The early regional development of human capital in Europe, 1790 – 1880

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Abstract

Recent theoretical advances underline the importance of human capital for long-run economic growth. However, lack of data makes it difficult to measure human capital before 1870 on the national level, let alone the regional level within countries. By using the age heaping method and a new large dataset, we approximate numeracy values in more than 500 regions in Europe between 1790 and 1880. Results indicate a significant gap in numeracy levels between advanced West and Central European countries and the rest of Europe. Nonetheless, differences in numeracy between and within countries converged over the century since the periphery caught up to the core European countries.

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Introduction

Human capital is one of the most important determinants of economic growth, particularly during the transition from Malthusian stagnation to modern growth as highlighted by Unified Growth Theory (Galor and Weil 2000, Galor and Moav 2002, Galor 2005). Already the first endogenous growth models in the 1980s underlined its major importance (Lucas 1988, Romer 1990). However, did the industrial revolution cause a similar explosion in human capital? Answering this question using quantitative techniques has turned out to be quite difficult. For European countries, estimations have been possible for some countries on the national level but at the regional level data is still missing. This paper aims at exploring human capital levels in European regions for the first time during the period 1790 to 1880 by using the "age heaping" method.

It is structured as follows: First, the existing evidence on the development of economic performance and of human capital in Europe in the 19th century is portrayed. Then, the age heaping method is presented in detail. Subsequently, the characteristics of the data and the spatial methodology are presented. Descriptive, cartographic and statistical results on mean numeracy values and regional disparities follow in the last section.

Differences between European countries in the 19th century

How did the economies of the various European countries in the 19th century develop in a comparative view? O'Rourke and Williamson (1997) state that economic performance was converging between the "core" and the "periphery" countries in Europe during the second part of the 19th century. "Core" describes at the same time the geographic location of countries in Europe as well as their industrial output. In this context, core countries are Belgium, France, Germany, Great Britain, The Netherlands and Switzerland, whereas the periphery countries are constituted by e.g. Finland, Ireland, Italy or Spain. Taking GDP per capita as an example, the authors conclude that periphery countries had only values of about a third of the core countries in 1870. Even though the periphery advanced until 1914, the later decades revealed important growth differences within this group. Particularly the Scandinavian countries caught up to the core whereas other countries in Southern Europe stayed behind. A factor for these different experiences was education (e.g. Sandberg 1979, Cipolla 1969, Tortella 1994).

Human capital in Europe

Evidence on regional development and regional disparities of human capital in Europe before the 20th century is rather scarce, particularly for the time before 1870. Human capital cannot be measured itself but has to be approximated by related, quantifiable variables. Examples of such proxies employed for modern times include literacy, enrolment rates, years of schooling or books per capita (e.g. Becker and Wößmann 2009, Benavot and Riddle 1988; for a discussion see Wößmann 2003). Becker and Wößmann (2009) argue that Religion has an influence on literacy since Protestantism encouraged reading the bible which was less the case for Catholicism. Similarly, Baten and van Zanden (2008) instrument human capital with religious diversity. Furthermore, human capital might have played a crucial role on the demographic transition within Europe as it has an important impact on fertility rates (Becker et al. 2009). Yet the causal relationship of fertility and human capital is not yet established since causation runs both ways in the study of Becker et al. (2009).

In addition to these indicators, the beginning of compulsory schooling might have had an effect on later educational levels. A minimum level of education of soldiers and ordinary citizens was supposed to ameliorate the military and economic position of the country (Brint 2006). The introduction of compulsory schooling, as evidenced by corresponding laws, varied enormously in European countries. Prussia, Sweden and Scotland were the first European countries to introduce compulsory schooling. Denmark (1814), Greece (1834) and Spain

(1838) were the first to follow in the 19th century, whereas other Western European countries such as Belgium (1914) or the Netherlands (1900) were very late in this respect. However, passing schooling laws and the reality of schooling have often been two different matters (e.g. Flora 1975). Other additional methodological concerns arise since compulsory schooling laws meant in part merely to erect school buildings. This, however, is not always equivalent to teaching pupils on a compulsory basis. For these reasons, compulsory schooling laws are not an appropriate means to measure time differences in human capital development since early schooling laws did not at all ensure having higher enrolment rates in later decades and centuries (Adick 2003). For instance, Prussia's initial lead in schooling laws in the 18th century did not result in higher enrolment rates at the end of the 19th century than in countries which *did* not have had such laws passed until then (Schneider 1982).

Most methods measuring human capital are not able to estimate human capital levels before the second part of the 19th century. To achieve this, signature capacity rates are used in a range of studies (e.g. Reis 2005, Mitch 1993, Schofield 1981). The potential disadvantages of this method are openly acknowledged by their applicants. For instance, it is not always possible to discern if the person himself signed a marriage contract or other documents and what importance has to be attributed to the responsible priest in this context. Additionally, this indicator is not always available in order to compare the regions of Europe on a larger scale.

By contrast, the "age heaping" strategy allows going beyond most of the limitations already mentioned. Thus, A'Hearn et al. (2009) trace numeracy levels for 16 European countries between 1350 and 1840. They observe a striking discrepancy between numeracy in Western Europe (e. g. France, UK, the Netherlands) and Eastern Europe. High numeracy levels were found for the Western European and Scandinavian countries already in the 17th and 18th centuries. Central Europe generally comes close to Western European numeracy levels, whereas Eastern Europe stays far behind. However, the divergence is the largest at the beginning of the data for Eastern Europe in the 17th century. This implies overall convergence in later periods. Similar results were established in an even more recent study on the development of global numeracy (Crayen and Baten 2010).

Age Heaping

What, then, is “age heaping”? This method investigates numeric skills of a population and has been used in a multitude of recent studies (e. g. A’Hearn et al. 2009, Manzel and Baten 2009, de Moor and van Zanden 2008, Clark 2007, O’Grada 2006). The age heaping method looks at the statements made in census records with respect to age. In earlier times in Europe, parts of a population did not know their exact age.[3] Consequently, individuals rounded their ages on “0” and “5”. For example, a 47 year old man erroneously told the census taker that he was 50 years old. Census records therefore depict a typical heaping on these ages.

Other factors than human capital could also be attributed to this phenomenon. For instance, false age declarations effected on purpose (e.g. to avoid the negative consequences of being part a particular age group) and bad state administrations played some role. The awareness of one’s age in early adulthood is also often increased thank to events such as marriage. However, other studies have already demonstrated that human capital plays the most important role for age heaping (Crayen and Baten 2010).

Moreover, age heaping highly correlates with literacy indicators when both are available (Crayen and Baten 2010). Contrasting literacy rates, the indicator measuring age heaping is calculated by using the data on the age distribution in the population statistics and is not already explicitly given in the statistics. By consequence, it is less prone to voluntary manipulation by state authorities. These may possibly have had in some cases an interest to govern a population characterised by high literacy levels in order to hush up the backwardness of their education and their economic system. Nevertheless, statisticians may be tempted to

[3] Yet age heaping is still to be observed in current censuses in parts of Asia and Africa.

smooth the peaks in the age distributions to arrive at the real age structure.[4] In addition to factors such as costs and time consumption invested in establishing detailed statistics for individual age years, this may be another reason why a range of census publications do not contain tables on individual ages but on age groups.

All in all, age heaping allows measuring basic numeric skills of a population in general and to analyse the development of human capital in most European regions in a long-term perspective in particular. In this paper, it is calculated by using a transformed Whipple Index, the so called ABCC Index. The Whipple Index (WI) relates the number of age observations on “0” and “5” to the total of observations. It is defined as follows:

$$WI = \frac{\sum_{i=5}^{14} n_{5i}}{\frac{1}{5}\sum_{i=23}^{72} n_i} \times 100,$$

where *i* stands for years of age and *n* for the number of observations. Values range between 100 and 500[5], where a value of 100 means that age heaping is not present and 500 all age observations end on “0” and “5”. Since this range is not very intuitive, A’Hearn et al. (2009) have proposed a new index, the so-called ABCC Index[6]. It is a linear transformation of the Whipple Index, as can be seen by the subsequent formula:

$$ABCC = \left(1 - \frac{WI - 100}{400}\right) \times 100.$$

The ABCC Index has the advantage to be handier and more comprehensive than the Whipple Index. Values are in the limits of 0 to 100, where 100 is the maximum numeracy level and 0 the lowest. Therefore, the following analyses are performed by using the ABCC Index.

Data

[4] Yet if they did so, then normally age heaping is equal to zero which can be mostly identified.
[5] Values below 100 are also possible but are normally found in samples with a low number of observations.
[6] The abbreviation “ABCC” mainly refers to the first letter of the authors names.

To compare the development of numeracy in most European regions, a new large dataset has been assembled from many individual sources. Sources are typically census records. This has the advantage that official documents are used. These are often well documented with respect to the methods employed during the census taking. Possible measurement problems can thus be avoided or corrected. Altogether, the database is made up of samples covering over 500 regions in 35 European countries (in today's borders) in the time span between 1790 and 1880. An overview of countries covered in this study and the corresponding time frame is given in Table 1. Since national borders changed during the 19th century (e.g. the French region Alsace was annexed by the German Empire in 1871), it is possible that a region is not listed in any available census or is included in censuses of two different countries. In the former case, we had to limit ourselves to these data restrictions, in the latter we interpolated the corresponding regional values or opted for the most appropriate one for inner-country comparisons.

For the age heaping method to be employed, data on individual ages is required. Unfortunately, some countries preferred not to ask the individuals of their population their exact age but instead these had to declare their age in certain age groups (20 – 25 years or 20 – 30 years, etc.). In these cases, it is not possible to employ the age heaping method. By contrast, sometimes countries preferred to indicate aggregated age groups in their official census publications instead of individual years due to space requirements or other reasons. This is valid for available publications of e.g. Portugal and Greece in the considered time period. Consequently, the evidence does not yet cover all European countries nor all birth decades in the period under study between 1790 and 1880. However, further research may allow collecting data for these countries or for a larger time span in some countries.

Looking at the regional level, it is important to define a "region" first. The territorial definition of a region corresponds to the current NUTS classification employed by the

European Union.[7] It is obvious that territorial units in the European countries in the 19th century were in many cases quite different from today.[8] In particular, the two World Wars changed the territories of many already existing countries and new countries were formed by splitting up old Empires (in particular Austria-Hungary). Besides, World War II had major impacts on the (ethnic and linguistic) composition of the population of many regions and administrative reforms carried out by the states changed the territorial characteristics of a multitude of regions.

By contrast, the population density itself has stayed more or less the same during the last 200 years, as shows Martí-Henneberg (2005). The author measured a high correlation of 0.83 comparing the population density patterns in the years 1870 and 2000. Thus, highly populated areas have globally stayed the same and have attracted individuals for decades and centuries. Based on this result, current population density patterns may correspond roughly to those in the second half of the 19th century and in many cases even before.

Having this in mind, it is clear that the use of NUTS territorial categories does allow to a certain extent a rough estimation of actual regional human capital values. Additionally, this method gives us the possibility to compare the data for the 19th century with more recent ones in future research. Consequently, we chose to adapt territorial administrative divisions of the 19th century as best as possible to those of the current NUTS classification, even though this leads inevitably to some geographical inaccuracies. Thus, data between 1790 and 1880 are available for some countries at the NUTS3 and others at the NUTS2 level. To harmonise territorial sizes we opted for the smaller NUTS2-level for all regions in our further data analysis. Unfortunately, the NUTS classification is only available for member states of the European Union and candidature countries as well as EFTA members. For this reason, a

[7] NUTS stands in French for "Nomenclature des Unités Territoriales Statistiques" (Nomenclature of Territorial Units for Statistics) and was adopted in 1988 in order to produce regional statistics within the European Union. Concerning geographical coverage, NUTS covers EU27, EFTA countries and Candidate Countries whose aim is to join the EU.

[8] Notable exceptions are e.g. Spain and France.

somewhat corresponding classification had to be found for other European countries. This concerned in particular countries located in East and South-East Europe such as Ukraine, Belarus and Serbia. We take the current territorial administrative division of these countries.[9] Table 2 gives more details on the countries and the regions contained in our data set.

Development of human capital in European countries

Due to the large number of countries under study, the European countries have been divided into several macroregions (Core industrial European countries[10], Austria-Hungary, Western European periphery countries (Ireland, Italy, Spain, Scandinavia), East European countries and South-East European countries; for more details see Table 3). The attribution to one macroregion was effected mainly by reason of geographical location and economic output.

In order to obtain a general idea of ABCC values for Europe, Figure 1 depicts the mean ABCC values for all European countries between 1790 and 1880. It shows only general tendencies and hence country labels have been omitted. More details on the various geographical macroregions can be found in Figure 2 to Figure 6. Since the focus here is on the differences within the macroregions and on a clear visualisation of ABCC trends, the scale of the ABCC mean values is *very* different in each figure. This has always to be taken into account when interpreting the development of ABCC values. On the other hand, it makes the interpretation of trends within the macroregions easier.

Several results can be highlighted: Firstly, countries from the European "core" are characterised by high ABCC values already at the beginning of the 19th century. Differences between these countries are minor, even if France catches up to Belgium or the Netherlands between 1790 and 1820.

[9] This is also proposed by the ArcGIS software we use for cartographic presentation of our results.
[10] Our classification for the core countries corresponds to the one employed by O'Rourke and Williamson (1997).

More diverse are the regional divergences in the Austro-Hungarian Empire. Looking at Cisleithania (today mainly constituted by Austria, the Czech Republic and Slovenia), ABCC values are very high and similar to those in the "core". The picture is quite different for Transleithania (today mainly Hungary, Slovakia, parts of Romania and Croatia[11]): Croatia enjoyed the highest ABCC values initially, followed by Hungary, Slovakia and today's Romanian provinces. Interestingly, this order stays rather constant over time, only Romania overtook Slovakia. Croatian and Romanian provinces follow similar patterns which is also true of Hungary and Slovakia. All parts of Transleithania are converging over the time span covered.

Moreover, the Scandinavian countries feature very high ABCC values. Italy and Spain are evolving rather slowly. Ireland is on a much lower level than other Western European countries.

Most regions of the Russian Empire form part of the category of East European countries. The range of ABCC values is very striking. It is astonishing that the Baltic States have so varied ABCC levels: Estonia is characterised by ABCC levels on the same level as in the core countries, whereas Latvia and Lithuania follow after large intervals. Latvia is with Belarus at the end of the numeracy ladder. Poland has initially quite a lead to Russia and Ukraine.

Finally, South-East Europe features the lowest numeracy values in our data set. The Caucasus regions (forming part of the Russian Empire) are the least numerate of all European regions. Numeracy in Bulgaria is a bit higher and increasing. Serbia (YU), Macedonia and Cyprus do better but their earliest birth decades are already relatively late with respect to the other countries.

All in all, we find noticeable differences in numeracy between and within the observed macroregions

[11] Today's Croatia was split between Cisleithania (mostly Dalmatia) and Transleithania (Croatia-Slavonia). Here we refer only to the part belonging to Transleithania.

Regional differences at the European level

For an additional insight into the regional disparities of European regions, Figure 7 to Figure 13 depict the cartographic representation of regional ABCC values between 1800 and 1860.[12] Some supplementary information is revealed by the maps. For example, there is a generalised North-South in Italy and a South-North divergence in Norway. A similar observation can be made for the first birth decades observed in Great Britain. Concerning Italy, its territorial division prior to 1861 also affected its human capital distribution: Northern regions have mostly higher ABCC values than southern ones. Economic differences between the South and the North of Italy prevail until today. German speaking regions in Germany and Cisleithania have high ABCC values. Furthermore, a core-periphery pattern discernible in Spain.

Disparities of regional human capital distribution

After these first cartographic impressions, can we statistically observe regional differences in the distribution of human capital within countries? Does convergence occur over time? To answer these questions we measure regional disparity by using the coefficient of variation (CV) which is defined as the standard deviation of regional ABCC values of a country divided by the average ABCC value of a country. We proceed similarly to the description of ABCC means[13]. However, we exclude those countries that had nearly solved their basic numeracy problem because the proximity to an ABCC value of 100 would bias the CVs. This applies to Core and Scandinavian countries. Thus, Figure 14 shows the general results over time and

[12] In order to discern as many regional differences as possible, the lowest available administrative classification (NUTS 3 or NUTS 2) has been selected in the cartographic representation. Some East European countries or parts of them have been omitted (e. g. Russia, the Caucasus countries) in order to depict more clearly the majority of regions in our data set. Note also that Danish ABCC values have not yet been included in the following maps.

[13] With regard to the ABCC mean, not all countries are included this time since for the smaller ones (e.g. Luxembourg, Iceland, Estonia, Cyprus) only data on the national level is available and thus regional disparities cannot be measured.

Figure 15 to Figure 18 the outcomes for the macroregions. As in the case of the ABCC means, please note the different scales.

Considerable differences in the CV can be found in Transleithania, Ireland, Italy and Spain. Numeracy in East European regions within their modern frontiers is widely dispersed. A particular case is Serbia. Serbia (YU) already includes in this case the region of Vojvodina[14] which belonged to Transleithania but was united with Serbia after World War I. This northern region features considerably higher ABCC values than the rest of Serbia. This has led to the very high coefficient of variation and may also highlight the persistence of regional human capital patterns. The only country with widening regional disparities in our sample is Bulgaria. In Bulgaria the southern regions advance much more in ABCC values than their northern counterparts, resulting in an increasing South-North gap.

In a nutshell, in almost all countries convergence is taking place. This can be taken as an important preliminary result of this paper.

Conclusion

This paper has examined the long-term development of human capital in more than 500 regions in Europe between 1790 and 1880. We have used age heaping to approximate human capital values and the NUTS classification to categorise regions according to current national borders. Even though both methods have their limitations and are prone to some possible biases, this has enabled us to estimate for the first time levels of human capital for most European countries in the 19th century.

Core Western and Central European countries enjoyed high numeracy levels and showed rather low spatial divergences of their human capital distribution throughout the period. Low and medium levels of numeracy as well as regional disparities were dominating in periphery countries. However, many of these countries caught up by the middle of the 19th century.

[14] The underlying census was the first undertaken in Yugoslavia 1921.

Therefore, we observe converging numeracy levels over the century. Future research will focus on possible explanations of intranational differences in numeracy by using e.g. distribution of urbanisation rates, land inequalities, democracy, religion, transport systems, schooling institutions and income levels. Furthermore, more spatial and geographic factors will be included in order to obtain deeper insights in the regional distribution of human capital.

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Appendix

Table 1 Time span of covered countries

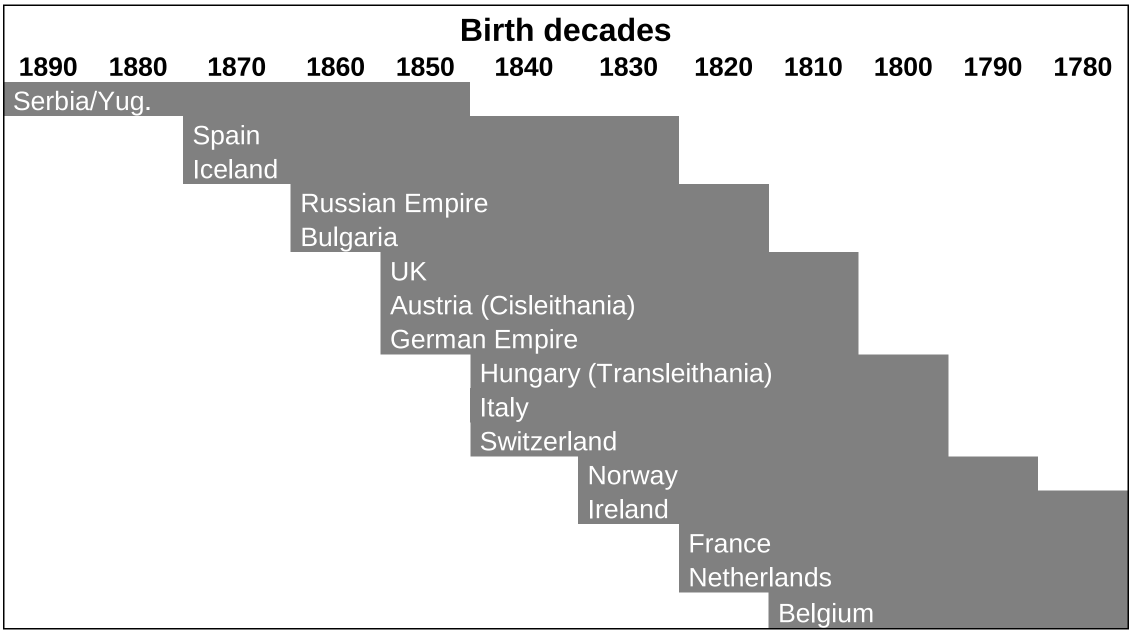

Table 2 Regional classification units

Code	Country	NUTS3	NUTS2	NUTS1	Non-NUTS[15]
AM	Armenia				1
AT	Austria	33			
AZ	Azerbaijan				1
BE	Belgium		11		
BG	Bulgaria		5		
BY	Belarus				4
CH	Switzerland	25			
CY	Cyprus			1	
CZ	Czech Rep.	14			
DE	Germany		46		
DK	Denmark	10			
EE	Estonia			1	
ES	Spain	49			
FR	France	85			
GE	Georgia				1
HR	Croatia	11			
HU	Hungary	19			
IE	Ireland		2		
IS	Iceland			1	
IT	Italy		22		
LT	Lithuania			1	
LU	Luxembourg			1	
LV	Latvia			1	
MD	Moldova				1
MK	FYROM				1
NL	Netherlands		11		
NO	Norway	19			
PL	Poland		7		
RO	Romania	16			
RU	Russia				34
SI	Slovenia	11			
SK	Slovakia	7			
UA	Ukraine				15
UK	United Kingdom	32			
YU (CS)	Serbia[16]				3

Note: Always the lowest available administrative division is listed. Regions are joined to construct country borders as in the 19th century in certain cases (e.g. Germany and Poland).

[15] "Non-NUTS" refers to countries which are not in the NUTS classification in this paper.
[16] Includes Vojvodina, Montenegro and Kosovo.

Figure 1 Mean ABCC values for all European countries

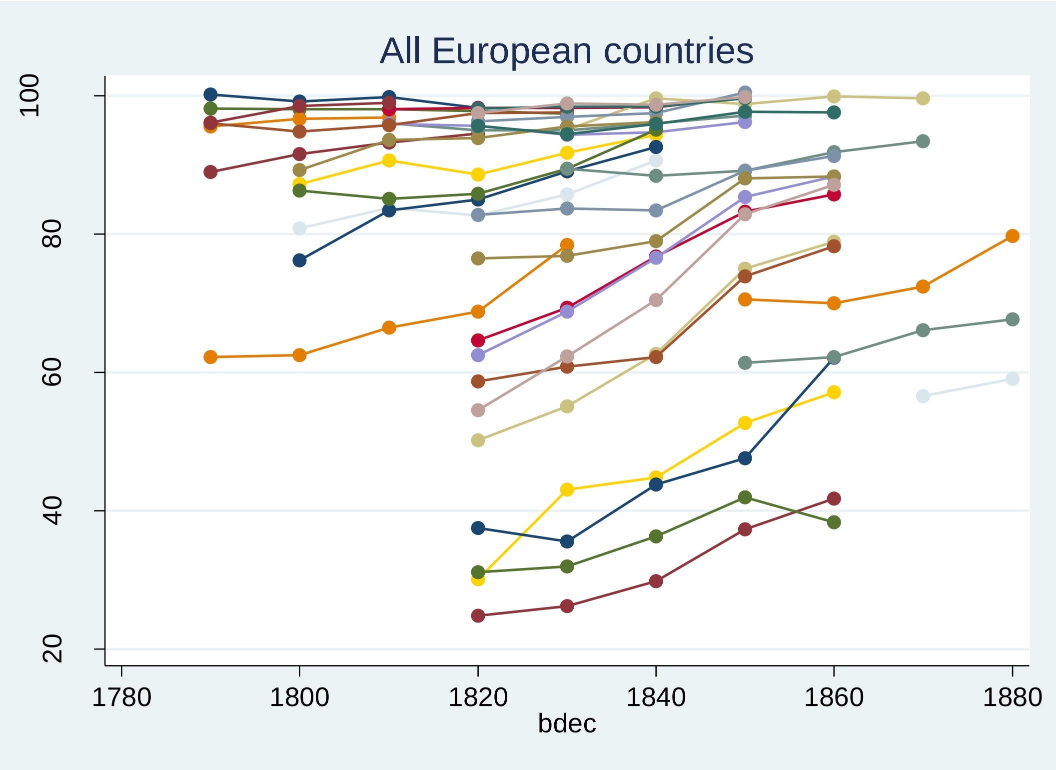

Table 3 Classification of countries to European macroregions

Core Europe	Austria-Hungary	Western Periphery	East Europe	South-East Europe
BE	AT	DK	BY	AM
CH	CZ	IE	LT	AZ
DE	HR	IS	LV	BG
FR	HU	ES	EE	CY
LU	RO	IT	PL	GE
NL	SI	NO	MD	MK
UK	SK		RU	YU (CS)
			UA	

Figure 2 ABCC of Core European countries

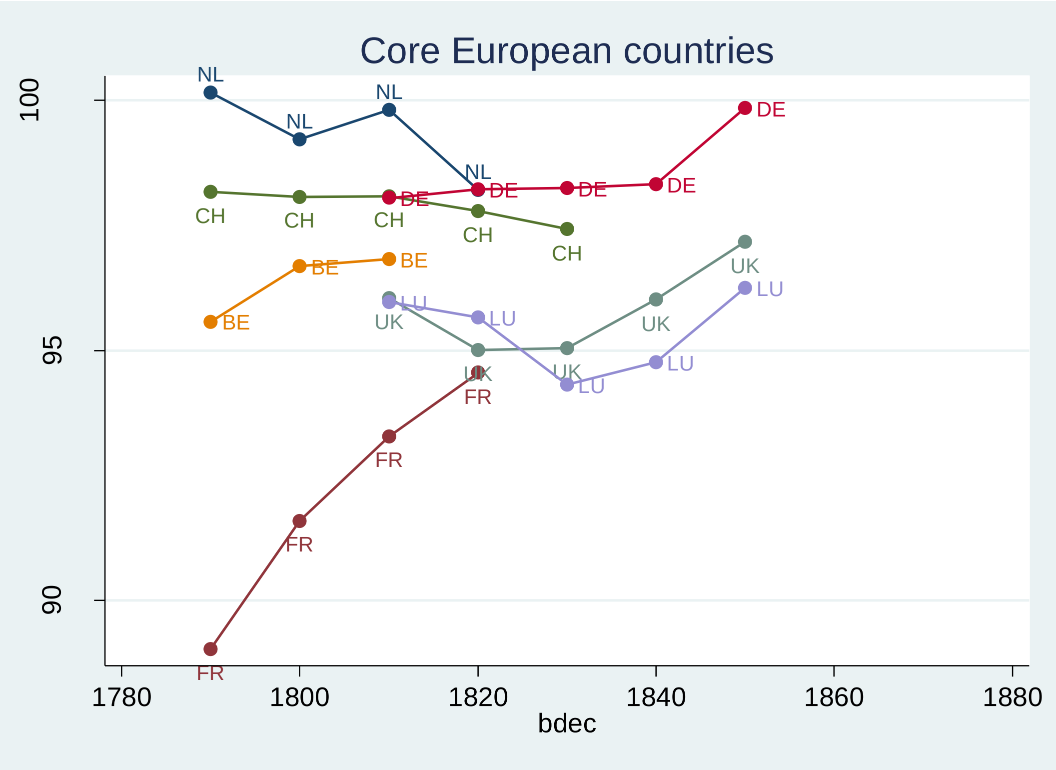

Figure 3 ABCC mean of the regions of Austria-Hungarian

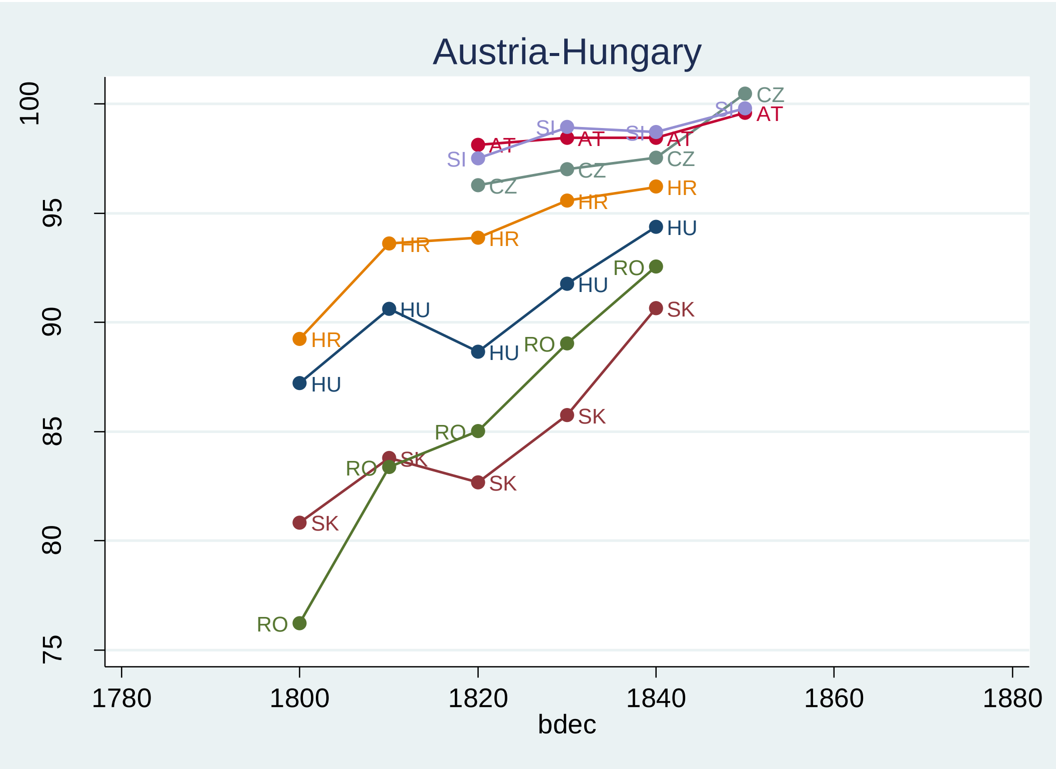

Figure 4 ABCC mean of Ireland, Italy, Spain and Scandinavian countries

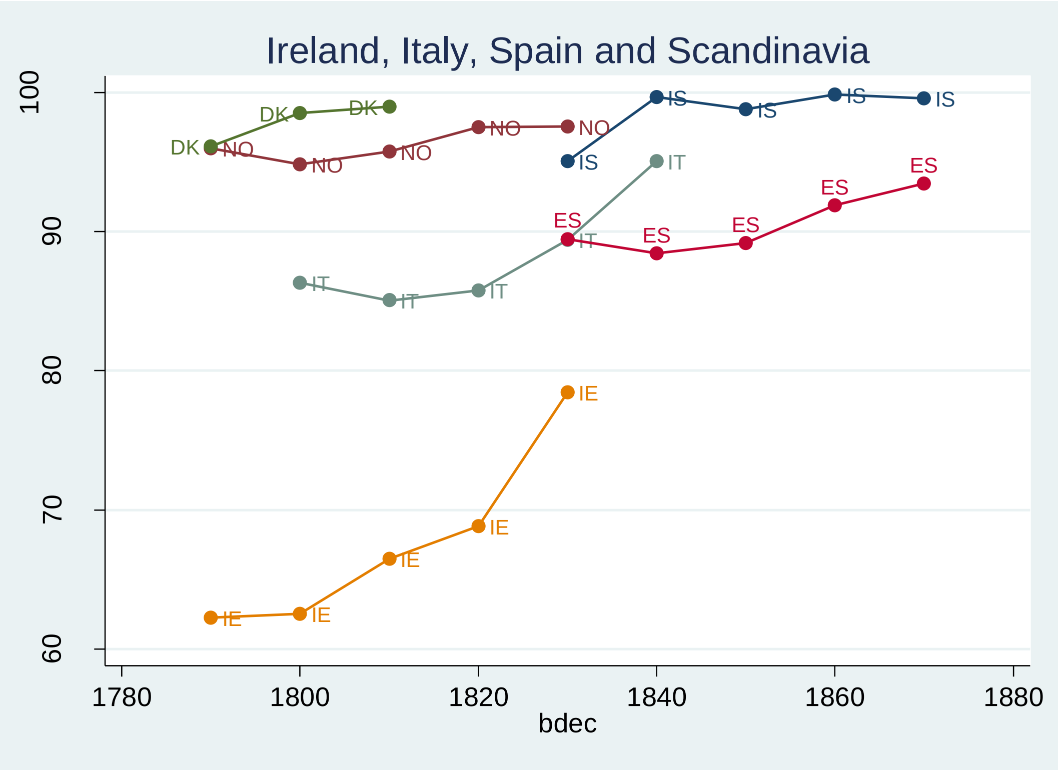

Figure 5 ABCC mean of East European countries

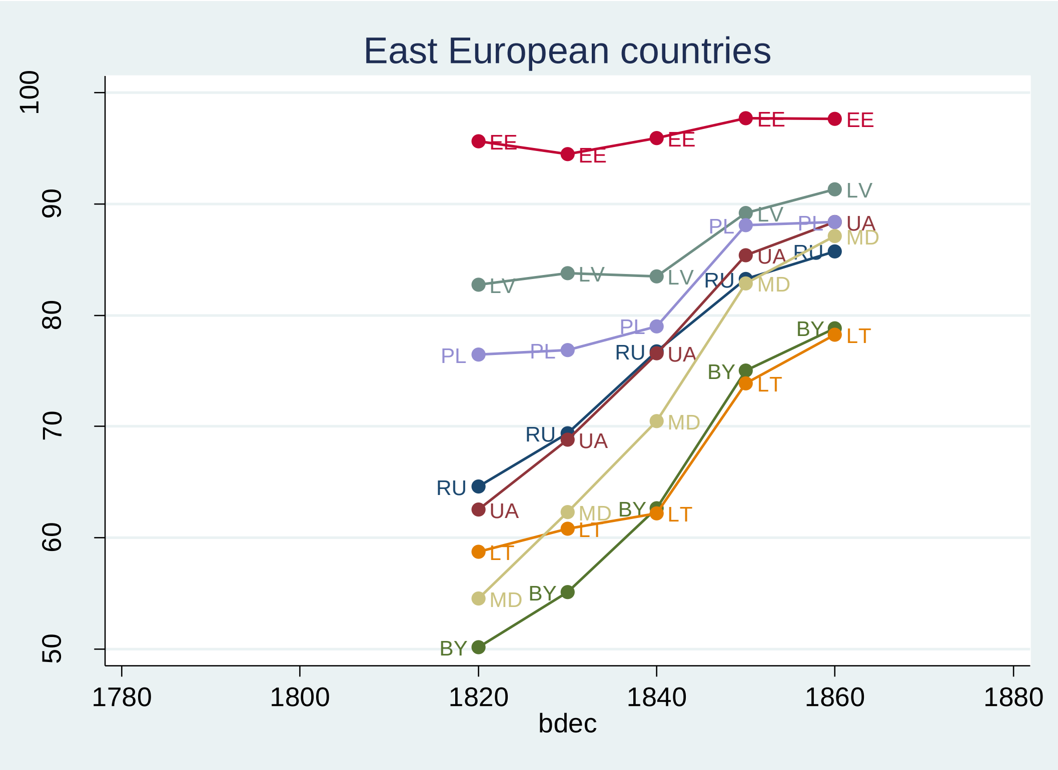

Figure 6 ABCC mean of South-East European countries

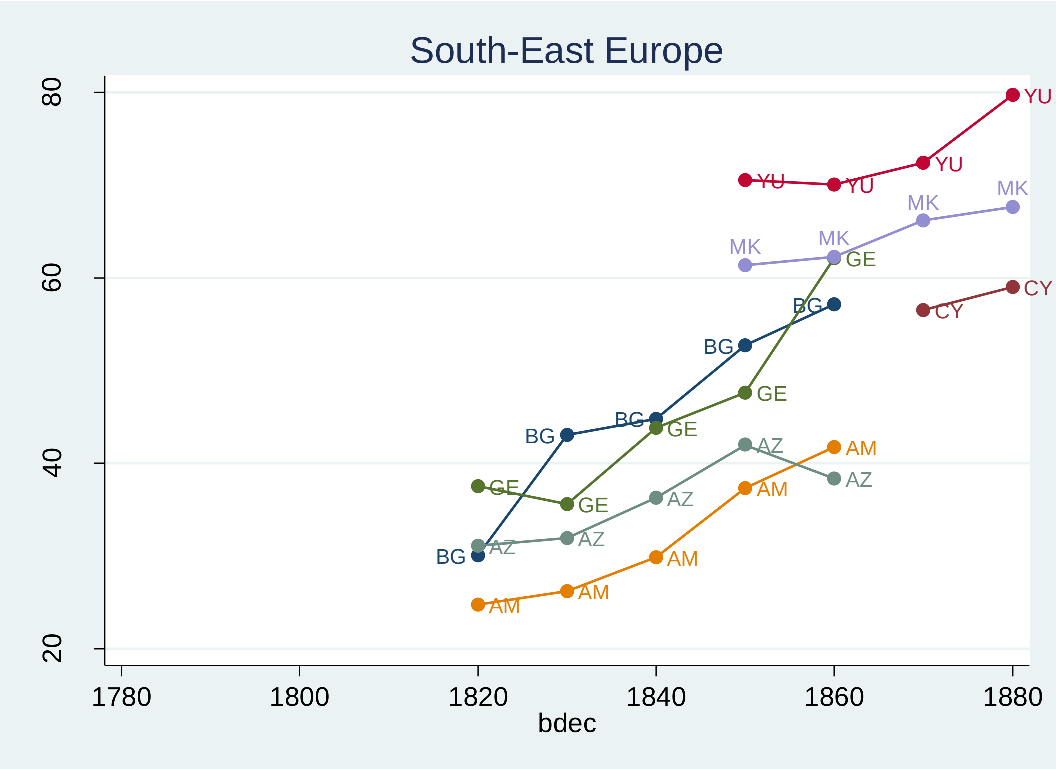

Figure 7 Regional ABCC differences in 1800

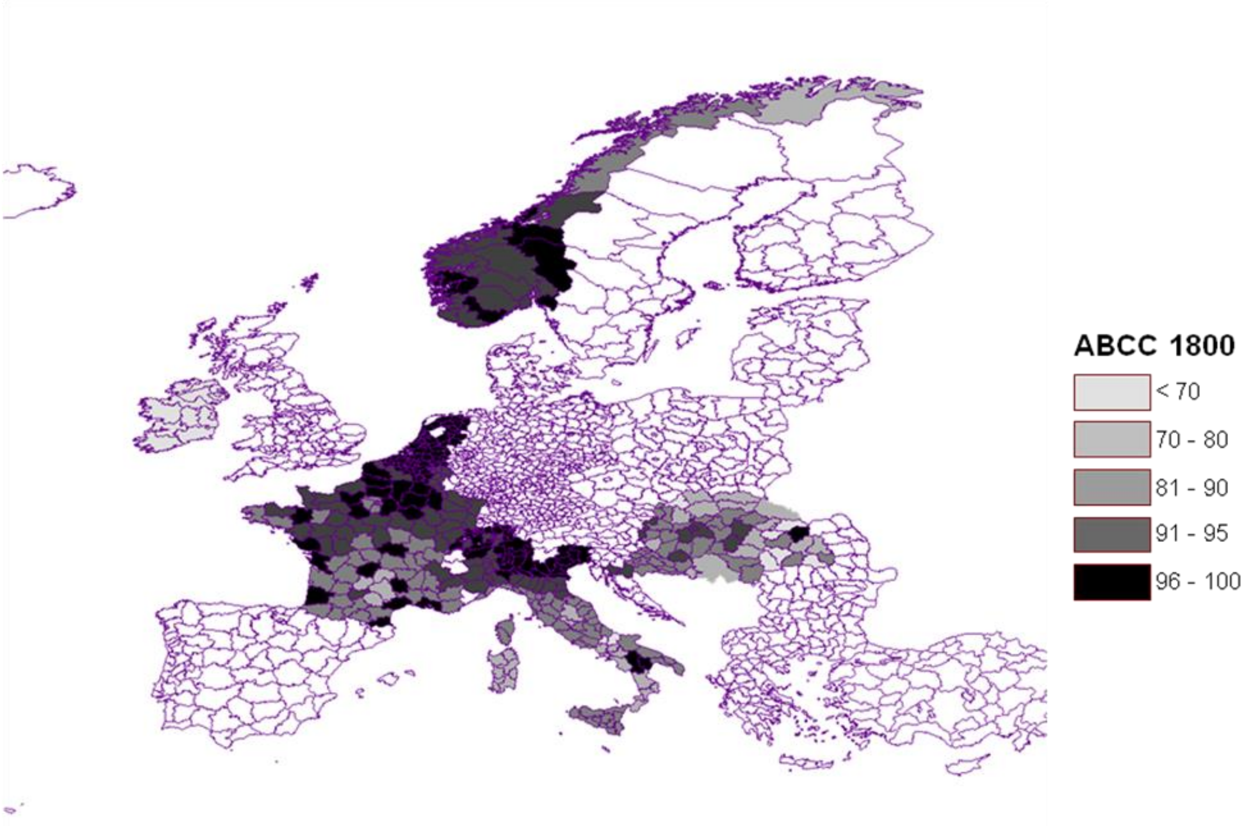

Figure 8 Regional ABCC differences in 1810

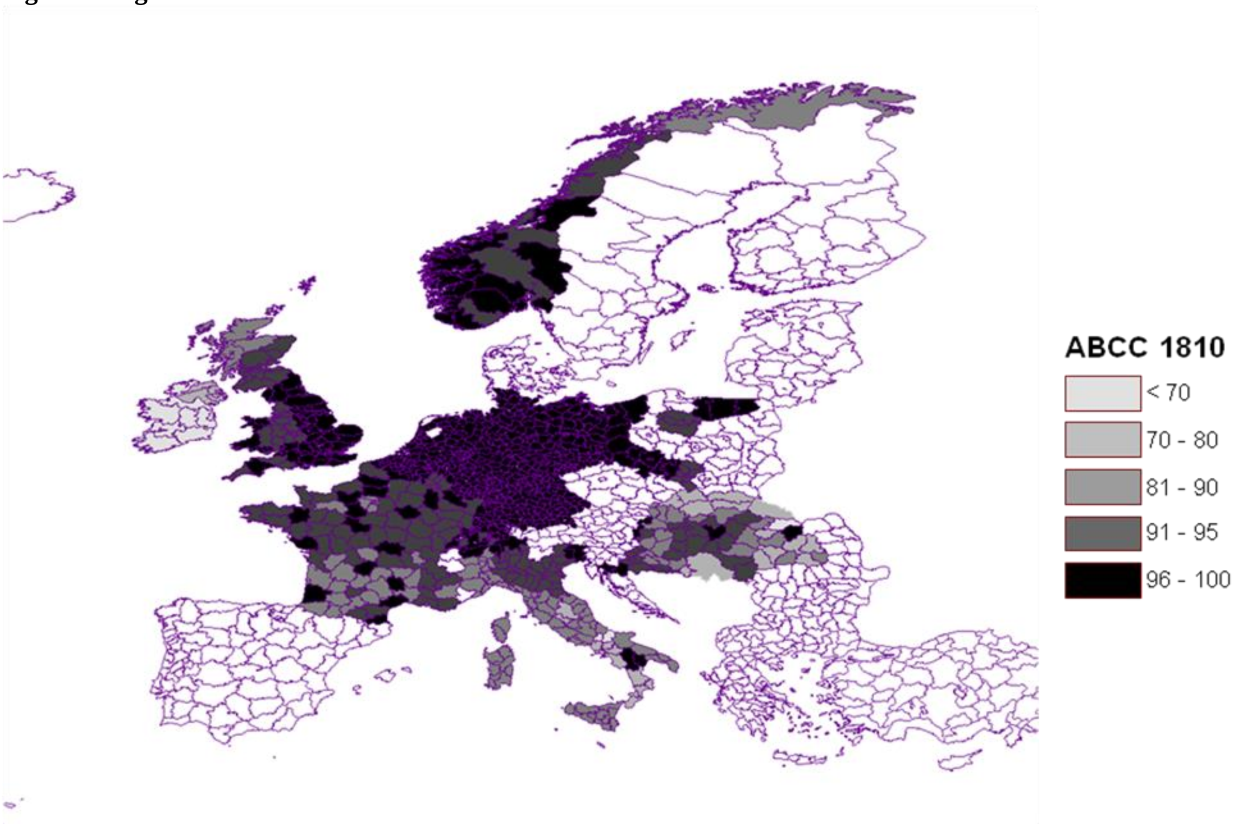

Figure 9 Regional ABCC differences in 1820

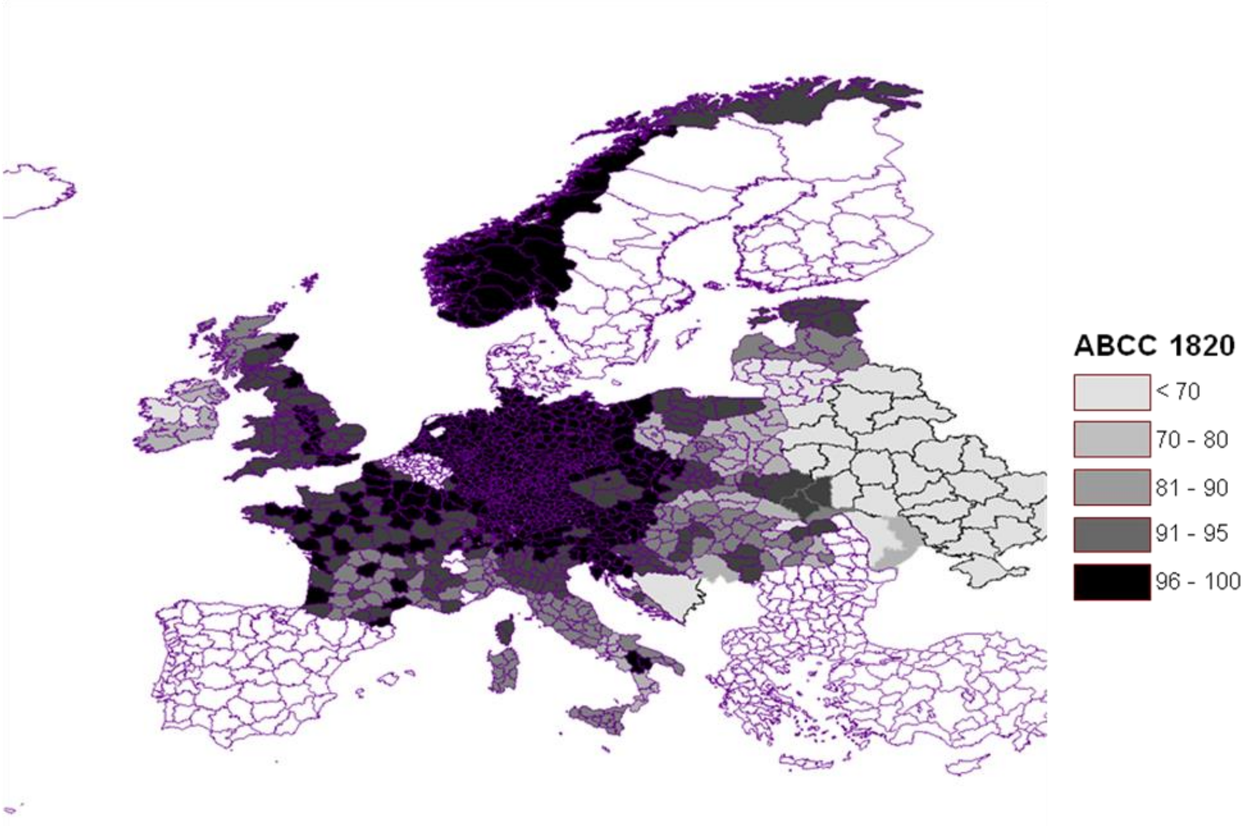

Figure 10 Regional ABCC differences in 1830

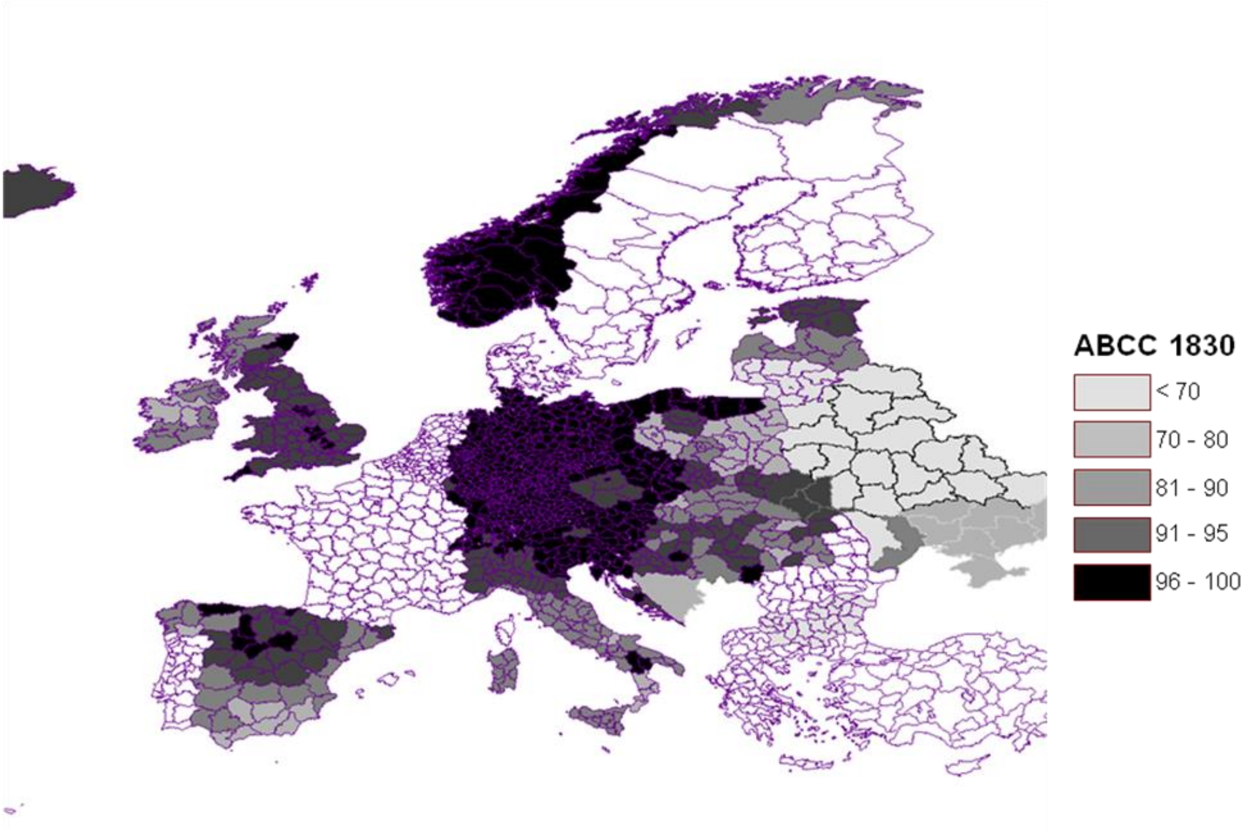

Figure 11 Regional ABCC differences in 1840

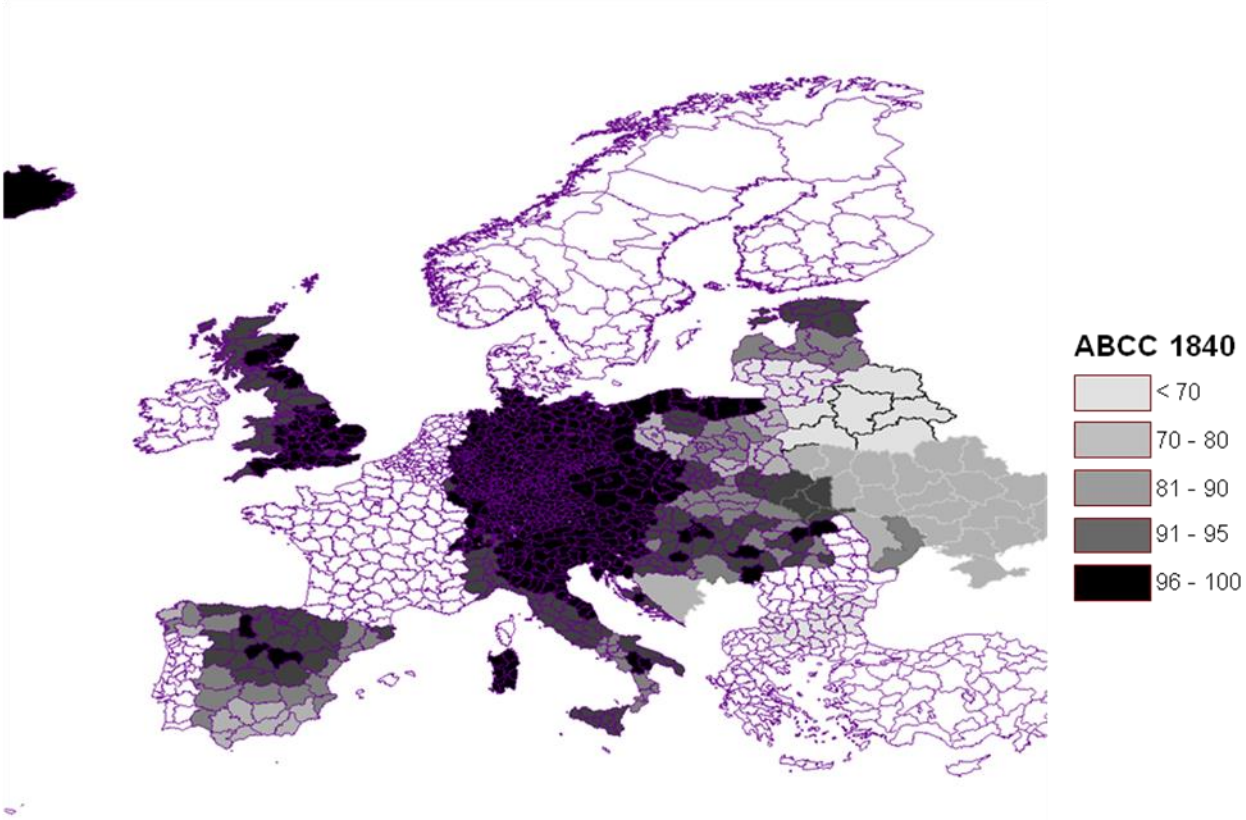

Figure 12 Regional ABCC differences in 1850

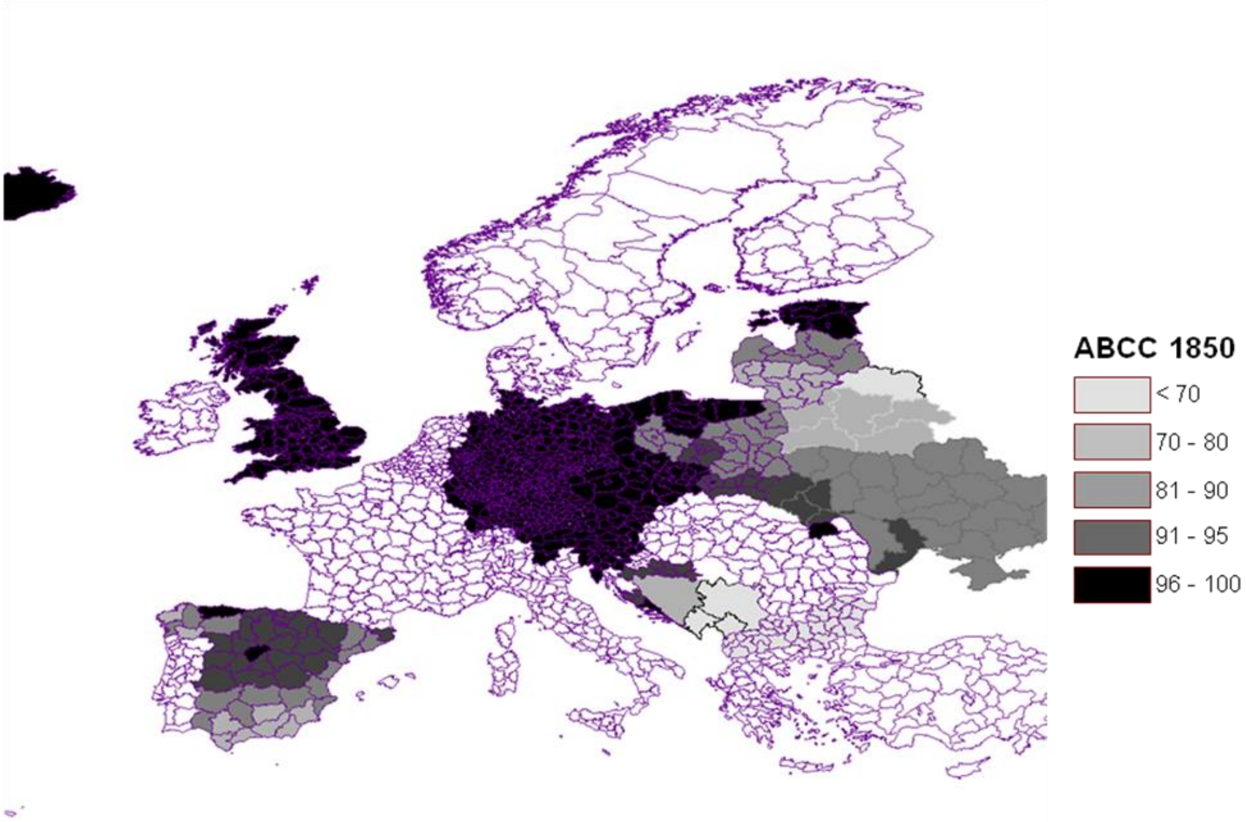

Figure 13 Regional ABCC differences in 1860

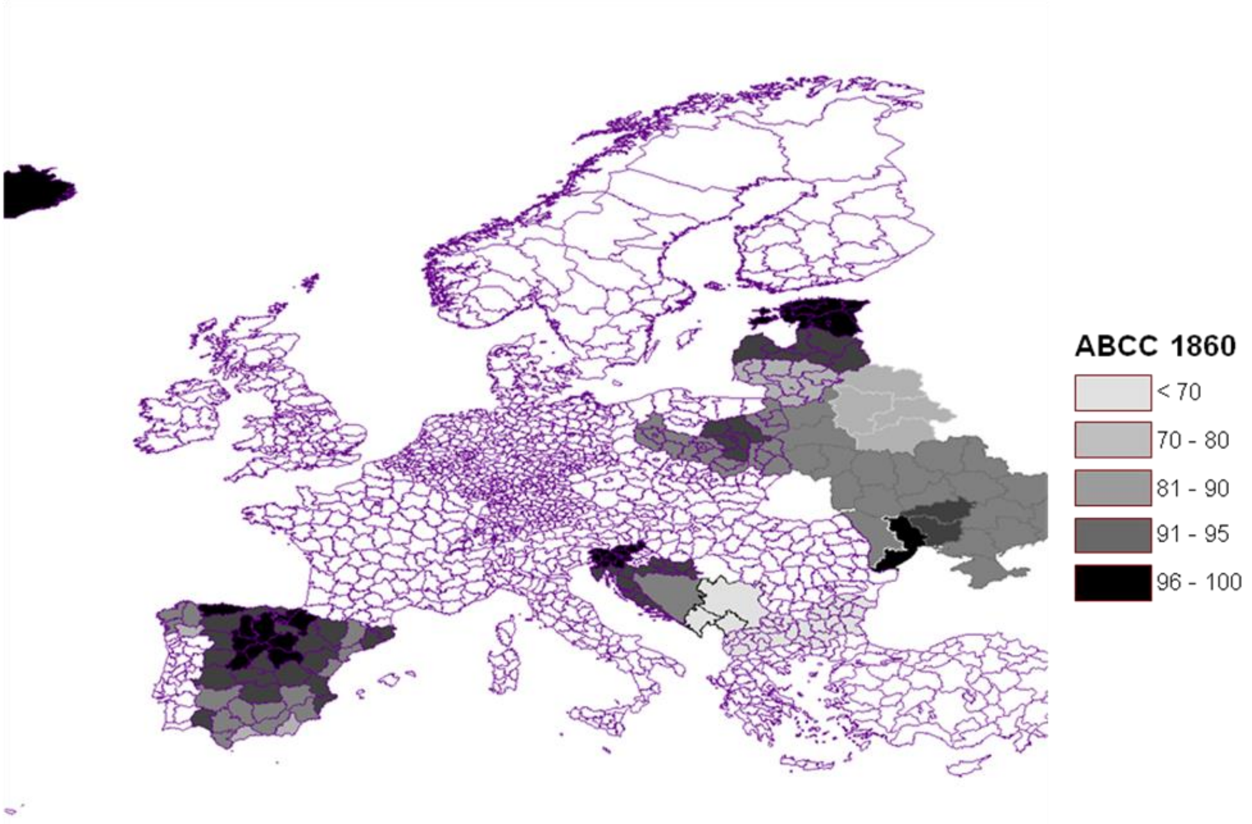

Figure 14 ABCC CV of all European countries

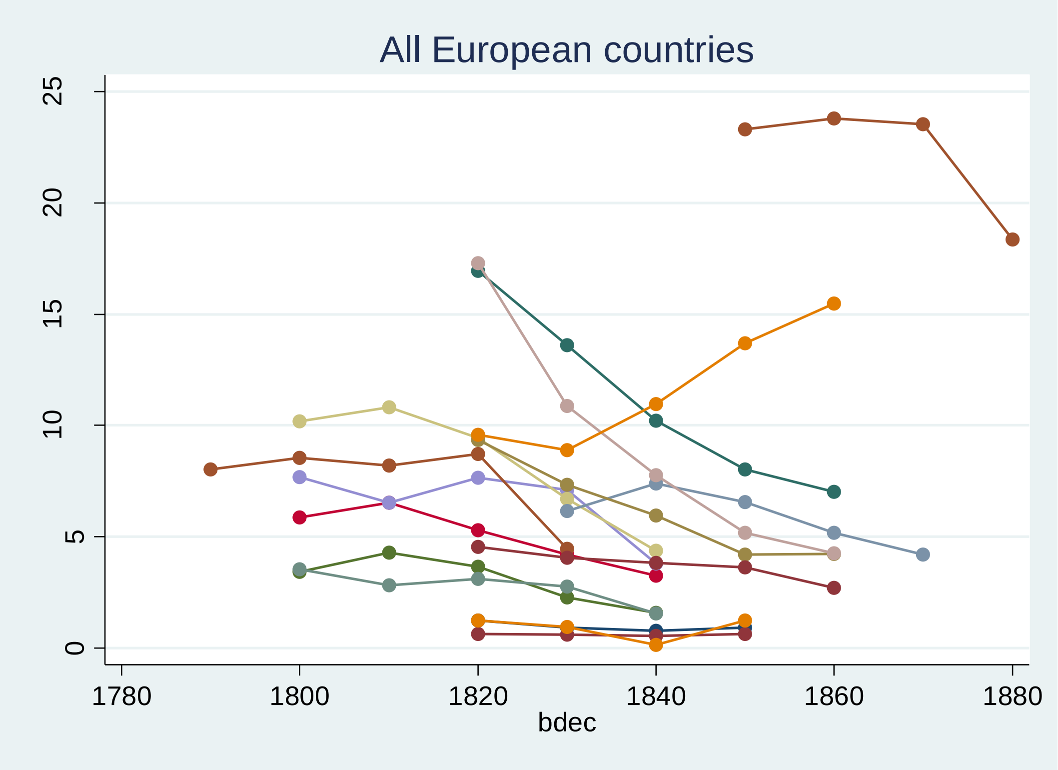

Figure 15 ABCC CV of the regions of Austria-Hungary

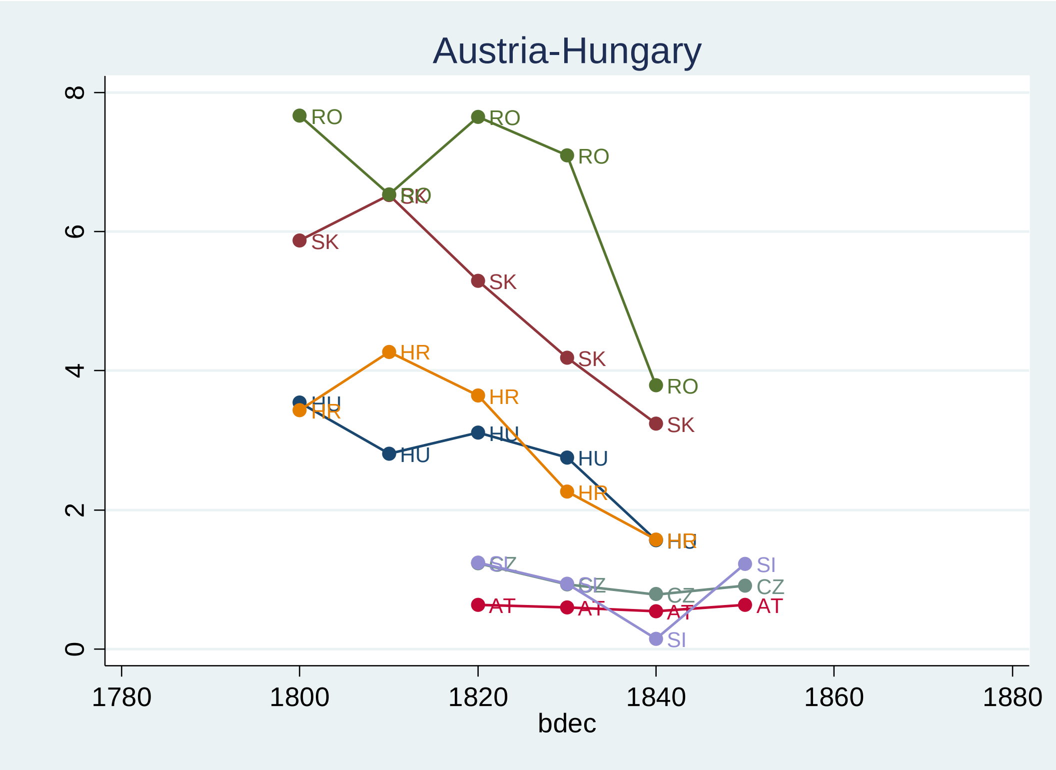

Figure 16 ABCC CV of Ireland, Italy and Spain

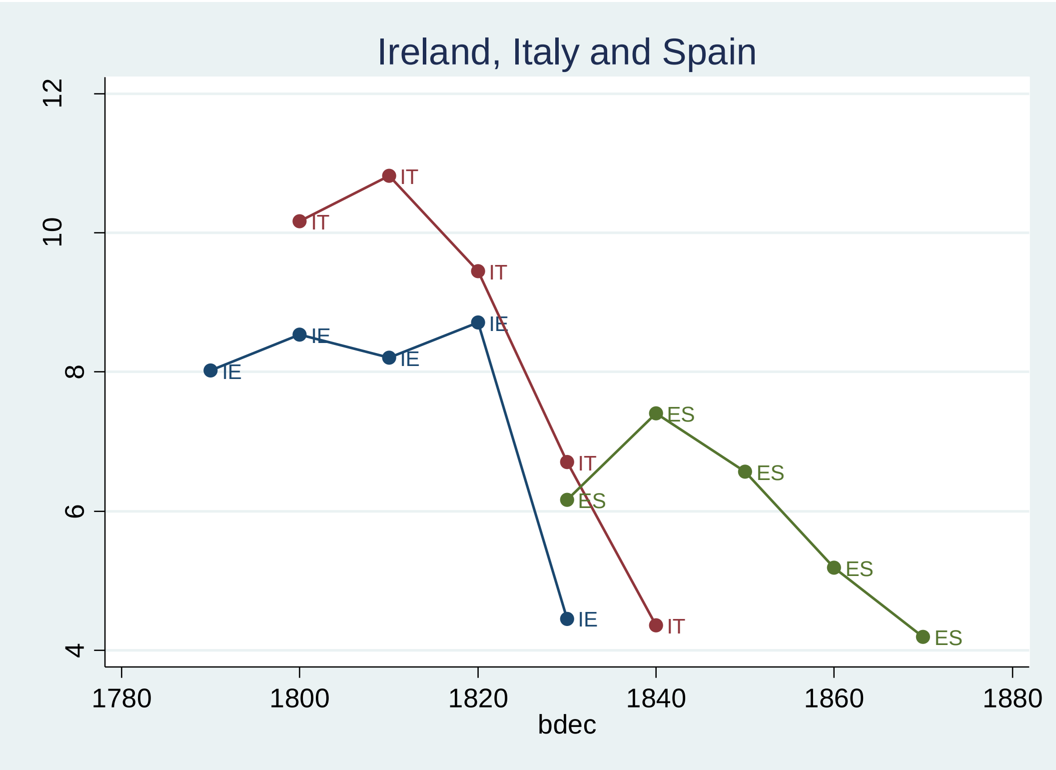

Figure 17 ABCC CV of East European countries

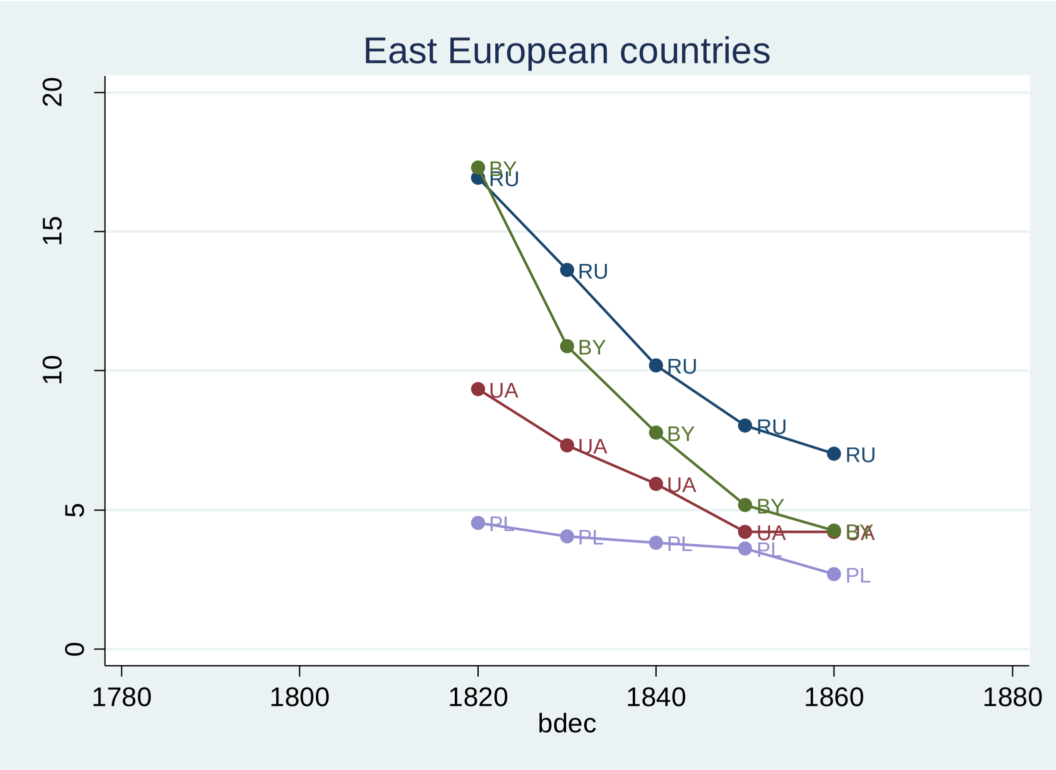

Figure 18 ABCC CV of South-East European countries