.944523E-02	-1.82001
B6	-.962616E-02	.010820	-.889642
B7	-.017500	.898950E-02	-1.94672
B8	-.023242	.780719E-02	-2.97698
B9	-.026075	.711963E-02	-3.66235
B10	-.018043	.895879E-02	-2.01399
B11	-.031352	.667474E-02	-4.69705
B12	-.012431	.010569	-1.17616
B13	-.030513	.677719E-02	-4.50237
B14	-.022990	.786032E-02	-2.92484
B15	-.022009	.812630E-02	-2.70832
B16	-.016348	.920961E-02	-1.77510
B17	-.028364	.738790E-02	-3.83923
B18	-.030678	.669943E-02	-4.57921
B19	-.011172	.010900	-1.02499
B20	-.028612	.724064E-02	-3.95158

B21	-.013495	.010672	-1.26445
B22	-.107880E-02	.014776	-.073009
B23	-.017599	.913924E-02	-1.92563
B24	.332952E-02	.017378	.191597

Sum of squared residuals = .139072E-03
Std. error of regression = .240721E-02
Variance of residuals = .579468E-05

Table C.3.N

Panel data for Norwegian counties, county-specific parameters

The B:s are reported as county-specific convergence rates in Table 5 in the main text. The A:s are county-specific constant terms. The numeration goes from 1 for Østfold to 19 for Nord-Norge (the same ordering as in Table A.1 and 5). Estimation method: Nonlinear Least Squares.

Log of Likelihood Function = 212.193
Number of Observations = 76

Parameter	Estimate	Standard Error	t-statistic
A1	.760645	.167268	4.54746
A2	.786035	.153193	5.13100
A3	.749884	.172190	4.35498
A4	.739762	.164429	4.49898
A5	.727156	.158071	4.60017
A6	.786238	.163547	4.80740
A7	.666563	.164429	4.05381
A8	.695314	.168519	4.12602
A9	.682425	.164899	4.13843
A10	.703743	.170571	4.12580
A11	.787256	.163255	4.82226
A12	.725149	.155351	4.66782
A13	.638987	.157668	4.05274
A14	.766963	.160454	4.77995
A15	.737934	.158126	4.66674
A16	.707625	.152794	4.63122
A17	.732828	.155099	4.72490
A18	.831524	.160034	5.19593
A19	.758783	.172336	4.40294
B1	.069177	.021457	3.22398
B2	.071032	.019792	3.58888
B3	.065767	.021224	3.09868
B4	.066967	.021009	3.18751
B5	.065504	.020123	3.25525
B6	.072218	.021358	3.38136
B7	.057576	.019802	2.90758
B8	.060946	.020510	2.97161
B9	.059233	.020054	2.95368
B10	.062308	.020996	2.96762
B11	.072050	.021272	3.38705
B12	.064188	.019480	3.29515
B13	.054279	.018719	2.89960
B14	.069594	.020747	3.35450
B15	.066077	.020090	3.28905
B16	.062795	.019225	3.26639

B17	.065737	.019753	3.32797
B18	.079133	.022001	3.59675
B19	.069994	.022571	3.10107

Sum of squared residuals = .016720
Std. error of regression = .020976
Variance of residuals = .439996E-03

Table C.4

Panel data for Swedish counties, group-specific parameters

The 5 groups are based on similar estimates from Table C.3. The three-letter code defined in Table 1 is used. The A:s are constant terms, the B:s are rates of convergence. Estimation method: Nonlinear Least Squares.

Group 1: STH/GOB/VML/MLM
Group 2: GVL/ÖRE/ÖGL
Group 3: BLE/SML/GOT/ÄLV/SKA/UPP
Group 4: VSB/KRI/KAL/JÖN/VML
Group 5: VNL/HAL/KRO/KOP/JML/NOB

Log of Likelihood Function = 346.386
Number of Observations = 72

Parameter	Estimate	Standard Error	t-statistic
A1	-.219903	.024536	-8.96228
A2	-.201766	.030934	-6.52243
A3	-.131503	.023376	-5.62547
A4	-.105820	.028807	-3.67337
A5	-.021816	.032412	-.673083
B1	-.030084	.286142E-02	-10.5135
B2	-.028115	.368082E-02	-7.63833
B3	-.019790	.291101E-02	-6.79821
B4	-.016584	.364018E-02	-4.55579
B5	-.562772E-02	.430196E-02	-1.30817

Sum of squared residuals = .279349E-03
Std. error of regression = .212265E-02
Variance of residuals = .450562E-05

Table C.5.I

Primary sector: Panel data for Norwegian counties, county-specific parameters

The B:s are county-specific convergence rates. The A:s are county-specific constant terms. The numeration goes from 1 for Østfold to 19 for Nord-Norge (the same ordering as in Table A.1 and 5). Estimation method: Nonlinear Least Squares.

```
Log of Likelihood Function =     148.817
Number of Observations =     76
```

Parameter	Estimate	Standard Error	t-statistic
A1	1.16987	.426372	2.74377
A2	.921584	.442444	2.08294
A3	1.18437	.165098	7.17371
A4	.904754	.373912	2.41969
A5	.666327	.330216	2.01785
A6	.858876	.366092	2.34607
A7	.947103	.442605	2.13984
A8	.751633	.347299	2.16422
A9	.809969	.347318	2.33207
A10	.633931	.311481	2.03521
A11	.616672	.410643	1.50172
A12	.450812	.246225	1.83089
A13	.602962	.276640	2.17959
A14	.659432	.313308	2.10474
A15	.466540	.312402	1.49340
A16	.467941	.365207	1.28131
A17	.543372	.297491	1.82651
A18	.713078	.315636	2.25918
A19	.360375	.440536	.818037
B1	.143121	.088646	1.61452
B2	.097876	.069931	1.39960
B3	.132692	.032173	4.12433
B4	.091336	.056266	1.62328
B5	.060581	.042656	1.42022
B6	.086209	.053684	1.60585
B7	.101744	.071595	1.42111
B8	.070587	.046422	1.52056
B9	.078529	.048762	1.61045
B10	.057615	.039576	1.45581
B11	.055424	.051042	1.08584
B12	.030816	.026562	1.16015
B13	.051884	.034149	1.51933
B14	.056195	.038298	1.46731
B15	.035779	.034935	1.02415
B16	.036011	.040444	.890376
B17	.042641	.033920	1.25712
B18	.065136	.040948	1.59071
B19	.024385	.044159	.552199

```
Sum of squared residuals = .088621
Std. error of regression = .048292
Variance of residuals = .233214E-02
```

Table C.5.II

Secondary sector (manufacturing): Panel data for Norwegian counties, county-specific parameters

Log of Likelihood Function = 200.887
Number of Observations = 76

Parameter	Estimate	Standard Error	t-statistic
A1	.769679	.195536	3.93625
A2	.996740	.199212	5.00341
A3	.936640	.193513	4.84019
A4	.783191	.202313	3.87119
A5	.760750	.198149	3.83928
A6	.781182	.192369	4.06085
A7	.661679	.199114	3.32311
A8	.684935	.197698	3.46454
A9	.851876	.197374	4.31605
A10	.727769	.211379	3.44295
A11	.852680	.200203	4.25907
A12	.757671	.199302	3.80162
A13	.593299	.196042	3.02640
A14	.718215	.189564	3.78878
A15	.832270	.195916	4.24810
A16	.784125	.169796	4.61804
A17	.741541	.189335	3.91654
A18	.953827	.189675	5.02875
A19	.730363	.193828	3.76809
B1	.068785	.024610	2.79496
B2	.100017	.030223	3.30931
B3	.090956	.027727	3.28046
B4	.071806	.026231	2.73742
B5	.068450	.025206	2.71562
B6	.069889	.024371	2.86768
B7	.056458	.023533	2.39909
B8	.057991	.022986	2.52285
B9	.079889	.026707	2.99134
B10	.063901	.025591	2.49705
B11	.078499	.026496	2.96263
B12	.067448	.025021	2.69567
B13	.046926	.021507	2.18185
B14	.062433	.023205	2.69051
B15	.077839	.026281	2.96180
B16	.069815	.021622	3.22883
B17	.064794	.023311	2.77955
B18	.094879	.028268	3.35644
B19	.065410	.024533	2.66620

Sum of squared residuals = .022513
Std. error of regression = .024340
Variance of residuals = .592458E-03

Table C.5.III

Tertiary sector (services): Panel data for Norwegian counties, county-specific parameters

Log of Likelihood Function = 196.162
Number of Observations = 76

Parameter	Estimate	Standard Error	t-statistic
A1	.748103	.199683	3.74646
A2	.781318	.183794	4.25105
A3	.702325	.206804	3.39609
A4	.712478	.196904	3.61841
A5	.714742	.192175	3.71922
A6	.764835	.197569	3.87123
A7	.682833	.192540	3.54645
A8	.728516	.196748	3.70279
A9	.590081	.197230	2.99184
A10	.736084	.196458	3.74678
A11	.804560	.190906	4.21443
A12	.763687	.183997	4.15053
A13	.736248	.197733	3.72343
A14	.825183	.202330	4.07839
A15	.733626	.193636	3.78868
A16	.726458	.192378	3.77620
A17	.747761	.185153	4.03861
A18	.804154	.197768	4.06614
A19	.771744	.206975	3.72869
B1	.067930	.025562	2.65749
B2	.070309	.023633	2.97500
B3	.059872	.024637	2.43015
B4	.063579	.024689	2.57514
B5	.064113	.024259	2.64289
B6	.069988	.025605	2.73336
B7	.059463	.023526	2.52751
B8	.065557	.024974	2.62503
B9	.048550	.022629	2.14551
B10	.066543	.025055	2.65587
B11	.074946	.025495	2.93963
B12	.069255	.023870	2.90136
B13	.067315	.025547	2.63493
B14	.077798	.027474	2.83167
B15	.065499	.024506	2.67273
B16	.065807	.024714	2.66277
B17	.068166	.024092	2.82942
B18	.075613	.026626	2.83978
B19	.071901	.027462	2.61816

Sum of squared residuals = .025494
Std. error of regression = .025902
Variance of residuals = .670898E-03

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