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Endowments vs. market potential: What explains the relocation of industry after the Polish reunification in 1918? ☆

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Abstract

How did the location of industry across interwar Poland react to the Polish reunification? After more than 120 years of political and economic separation, Poland was reunified at the end of 1918. In consequence, the removal of internal tariff barriers and improved infrastructure strengthened the domestic market, while foreign market relations were cut off. Similarly, the geographical distribution of factor endowments was changed, for example, through internal migration. How did these forces interact to determine the location of industry? We survey the dynamics of industrial location between 1902 and 1925–1937 and estimate a specification that nests market potential and comparative advantage to quantify their respective impact during the interwar years. The results point to a role for both, comparative advantage and access to markets. We show that both statistically and economically the most important factors were the endowment with skilled labour and inter-industry-linkages.

JEL classification: F10; F11; F12; F14; F15; N74; R3

keywords: Economic geography; Economic integration; Interwar period; Poland

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1. Introduction

A popular concern about economic integration (or ''globalisation'') is that the removal of barriers to trade and factor mobility will deepen initial differences in the spatial distribution of economic activity. Intuitively, firms tend to settle at locations that minimize transport and communication costs related to inputs (supply) and outputs (demand), and hence to settle close to the market which is largest in terms of economic activity. This implies a process of cumulative causation. In fact, this is an old idea, but the necessary microfoundations for this to hold were only recently developed in the wake of the New Economic Geography (NEG). However, there is a competing view to this. The neoclassical Heckscher–Ohlin–Vanek (HOV)-model, which abstracts from transport and communication costs, implies that the distribution of economic activity is determined by the distribution of comparative advantage, i.e., by endowments available at one location relative to that available at alternative locations (see Brülhart, 1998).[1] Under some further assumptions, free trade will ensure that the levels of economic activity as measured in factor prices will tend to converge across locations. The introduction of transport costs into these models does not alter this prediction because better integration will bring us back towards the outcome of the benchmark model. Ricardian models have quite similar implications about the effects of economic integration on geography (see Eaton and Kortum, 2002). Thus, theory is silent about the effects of better economic integration on location, just because we do not know much about the empirical relevance of HOV- and NEG-type mechanisms.

Recent empirical studies, such as Davis and Weinstein (1999, 2003), Ellison and Glaeser (1999), or Midelfart-Knarvik et al. (2000, 2001) all argue along two lines. First, NEG- and HOV-models are not mutually exclusive but rather stress different aspects of a trade-off situation that firms (or migrants) face with respect to their location choice. Second, all location theories rely on the interaction of location characteristics with the characteristics of a certain economic activity. HOV-theories predict that industries which heavily depend on a certain input-factor will tend to settle at locations with a relative abundance of that factor. Similarly, NEG-theories predict that the impact of a location's market potential increases in the industries' sensitivity to input and output linkages. Hence, we can try to explain the relative size of different economic activities at different locations by a set of HOV-type and NEG-type interactions between industry and location characteristics. However, so far, all empirical studies on the determinants of economic geography suffer from endogeneity problems. Obviously, in NEG-models it is difficult to identify the driving forces, because endogeneity is at the very core of the theory. Instrumental variable approaches could help only as far as there are good instruments available. A more robust and promising approach was recently promoted by Redding and Sturm (2005), in an earlier variant by Davis and Weinstein (2002): if there was some large exogenous shock to potential determinants of industrial location, this can help to identify the driving mechanisms.

This motivates a closer look into the case of Interwar Poland. The various regions of Poland experienced in 1918 a severe shock in their access to markets. Since the late eighteenth century Poland had been politically and economically partitioned into several areas between Russia, Prussia, and the Habsburg monarchy. After Poland's reunification in

[1] This holds only as long as the initial factor endowment of locations is not too different.

1918, these areas experienced a quick economic integration, while foreign economic links were cut-off or considerably loosened. As shown in Wolf (2005) it is possible to identify the impact of these exogenous border changes on trade flows and thereby on regional market potential during the interwar years. A second argument for our case comes from the fact that most institutional differences between the various parts of Poland were removed already in about 1925. Hence, regional performance during the interwar years was not driven any more by institutional differences between regions as has been argued for the historical performance of American economies by Acemoglu et al. (2001). Finally, in stark difference to most economies today, Poland had virtually no industrial policy up to 1936. As shown in a recent empirical paper by Midelfart-Knarvik and Overman (2002), the industrial policy of the European Union strongly affected the location of industry across EU regions. Insofar as these policy interventions were endogenous reactions to the actual economic geography, it is usually very difficult to assess the role of HOV- or NEG-mechanisms net of policy interventions. The rest of the paper is organized in five sections. Section 2 gives some historical background, while Section 3 surveys the evidence on changes in industry location across Poland in the wake of the border changes. In Section 4, we examine how integration affected the characteristics of locations, namely their comparative advantages and their market potentials and how industries differed in their sensitivity with respect to those characteristics. In Section 5, we estimate the actual impact of these possible determinants on industry location and conduct several robustness checks. Section 6 summarizes the evidence and concludes.

2. Historical background on changing borders and integration

The partitions of Poland at the end of the eighteenth century between the empires of Russia, Habsburg and the emergent Prussia made Poland disappear from the European map. Only the specific constellation at the end of the First World War, where all three partition powers were severely weakened through war and revolution, opened the way for its restoration. While these changes in political borders were associated with breaks in the administrative structure and hence statistical description of the "Polish economy," it is possible to trace the main parts of the Polish territory over time. In official statistics after 1918, the state was organized in 17 administrative units (vojvodships) that followed the former partition borders. These units are often found to be aggregated into four groups: the western, southern, and central vojvodships, covering approximately the former partition areas of Prussia, Habsburg, and Russia, respectively, and the eastern vojvodships, covering newly attained areas in the east.[2] The area of the central vojvodships is roughly congruent with the former "Kingdom of Poland" that up to the Polish insurrection in 1863 had autonomy within the Russian empire. Map 1 shows the borders of Poland as in 1921, and indicates the former partition borders. Map 2 shows that the administrative borders of vojvodships followed the former partition borders.[3]

[2] Western vojvodships comprised: Poznań, Pomerania, Silesia; central: city of Warsaw, Warsaw, Lódź, Kielce, Lublin, Białystok; southern: Kraków, Lwów, Stanisławów, Tarnopol; eastern: Wilno, Nowogrod, Polesia, Wolhynia; see *Mały Rocznik Statystyczny*, Warsaw (1939).

[3] The only exception to this rule is the vojvodship of Białystok, where only the western part belonged to the former Kingdom of Poland, see Map 2.

Map 1. Poland as in 1921 and the former partition borders. Based on Rocznik Statystyczny 1928, Warsaw (1929).

The three partition areas developed increasingly tight economic links with their respective partition powers, especially during the second half of the nineteenth century. For example, wheat price differentials between Kraków, Lwów, and Vienna before the First World War show a strong decline over this period. Similarly, as shown by Fremdling and Hohorst (1979), price integration between Poznań and Berlin proceeded during the

Map 2. Administrative structure—vojvodships (1921–1938). Based on Rocznik Statystyczny 1928, Warsaw (1929).

nineteenth century. Also, economic links between the Kingdom of Russia and the rest of the Russian Empire grew closer after the removal of the internal tariff barrier in 1851 and the introduction of a common external tariff. The tariff conflicts between Germany and Russia after 1881 deepened the integration of the Polish regions with their partition

Table 1
Poland's trade with Germany, the Habsburg successor states, and the USSR (as % of total trade value, current prices)

	1923	1926	1928	1932	1935	1937
Germany						
Imports from	44	24	23	20	14	15
Exports to	51	25	34	16	15	14
Successor states of the Habsburg monarchy						
Imports from	14	13	14	10	9	9
Exports to	16	21	26	17	13	10
USSR (estimations)						
Imports from	nd	nd	1.2	nd	1.7	1.2
Exports to	nd	nd	1.5	nd	1.2	0.4

Sources. Jerzy Tomaszweski (1968), *Związki handlowe państw sukcesyjnych w okresie międzywojennym* [The trade relations of the successor states during the interwar period], in: Studia z Dziejów ZSSR i Europy Srodkowej [Studies of the History of the USSR and Central Europe], vol. IV, Warsaw, p. 86 and *Rocznik Handlu Zagranicznego, Statystyka Polski, Serja C* [Statistical Yearbook of Foreign Trade, Polish Statistics], Warsaw, different years.

powers even more.[4] After the First World War, the situation was dramatically altered. The new outer borders of the Polish economy cut off the economic links that had evolved since the late eighteenth century between Germany and western Poland, Galicia and other parts of the Habsburg monarchy, and the Kingdom of Poland and Russia. The following table surveys the new geography of Polish external trade (see Table 1).

The flip-side of this disintegration with respect to the partition powers was domestic integration. The major challenge to building up a Polish state was to unify its different parts. Owing to the long period of partition, there were different legislations about virtually all aspects of social, political, and economic life. Tariffs, regulations, and a lack of transport and communication facilities prevented people from reacting to those different legislations in an efficient way. These institutional obstacles to integration were surprisingly quick erased—in almost all cases until 1926. Trenkler and Wolf (2005) estimate integration across the former borders in terms of monthly wheat prices 1921–1937 at various Polish locations. According to this evidence, the former partition borders were an obstacle to arbitrage trade in grains only until 1924. But other markets were more sluggish in their adjustment to the new borders. An analysis of domestic trade shipments covering nearly all domestic trade flows within and across the former partition borders shows that the impact of borders was persistent but decreasing over time. If measured against the current European Union or even the US domestic market, Interwar Poland was a rather well integrated economy (Wolf, 2005). Hence, we do know by today that Poland experienced a quite massive integration shock in 1918, separating the partition areas from the former partition powers and integrating them between each other. Now, what did this do to the location of industry?

3. How did industry location change?

We measure the level of economic activity at locations and their changes over time in terms of employment similar as in Midelfart-Knarvik et al. (2000). Other data, such as value added

[4] See Rosa Luxemburg, "Die Industrielle Entwicklung Polands," Leipzig 1898, p. 9ff.

or output data, are not available at the necessary level of disaggregation over time, locations, and industries. We make use of two sets of regional employment data. First, we use data compiled by the Polish Central Statistical Office (1994) on the employment structure of various Polish regions in about 1902, which we adjust for territorial changes in the western vojvodships after 1918. Second, for the interwar period we use the most disaggregated data set available, namely employment data from the *Inspekcja Pracy* [Labour Inspection].[5] For 1902, a year well in the partition period, we have employment data on four larger regions of Poland, covering employment in five industrial sectors and mining. For the years 1925–1937 our dataset covers employment in all sectors, including agriculture. Overall, there is information on 20 economic activities based on all units with more than four employees. The data were published for 12 "inspection districts" covering the whole territory of Poland. The inspection districts follow the vojvodship borders except that some vojvodships were aggregated. The Silesian data for 1925–1929 must be completed by *Statystyka Pracy* [Labour Statistics], published by the main statistical office (GUS).[6] The definition of the five industrial sectors as in 1902 is comparable to that of the interwar years, so we are in a position to trace the regions across the structural break of the First World War and thereafter into the late 1930s.

Before we describe this data set quantitatively, it is necessary to clarify some measurement issues (see Overman et al., 2003). First, we can make statements about the *specialization* of a given region. In this case, the unit of interest will be the share of a certain activity k in the total economic activity of region $i(s_i^k(t))$, defined as

$$s_i^k(t) = \frac{x_i^k(t)}{\sum_k x_i^k(t)}, \tag{1}$$

where $x_i^k(t)$ measures the level of economic activity k at location i and time t. Second, we can make statements about the *localization* of a given economic activity. How concentrated is economic activity as a whole and how concentrated is a given industry? Which industries tend to agglomerate, which industries are rather dispersed? Then the unit of interest will be $\ell_i^k(t)$, the share of a certain location i in the total economic activity of industry k, defined as

$$\ell_i^k(t) = \frac{x_i^k(t)}{\sum_i x_i^k(t)}, \tag{2}$$

where again $x_i^k(t)$ measures the level of economic activity k at location i and time t. Localization and specialization capture related but different aspects of spatial developments. We expect to find at least some industrial concentration if regions are highly specialized. However, because industries and regions typically differ in size, these two measures can (and typically do) differ quite a lot. To summarize both kind of information in a single variable we can make use of the location quotient $r_i^k(t)$, that standardizes a location's specialization $s_i^k(t)$ by the industries' share in total activity and an industry's localization by the location's share in total activity:

[5] *Inspekcja Pracy 1925–1937, Table 1*, Warsaw (1926–1938).

[6] GUS, *Statystyka Pracy* [Labour Statistics], 1928, No. 4, pp. 259–260 and GUS, *Statystyka Pracy* [Labour Statistics], 1937, No. 2, p. 87. Also see Zbigniew Landau and Tomaszewski (1971), *Robotnicy Przemysłowi w Polsce* [Industrial Worker in Poland], Warsaw.

$$r_i^k(t) = \frac{x_i^k / \sum_i x_i^k}{\sum_k x_i^k / \sum_i \sum_k x_i^k} = \frac{x_i^k / \sum_k x_i^k}{\sum_i x_i^k / \sum_i \sum_k x_i^k} \tag{3}$$

Later, we will treat this quotient as a dependent variable and investigate its determinants.

To start with the big picture of empirical evidence, Fig. 1 shows industrial employment in the three historical parts of Poland, namely the former Russian, German, and Austrian partition areas, and in five industrial sectors 1902, 1927, and 1937. We distinguish within the former German partition area to separate Upper Silesia from the rest, because this region appears to be a rather special case. To be comparable between 1902 and the interwar years, we exclude for a while the areas in the east that Poland attained from Russia after 1918.

First, note that Polish industrialization proceeded after 1918 insofar as the total number of industrial workers in these regions increased between 1902 and 1927 by about 60% while the total population grew by about 30%. But while the traditional textile industry in the Kingdom of Poland defended its important position, regions outside the centre and other industries developed much more dynamically. Fig. 2 shows the regional employment shares $\ell_i^k(t)$ for the years 1902, 1927, and 1937.

The share of the central vojvodships in total industrial employment of the four regions dropped from over 61% to about 45%, while all other regions—especially Galicia—could increase their shares. That is, industrialization reached—while still being limited—some of the most backward areas of Poland during the interwar years. Moreover, the very different growth rates across industrial sectors suggest that the regional division of labour was fundamentally altered in response to the change in borders.

We turn next to the much more detailed interwar data and analyse the pattern of interregional specialisation and industrial localization. To describe changes in regional specialization we use Krugman's specialization index $K_i(t)$, defined as:

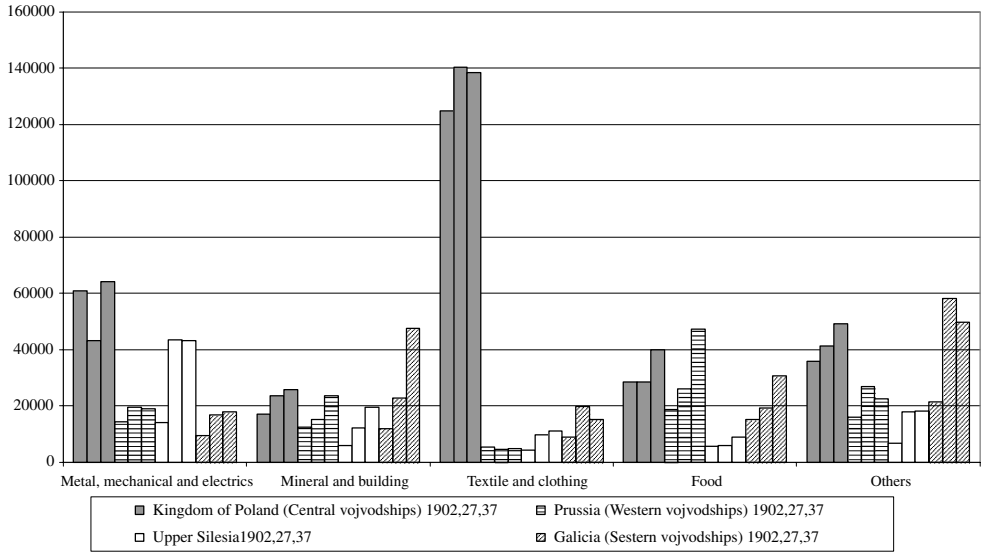

Fig. 1. Changes in industrial employment in four parts of Poland (1902–1937).

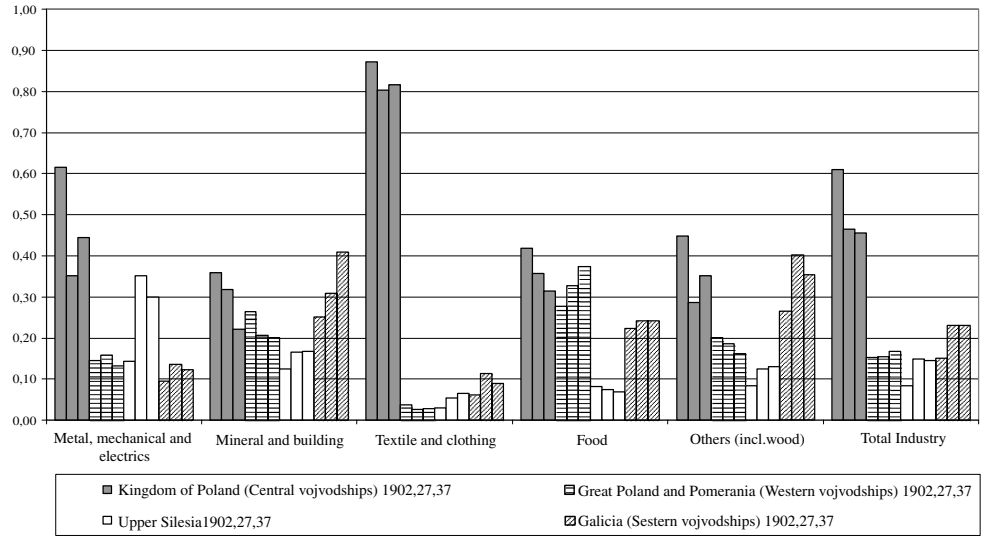

Fig. 2. Regional employment shares 1902, 1927, and 1937.

$$K_i(t) = \sum_k abs(s_i^k(t) - s_i^{-k}(t)), \quad K \in [0, 2], \tag{4}$$

where $s_i^{-k}(t)$ is the share of industry k in the total production of all regions *except* region i. Thus, the Krugman index summarizes a region's differences in specialization with respect to the rest of Poland over all industries. It takes the value of zero if a region's industrial structure is identical to the rest of Poland, and the value of two if the region has no industries in common with the rest of Poland. Table 2 gives the Krugman index for industrial employment for each of the 12 inspection districts.

There is an increase in average industrial specialization from 0.71 to 0.77, interrupted by the depression period (1929–1932). To compare, the average of a Krugman index applied to data of industrial production across the European Union increased from 0.33 in the 1970s to 0.35 in the 1990s.[7] For example, the district of Lódź proves to be highly specialized, which can be traced back to the impact of its textile industry. The average "interregional division of labour" increased during the interwar period with a temporal relapse into more self-subsistent regional economies during the depression years. The most important factor here might be an effect of asymmetric deflation. Insofar as prices of some goods (for example, agricultural goods) declined during the depression faster than other prices (for example, railway tariffs), there may have been incentives to disengage from interregional trade. This is also suggested by the fact that trade margins of trade cooperatives decreased dramatically between 1928 and 1933: net profits as a share of total sales decreased from 0.53% in 1928 to 0.24% in 1930, 0.23% in 1932, before they started slowly to recover.[8]

Next, how do these changes in specialization correspond to a higher spatial concentration of industries? We constructed a simple index of industrial concentration as:

[7] See Midelfart-Knarvik et al. (2000, p. 6).
[8] See GUS, Statystyka Spoldzielni zwiazkowych 1928–1933, Warsaw (1936).

Table 2
Krugman's specialization index (all activities, 1925–1937)

	Wa	Lo	Kie	Lu/Wol	Bial/Pol	Krak	Silesia	Lw, T and St	Poz	Pom	Will/Now	Average
1925	0.458	1.428	0.523	0.853	0.498	0.400	0.649	0.694	0.719	0.642	0.980	0.713
1926	0.540	1.415	0.527	0.885	0.413	0.379	0.701	0.792	0.728	0.711	0.884	0.725
1927	0.585	1.374	0.514	0.843	0.511	0.323	0.679	0.817	0.753	0.736	0.909	0.731
1928	0.577	1.336	0.482	0.858	0.917	0.402	0.643	0.785	0.675	0.704	0.893	0.752
1929	0.516	1.252	0.541	0.889	0.914	0.343	0.622	0.777	0.644	0.668	0.831	0.727
1930	0.540	1.285	0.519	0.985	0.797	0.374	0.712	0.734	0.718	0.690	0.778	0.739
1931	0.525	1.277	0.525	0.954	0.582	0.458	0.679	0.732	0.710	0.705	0.761	0.719
1932	0.505	1.307	0.523	0.958	0.618	0.543	0.682	0.683	0.758	0.691	0.710	0.725
1933	0.546	1.332	0.550	0.918	0.849	0.571	0.724	0.666	0.813	0.715	0.724	0.764
1934	0.587	1.306	0.506	0.912	0.745	0.533	0.725	0.665	0.778	0.714	0.826	0.754
1935	0.590	1.316	0.592	0.940	0.741	0.562	0.670	0.676	0.773	0.821	0.782	0.769
1936	0.627	1.315	0.594	0.951	0.700	0.549	0.636	0.676	0.780	0.752	0.965	0.777
1937	0.607	1.291	0.687	0.967	0.789	0.505	0.631	0.718	0.762	0.713	0.797	0.770

Sources. Inspekcja Pracy 1925–1937, Table 1, Warsaw (1926–1938) and GUS, *Statystyka Pracy* (1928/4), pp. 259–260 and GUS, *Statystyka Pracy* (1937/2), p. 87.

$$G^k(t) = \sum_{i=1}^{N} abs(\ell_i^k(t) - area_i), \quad G^k \in [0, 2], \tag{5}$$

where $area_i$ denotes a districts's share in total usable land (as in 1931). This control for area is important, because otherwise size differences would contaminate the results. An index of zero would imply that the employment in the industry is equally distributed across space; while an index of 2 means that the industry is completely concentrated in one of the 12 districts. Table 3 summarizes the evidence for the most important industries, where we distinguish the periods before, during, and at the end of the great depression.

Most industries show a slight increase in concentration, but there are remarkable exceptions. The (mainly Silesian based) mineral and metallurgical industries spread out, as well as the wood industry, which started to develop in the eastern districts. The overall increase in concentration is not in an obvious manner related to certain groups of industries. "High-tech" industries, such as chemical and printing industries tend to concentrate, but also do the leather, food, and clothing industries. We can conclude that industry location changed a lot during the period, and we expect this to be related to changes in economic integration. But the development of Poland's east suggests that other forces must also have been at work. The descriptive evidence does not point to any particular set of explanations. An increased interregional division of labour might be seen as evidence in favour of HOV-type mechanisms of industrial location. It might equally be seen as the flipside of a process of concentration in some industries, due to NEG-type mechanisms. What forces dominate is left to an econometric analysis. The next section looks into the development of several possible determinants of industrial location.

4. Tracking comparative advantage and market potential over time

In order to match the available evidence on industrial location and its potential determinants, we need to aggregate the data up to congruent areas. The available data allows us to

Table 3
Index of spatial concentration (1925–1937)

	1925–1928	1929–1934	1935–1937
Mineral industry	0.811	0.730	0.737
Metallurgy	1.349	1.442	1.422
Mechanics and electrics	1.005	0.989	0.979
Chemicals	0.895	1.010	1.055
Textiles	1.444	1.466	1.433
Paper	1.037	1.020	1.032
Leather	0.716	0.734	0.738
Wood	0.529	0.409	0.371
Food	0.590	0.626	0.605
Clothing	0.878	1.004	1.035
Building	0.700	0.877	0.693
Printing	0.879	0.915	0.990
Average	0.903	0.935	0.924

Sources. See Table 2.

distinguish between the three former partition areas, and additional sub-areas, namely within the former German partition area, and within the former Russian partition area. This leads us to define five big regions as shown in Map 3. Let us term them Central vojvodhships (approximately congruent with the former Kingdom of Poland), Eastern vojvodhips (congruent with the rest of the former Russian partition), Western vojvodships (congruent with the vojvodships of Pomerania and Poznań), Silesia (congruent with the vojvodship of Katowice), and Southern vojvodhips (congruent with the former Austrian partition).

The integration of those areas presumably affected the location of industry through a multitude of channels. The removal of barriers enhanced not only domestic trade, but possibly also factor movements and the dispersion of knowledge, i.e., it changed the area's comparative advantages in terms of endowments. Table 4 summarizes the evidence on relative endowments for the five parts of Poland that is available for the period 1926–1934: the areas' share in Poland's mineral resources (coal, petrol, other fuels), the abundance of labour as measured by the areas' population share, the availability of skilled labour (i.e., the areas' share in the total literate population), and the areas' share in total patent announcements. The latter is meant to give a rough proxy for access to innovative production technology. A region where only a very small fraction of patent announcers live is probably not an area of high innovative activity, while conversely a lot of patent announcements need not imply that all of these patents were economically relevant.[9] The different sources of that data and the construction of variables are described in Appendix A.

The rather small area of Silesia possessed about 64% of all Polish mineral resources, was very labour abundant, and endowed with a quite highly skilled labour force. The southern vojvodships initially had a high share in patent announcements, which decreased over the period, probably because the only two universities on the area of Poland before World War I, Lwów and Kraków, were situated in that part, but lost importance after the installation of universities at Warsaw and elsewhere. Skilled labour was best available in

[9] See Jaffe et al. (1993) for a discussion of the issue in the context of industrial location.

Map 3. Defining five big areas. Based on Rocznik Statystyczny 1928, Warsaw (1929).

the former German parts of Poland, Silesia, Pomerania, and Poznań. However, because our measure refers to the share of population that is literate in Polish language it implies a ''Polish bias'' due to the ethnic composition of the respective population. This composition was rather homogeneous in the western parts of Poland, and rather inhomogeneous in the east. Nevertheless, it makes sense to ask whether the availability of people able to read and write in Polish language had an impact on the location of industry.

Table 4
Changing endowments (1926–1934)

	Territory share	Mineral resources	Share in total literate population			Share in patent announcements			Population share		
		Mean 1926–1934	1926	1930	1934	1926	1930	1934	1926	1930	1934
Central	0.174	0.188	0.199	0.213	0.227	0.348	0.451	0.539	0.221	0.227	0.233
Eastern	0.470	0.033	0.285	0.301	0.316	0.038	0.066	0.027	0.327	0.332	0.336
Western	0.126	0.023	0.166	0.151	0.136	0.114	0.148	0.092	0.123	0.119	0.114
Silesia	0.008	0.643	0.048	0.046	0.043	0.144	0.128	0.158	0.035	0.035	0.036
Southern	0.222	0.113	0.302	0.290	0.277	0.356	0.207	0.185	0.294	0.288	0.282

Sources. See Appendix A.

Let us turn to the areas' market potential. As argued in the introduction, a key idea in location theory is that firms tend to settle at the market with the highest market potential to minimize costs. There are different approaches in the literature on how to measure a location's market potential, i.e., its access to purchasing power across the economy. The standard is still Harris (1954) who proposed a rather ad hoc formula, where market potential of location j (MP_j) increases in purchasing power (PP_j) of all locations i, but decreases in distance ($dist_{ij}$) to j:

$$MP_j(Harris) = \sum_i \frac{PP_i}{dist_{ij}}. \tag{6}$$

Redding and Venables (2004) suggest that we can easily derive such a function from a standard gravity-model and thereby estimate its functional form. As shown in Wolf (2005) it is possible to estimate such a gravity model in the case of interwar Poland based on a rich set of bilateral domestic trade data between the different parts of Poland. In addition, this allows us to keep track of economic integration, in our case to explicitly take into account the exogenous variation in market potential due to the change in borders. We estimate the following specification:

$$\log(X_{ij,t}) = \sum_{k=1}^{K} \beta_k + \beta_2 \log(Y_{i,t}) + \beta_3 \log(Y_{j,t}) + \beta_4 \log(dist_{ij}) + \beta_5 \log(REM_{i,t}) + \beta_6(Adjacency_{ij}) + \sum_n \beta_n parbord_{ij}^n + \varepsilon_{ij,t}, \tag{7}$$

where $X_{i,t}$ is the value of aggregate bilateral trade between two areas I and j at time t, K is the number of areas, β_k captures fixed effects of area k, $Y_{i,t}$ and $Y_{j,t}$ capture the size of the importing and the exporting area at t, $dist_{ij}$ is a distance variable, and $REM_{i,t}$ controls for remoteness of area i relative to other areas at time t. With $Adjacency_{ij}$, we also control for neighbourhood-effects, which often prove to have a significant impact in similar specifications. The border dummy $parbord_{ij}^n$ takes the value of one if only one of two locations i and j was formerly part of partition area n, and zero otherwise. This leads us to a measure of market potential, which is now increasing in the importing region's economic size, decreasing in the estimated impact of distance, and directly changing with the impact of former borders:

$$MP_j = \exp(1)^{\beta j} \left\{ \sum_k^K [(Y_k)^{\beta 2} (dist_{jk})^{\beta 4} (REM_j)^{\beta 5} \exp(Adjacency_{jk})^{\beta 6} \sum_n \exp(parbord_{jk}^n)^{\beta n}] \right\}. \tag{8}$$

Table 5
Evolution of regional market potential (MP) as a share of total Polish market potential (1926–1934)

	Share in Poland's territory	1926	1927	1928	1929	1930	1931	1932	1933	1934
RuCentral	0.174	0.177	0.173	0.176	0.172	0.153	0.187	0.191	0.195	0.196
RuEast	0.470	0.149	0.148	0.150	0.147	0.134	0.164	0.167	0.170	0.173
Prussia	0.126	0.215	0.218	0.228	0.224	0.221	0.210	0.204	0.202	0.194
Silesia	0.008	0.119	0.117	0.112	0.106	0.125	0.121	0.119	0.101	0.099
Austria	0.222	0.340	0.343	0.334	0.351	0.367	0.318	0.318	0.331	0.337

Sources. See text.

Table 5 shows how the share of the five big regions in total Polish market potential. Again, we also give the regions' shares in Poland's territory.

According to this estimation it was *not* the geographical centre of Poland which had the highest market potential, but due to the long period of political and economic separation the rather peripheral regions. This changed somewhat between 1926 and 1934, when the central area around Warsaw improved its relative position within the domestic market, but this process was apparently rather slow. The huge eastern part of the former Russian partition area possessed only a minor part of Poland's total market potential, while the shares of the former Austrian area and that of the regions of Pomerania and Great Poland (Prussia) were rather large in relation to their area. Silesia stands out with a massive share in market potential, mainly due to the size of her own market and her close ties with foreign markets.

Finally, it is crucial to note that all those changes in comparative advantage and market potential should affect different industries in a different manner. As usual in trade theory, we might distinguish the industries by their respective "factor intensities," i.e., their sensitivity to changes in a given endowment or market potential. All data refer to the industrial structure of interwar Poland, except the proxy for the industries' sensitivity to changes in market access, which is based on a German input–output table for 1936. Here, the data restrict us to consider only input (or supply or "forward") linkages, i.e., the sensitivity of industries with respect to the access to supply markets (see Appendix A for the sources). Table 6 gives the evidence for 10 different industries. The availability of data forces us to assume that these industry characteristics did not change over time.[10]

5. Econometric analysis: what drives industrial location?

In this section, we draw all the mentioned pieces of evidence together and quantify the relevance of HOV- and NEG mechanisms in determining the location of industry across Poland. We also want to examine whether their respective impact changed over time due to the ongoing process of economic integration (or other time-specific factors). Let us assume that both, a location's specialization $s_i^k(t)$ and an industry's localization $\ell_i^k(t)$ depend on a set of interactions between location characteristics y_i (endowments and market potential) and the industries' sensitivity with respect to those characteristics, denoted by z^k. To capture both aspects of industrial geography

[10] This assumption needs to be made even for contemporaneous studies on industry location, see, for example, Midelfart-Knarvik et al. (2000, 2001).

Table 6
Industry characteristics

	Fuel intensity	Labour intensity	Skill intensity	Patent intensity	Intermediates
Mineral industry	4.3119	0.342	0.047	2.639	0.660
Metallurgy	2.866	0.243	0.104	3.227	0.439
Mechanics/electrics	1.823	0.467	0.162	4.275	0.367
Chemicals	4.282	0.150	0.143	9.560	0.425
Textiles	1.031	0.210	0.052	0.797	0.556
Paper	4.464	0.170	0.080	7.089	0.568
Leather	1.685	0.111	0.074	6.557	0.571
Wood	0.725	0.190	0.062	2.404	0.478
Food	1.348	0.089	0.111	1.492	0.535
Printing	0.039	0.347	0.119	10.515	0.353

Sources. See Appendix A.

simultaneously we make use of the location quotient $r_i^k(t)$ as defined in (3). Consider the following specification:

$$\log(r_i^k) = \sum_i \sum_k \eta_i^k + \beta_i^k[h] \sum_i \sum_k z^k[h] \log(y_i)[h] + \varepsilon_i^k. \tag{9}$$

The left-hand side is the location quotient of industry k at location i in time t, which controls for size differences between locations and industries. We regress this on a set of interactions between the vector of location characteristics (in logs) and the vector of industries' sensitivities (as elasticities) denoted by $\sum_i \sum_k z^k \log(y_i)$. For each interaction $[h]$ we estimate a separate coefficient $\beta_i^k[h]$. Finally, we add dummies to account for all kind of fixed location and industry effects, η_i^k. This allows us to control for omitted variables, which are probably quite important for two reasons. First, our data on location and industry characteristics are certainly limited and second we need to take into account that we measure industrial location in terms of employment. Ellison and Glaeser (1999) use a similar specification in their investigation into the location of US-industries, and Midelfart-Knarvik et al. (2000, 2001) derive exactly this specification from a fully specified location model to analyse industrial location across the EU. However, in both these cases the empirical specification was derived for industrial location measured in terms of output or value added. Hence, we have to modify our model to account for this fact:

$$\begin{aligned} \log(r_{i,\text{output}}^k) &= \log(r_{i,\text{employment}}^k * pr_i^k) + \sum_i \sum_k \eta_i^k + \beta_i^k[h] \sum_i \sum_k z^k[h] \log(y_i)[h] + \varepsilon_i^k, \\ \log(r_{i,\text{employment}}^k) &= \sum_i \sum_k \eta_i^k - \log(pr_i^k) + \beta_i^k[h] \sum_i \sum_k z^k[h] \log(y_i)[h] + \varepsilon_i^k, \end{aligned} \tag{10}$$

assuming that those productivity differences specific to an industry at a given location which are not captured in endowment differences such as the different usage of skilled labor are invariant over time. If so, the set of industry-location fixed effects controls for those differences. We estimate the relevance of the following interactions between location characteristics and industry characteristics for the location of industry:

(1) market potential and the share of intermediate inputs in gross production value,
(2) mineral endowments and fuel intensity,

(3) labour abundance and labour intensity,
(4) skill availability and skill intensity,
(5) patent announcements and patent intensity.

Estimation for the five regions of Poland (see Map 3) is done by pooling over the 10 industries and 9 years in our sample, which gives a total of 450 observations. We start with a simple pooled OLS-estimation.[11]

In the first column we pool over all industries, locations, and years. We find that the interactions between the endowment with literate population and the industries' skill intensity and that between patent announcements and patent intensity are significantly different from zero and have the expected positive sign. There is also evidence of a forward linkage: the interaction between market potential and the industries' sensitivity with respect to intermediate supply is significant and positive. Hence, regions with an increasing endowment with skilled labor (for example, Warsaw) attracted an increasing share of skill intensive industries (for example, chemical or mechanical industries). The same holds in the opposite direction. Regions that lost in terms of relative endowment with skilled people (for example, Lwów) lost in terms of skill intensive industries. Table 7 column 2 gives time varying estimates of the effects of interactions on industrial location. We see that regions with good access to skilled labor increasingly attracted firms with a high sensitivity w.r.t. the availability of skilled people. And locations with a high innovative activity as proxied by patent announcements started to attract industries that used these patents a lot at the end of the period under consideration. However, the impact of market potential vanishes.

This leads us back to the issue of endogeneity as mentioned in the introduction to this paper. Some part of the relocation dynamics were most probably due to the exogenous changes in borders and its impact on our measure of market potential. But one might still wonder, whether a region's market potential can be used as an independent variable, because the location of industrial and final demand as measured by industrial employment obviously affects our measure of market potential. This could also explain the difference between the estimated pooled impact of market potential on industry location as opposed to time-specific effects. If market potential mattered with a time lag, its impact may not be detectable during the very short sub-periods of 3 years. In column 3 we address this issue of possible endogeneity using a two-stage least squares estimators, where we instrument for market potential at time t by market potential at time $t-1$. This way the results from the pooled regression can be repeated, with a highly significant effect of the interaction between skill-intensity and the regions' endowment with literate population and with a strong forward linkage.

However, we still do not know the relative importance of these interactions. After all, the fact that the estimated coefficients have the right sign and a statistically significant does not tell much about their relative economic significance. Therefore, we standardize all variables at a given point in time to have a mean value of zero and a standard deviation of one and repeat our analysis.[12] Table 8 gives the result of that exercise.

[11] We tried several other estimation techniques including feasible GLS and SUR-estimators which all delivered very similar results. These results are given in an earlier working paper version, see Wolf (2004).

[12] To be specific, we calculate for all variables their mean and standard deviation over the cross-section at any point in time and use this to derive time-specific and—where it applies industry-specific—standardized variables. Accordingly, the intensities were standardized over industries.

Table 7
What determines the location of industry?

Interaction	Period	Pooled	Pooled with time-varying coefficients	Pooled with time-varying coefficients and instruments
Method		OLS	OLS	TSLS
Ln (MP) * Intermediates	1926–1928	**0.288** (0.004)	−0.021 (0.912)	**1.159** (0.006)
	1929–1931		−0.061 (0.726)	**1.132** (0.008)
	1932–1934		0.010 (0.948)	**1.065** (0.005)
Ln (Minshare) * fuel	1926–1928	0.002 (0.249)	0.002 (0.297)	−0.001 (0.520)
	1929–1931		0.002 (0.197)	−0.001 (0.647)
	1932–1934		0.002 (0.842)	−0.001 (0.688)
Ln (Popshare) * labint	1926–1928	−0.152 (0.938)	−0.472 (0.840)	−4.969 (0.129)
	1929–1931		−0.388 (0.869)	−4.908 (0.134)
	1932–1934		−0.409 (0.861)	−4.882 (0.136)
Ln (Skillsh) * skillint	1926–1928	**4.541** (0.013)	**5.213** (0.026)	**10.776** (0.001)
	1929–1931		**5.073** (0.028)	**10.622** (0.001)
	1932–1934		**4.872** (0.033)	**10.532** (0.001)
Ln (Patshare) * patint	1926–1928	**0.008** (0.037)	**0.006** (0.129)	0.005 (0.314)
	1929–1931		**0.008** (0.078)	0.006 (0.255)
	1932–1934		**0.008** (0.053)	**0.006** (0.101)
Location-industry fixed effects		Yes (sign.)	Yes (sign.)	Yes (sign.)
Adj. R^2		0.978	0.978	0.977
SE of regression		0.107	0.106	0.109
Sum of squared residuals		4.494	4.336	3.998
Durbin–Watson		2.215	2.207	2.181

We find that indeed both, the NEG- and the HOV-mechanism are economically relevant. Note that if we restrict the attention to the significant coefficient estimates, they approximately add up to one (Table 8, second column). Changes in market potential explain overall about one third of the total variation in location quotients as measured by employment data. In turn, changes in skill endowments explain about half of the total variation, while changes in innovative activity as proxied by patent announcements account for roughly 15%. Note that our findings on interwar Poland are surprisingly similar to those of Midelfart-Knarvik et al. (2000) who estimated a specification very close to our specification, but used data on industrial production instead of employment data to measure industrial activity across 14 member states of the EU between 1970 and 1997. They also found that both kinds of mechanisms are important to determine the location of industry, interactions based on a location's market potential as well as interactions based on a location's comparative advantage. As in the case of interwar Poland the availability of an educated labour force is found to be very important for the location of skill-intense industries across the EU, but in addition to that they identify a specific role for the availability of research staff. Furthermore, they estimate a strong and significant effect of a location's market potential, but point to the importance of forward rather than backward linkages. Obviously, these "differences" between the contemporaneous EU and our historical case might be due to measurement issues. But overall the results suggest that similar mechanisms that might prevail in very different historical circumstances.

Table 8
Economic significance? Pooled regressions for Polish industry, with standardized variables, 1926–1934, bold letters indicate significance, p values in parentheses

Interaction	Pooled	Pooled
Ln (MP) * Intermediates	0.364 (0.048)	**0.365** (0.041)
Ln (Minshare) * fuel	0.030 (0.832)	—
Ln (Popshare) * labint	−1.427 (0.166)	—
Ln (Skillsh) * skillint	**0.619** (0.005)	**0.458** (0.028)
Ln (Patshare) * patint	**0.136** (0.005)	**0.141** (0.038)
Location-industry fixed effects	Yes (sign.)	Yes (sign.)
Adj. R^2	0.948	0.947
SE of regression	0.228	0.229
Sum of squared residuals	20.633	20.939
Durbin–Watson	2.291	2.321

6. Summary and conclusion

In this paper, we analysed the relocation of industry across Polish regions in the wake of the reunification shock of 1918. Following recent studies, we tried to identify some potential mechanisms behind industrial location as suggested by HOV- and NEG-models, and estimated their respective relevance at different points in time. The data allowed us to do this for the location of industry on a panel of five regions and ten industries between 1926 and 1934. First, our evidence on the dynamics of comparative advantage and market potential suggested that economic integration affected the economy through a multitude of channels. Internal migrations, shifting centres of innovation, and not least the diminishing impact of the former partition borders changed the regional characteristics and thereby the incentives to move industrial plants. Second, there is evidence of an increasing "interregional division of labour" across Poland during the interwar years, while the degree of spatial concentration was close to constant over time. Third, trying to keep track of these changes in a time-specific estimation framework, we found evidence that several mechanisms affected industrial location simultaneously, similar to the results of Midelfart-Knarvik et al. (2000) on industrial location across the EU. There was a strongly significant and economically important forward linkage but also a significant and even larger effect of the interaction between skill-intense industries and a location's endowment with a skilled labour force, as well as an increasingly important role for innovative activity. Poland's industry adjusted to the dramatic border changes in the wake of the First World War in a manner which was surprisingly similar to the dynamics of the modern European Union.

Appendix A. Data sources and description to Section 4

A.1. Evidence on industry characteristics

As a rule, intensities are defined as the share of an industry-specific cost component in the industries' total costs. Where this was not possible, the usage of a given factor was compared to the total industrial usage and weighted by the size of the industry.

- Fuel intensity
  Definition: industries' share in total industrial usage of fuels (Coal, Coke, Charcoal, Wood, Petrol), weighted by total employment share. Data on Coal from Komitet Ekonomiczny Ministrów (1928), *Sprawozdanie Komisji Ankietowej. Badania Warunków i Kosztów Produkcji oraz Wymiany, Tom V, Węgiel*, Warsaw. Data on other fuel usage as in 1936 (Coal, Coke, Charcoal, Wood, Petrol) from GUS, *Mały Rocznik Statystyczny 1939*, Warsaw (1939) = *MRS* (*1939*).
- Labour intensity
  Definition: annual labour costs (skilled and unskilled) as share of total sales. Data from *MRS* (*1939*).
- Skill intensity
  Definition: share of non-manual workers in total workforce, mean of 1932–1937. Data from *MRS* (*1939*).
- Patent intensity (R&D)
  Definition: announced industry-specific patents per total announced patents, mean of 1924–1937, weighted by industries employment share. Data from Urząd Patentowy, *Wiadomości Urzędu Patentowego*, Warsaw (1924–1937).
- Use of Intermediates
  Definition: total use of intermediates in gross production value, Polish industry proxied by German industry as in 1936. Data from Reichsamt fuer Wehrwirtschaftliche Planung, *Die Deutsche Industrie*, Berlin (1939).

A.2. Evidence on location characteristics

- Mineral output
  Data: share in total export shipments (within area, within Poland, foreign) of minerals from Ministerstwo komunikacji, Centralne Biuro statystyki przewozów P.K.P.,
  Rocznik statystyczny przewozu towarów na polskich kolejach państwowych według poszczególnych rodzajów towarów [SYToR], Warsaw, (1925–1937).
- Labour abundance
  Data: share in total population; population data interpolated by census data 1921 and 1931 from GUS, *Rocznik Statystyczny Rzeczypospolitej Polskiej* (*1928*) and *MRS* (*1939*).
- Skilled labour
  Data: share of total population literate in Polish language in total population, interpolated by census data 1921 and 1931 from GUS, *Rocznik Statystyczny Rzeczypospolitej Polskiej (1928)* and *MRS* (*1939*).
- Patent (R&D)–production
  Data: share in total number of announced patents by residence of announcer (vojvodship) from Urząd Patentowy, *Wiadomości Urzędu Patentowego*, Warsaw (1924–1937).
- Market Potential 1926–1934
  Share in total domestic imports (including intra-regional trade), and share in total imports from abroad; share in total domestic exports (including intra-regional trade), share in total exports to locations abroad. Source: *SYToR* (see mineral output).

A.3. Bibliography

A.3.1. Statistical sources and government publications

Dziennik Ustaw Rzeczypospolitej Polskiej, 1923–1927, Warsaw.
Główny Urząd Statystyczny [GUS] (1923–1929), *Rocznik Statystyczny Rzeczypospolitej Polskiej*, Warsaw.
GUS (1929–1938), *Statystyka Cen*, Statystyka Polski, Warsaw.
GUS (1927–1937), *Statystyka Pracy*, Warsaw.
GUS (1939), *Mały Rocznik Statystyczny 1939*, Warsaw.
GUS (1994), *Economic History of Poland in Numbers*, Warsaw.
Komitet Ekonomiczny Ministrów (1928), *Sprawozdanie Komisji Ankietowej. Badania Warunków i Kosztów Produkcji oraz Wymiany, Tom V, Węgiel*, Warsaw.
Ministerstwo Komunikacji (1928), *Dziesięciolecie Polskich Kolei Państwowych 1918–1928*, Warsaw.
Ministerstwo komunikacji, Centralne Biuro statystyki przewozów P.K.P. (1925–1937), *Rocznik statystyczny przewozu towarów na polskich kolejach państwowych według poszczególnych rodzajów towarów* [SYToR], Warsaw.
Ministerstwo Pracy i Opieki Społecznej (1926–1938), *Inspekcja Pracy*, Warsaw.
OECD (1990), *Input-Output-Tables*.
Reichsamt fuer Wehrwirtschaftliche Planung (1939), *Die Deutsche Industrie*, Berlin.
Szturm de Sztrem, Edward (1924), *Ceny Ziemi*, Kwartalnik Statystyczny (I/4), pp. 265–274.
Urząd Patentowy (1924–1937), *Wiadomości Urzędu Patentowego*, Warsaw.

References

Acemoglu, D., Robinson, J., Johnson, S., 2001. The colonial origins of comparative development: an empirical investigation. American Economic Review 91 (5), 1369–1401.
Brülhart, M., 1998. Economic geography, industry location, and trade: the evidence. World Economy 21 (6), 775–801.
Davis, D., Weinstein, D., 1999. Economic geography and regional production structure: an empirical investigation. European Economic Review 43, 379–407.
Davis, D., Weinstein, D., 2002. Bombs, bones, and breakpoints: the geography of economic activity. American Economic Review 92 (5), 1269–1289.
Davis, D., Weinstein, D., 2003. Market access, economic geography, and comparative advantage: an empirical assessment. Journal of International Economics 59 (1), 1–23.
Eaton, J., Kortum, S., 2002. Technology, geography and trade. Econometrica LXX, 1741–1779.
Ellison, G., Glaeser, E.L., 1999. The geographic concentration of industry: does natural advantage explain agglomeration? American Economic Review 89 (2), 311–316.
Fremdling, R., Hohorst, G., 1979. Marktintegration der preußischen Wirtschaft im 19. Jahrhundert: Skizze eines Forschungsansatzes zur Fluktuation der Roggenpreise zwischen 1821 und 1865. In: Fsremdling, Tilly (Eds.), Industrialisierung und Raum: Studien zur regionalen Differenzierung im Deutschland des 19. Jahrhunderts, Stuttgart, pp. 56–101.
Jaffe, A., Trajtenberg, M., Henderson, R., 1993. Geographic localization and knowledge spillovers as evidence by patent citations. Quarterly Journal of Economics 108 (3), 577–598.
Harris, C., 1954. The market as a factor in the localization of industry in the United States. Annals of the Association of American Geographers 64, 315–348.
Landau, Z., Tomaszewski, J., 1971. Robotnicy Przemysłowi w Polsce. Książkai Wiedza, Warsaw.

Midelfart-Knarvik, K.H., Overman, H.G., 2002. Delocation and European integration: is structural spending justified? Economic Policy 35, 322–359.
Midelfart-Knarvik, K.H., Overman, H.G., Redding, S., Venables, A., 2000. The Location of European Industry. Economic Papers No. 142, European Commission, D-G for Economic and Financial Affairs, Brussels.
Midelfart-Knarvik, K.H., Overman, H.G., Venables, A., 2001. Comparative advantage and economic geography: estimating the determinants of industrial location in the EU. London School of Economics, mimeo.
Overman, H., Redding, S., Venables, A., 2003. The economic geography of trade, production and income: a survey of empirics. In: Harrigan, J., Choi, K. (Eds.), Handbook of International Trade. Blackwell, Oxford.
Redding, S., Venables, A., 2004. Economic geography and international inequality. Journal of International Economics 62 (1), 53–82.
Redding, S., Sturm, D., 2005. The costs of remoteness: evidence from German division and reunification. CEPR Discussion Paper 5015.
Trenkler, C., Wolf, N., 2005. Economic integration across borders: the Polish Interwar Economy 1921–1937. European Review of Economic History 9 (2), 199–231.
Wolf, N., 2004. Endowments, market potential, and industrial location: evidence from interwar Poland (1918–1939). CEP discussion paper 609, London School of Economics.
Wolf, N., 2005. Path dependent border effects: the case of Poland's reunification (1918–1939). Explorations in Economic History 42, 414–438.