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Geography and intra-national home bias: U.S. domestic trade in 1949 and 2007

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Abstract

This article examines home bias in U.S. domestic trade in 1949 and 2007. We use a unique data set of 1949 carload waybill statistics produced by the Interstate Commerce Commission, and 2007 Commodity Flow Survey data. The results show that home bias was considerably smaller in 1949 than in 2007 and that home bias in 1949 was even negative for several commodities. We argue that the difference between the geographical distribution of the manufacturing activities in 1949 and that of 2007 is an important factor explaining the differences in the magnitudes of home-bias estimates in those years.

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1. Introduction

The effect of borders on trade has received considerable attention in recent years. Since the seminal paper by McCallum (1995), which showed that, after controlling for numerous explanatory factors, trade between the Canadian provinces was about 22 times higher than their trade with U.S. states, scholars have paid close attention to the robustness as well as explanation of border effect. One surprising result that has emerged from this literature is that home bias is not found only in international trade; domestic trade also exhibits a rather substantial border effect (Hillberry, 1999; Nitsch, 2000; Wolf, 2000; Chen, 2004; Millimet and Osang, 2007; Coughlin and Novy, 2013).

These results may seem surprising in that U.S. domestic trade is not affected by the usual policy-made trade barriers so other explanations for home bias must be sought. A number of papers point to the structure of production and the spatial distribution of economic activities as an important factor explaining home bias in domestic trade (Hillberry, 1999; Hillberry and Hummels, 2003, 2008; Chen, 2004). If this argument is correct, it suggests that intra-national home bias probably does not connote significant welfare losses from barriers to trade. Recently, attention has turned to so-called ‘dark’ border-related costs that stem from differences in information, tastes or networks such that preferences are skewed towards or transaction costs are lower for locally produced goods (Head and Mayer, 2013). Here there may be some elements of market failure and welfare losses. In either case, however, there are real reasons why intra-national home bias could exist and it would be incorrect to dismiss evidence of it as a statistical artefact.

We explore this hypothesis in more depth. Specifically, we examine the home bias of U.S. domestic trade in 1949 and 2007, respectively, by estimating gravity regressions at the aggregate as well as the commodity level. The article makes two contributions. First, it examines the variations of home bias across commodities and time. Second, it investigates the relationship between the magnitude of the intra-state home bias and the changing spatial distribution of manufacturing activities. Indeed, analysing home bias in 1949 and 2007 provides a unique opportunity to examine such relationships at the times when the geographical distributions of industries were dramatically different. If the spatial distribution of industrial activities matters, then we should observe that different patterns of geographical location of industries affect the intra-national home bias.

It is a well-known fact that the spatial distribution of economic activities across U.S. regions underwent significant changes in the last century. The industrialization of the U.S. economy in the second half of the 19th century brought about a divergence in regional specialization. In manufacturing, regions became highly specialized and by the turn of the 20th century, most of manufacturing employment was concentrated in the regions of New England, Middle Atlantic and East North Central, later labelled the ‘Manufacturing Belt’ (Fritz, 1943; Perloff et al., 1960; Meyer, 1983, 1989; Kim and Margo, 2004; Holmes and Stevens, 2004; Klein and Crafts, 2012). This pattern was sustained until the 1940s, after which the degree of regional specialization declined (Kim, 1995). Indeed, while in 1947, a little >70% of manufacturing employment was concentrated in the Manufacturing Belt, it was only 40% in 1999 (Holmes and Stevens, 2004). This dramatic decline in the importance of the Manufacturing Belt went hand-in-hand with a rise in the importance of the southern states such as Tennessee, Arkansas, Mississippi and Texas, and the emergence of the Sun Belt (Glaeser and Tobio, 2008; Glaeser et al., 2011). Overall, we can say that the spatial distribution of economic activities evolved from one of concentration in the north-east at the turn of the 20th century to one of dispersion towards the south by the end of the 20th century although this pattern was of course not uniform across all industries (Kim, 1995).

This article examines the implications of changes in the geographical distribution of manufacturing activities in the second half of the 20th century for U.S. domestic trade in manufactures. It shows that home bias in 1949 was considerably smaller than in 2007 (and for many commodities even negative) and finds that this can be explained by the change in the spatial distribution of industries. Specifically, the study finds that the U.S. inter-state trade in 1949 was more prevalent than in 2007 and that this was very likely connected to the existence of the Manufacturing Belt. Once the Manufacturing Belt dissolved and industrial activities moved to the south, intra-state trade became more important, causing home bias to increase. Domestic trade flows are analysed with 2007 Commodity Flow Survey data and a unique data source of railroad trade flows in 1949, compiled by the Interstate Commerce Commission; the spatial distribution of industries is captured by a version of the Ellison and Glaeser (1997) index due to Maurel and Sedillot (1999).

The article proceeds as follows. Section 2 derives a gravity regression equation. Section 3 discusses the data sources, Section 4 presents the regression results, Section 5 discusses them and the last section concludes.

2. Estimating home bias

This section presents a theoretical and empirical framework for estimating the home-bias effect. We follow an approach that is common in the home-bias literature: a gravity regression. To derive the gravity regression equation, we use the widely adopted framework due to Anderson and Wincoop (2003).[1] Let us denote X_{ij}^k as the value of shipments of commodity k at destination prices from origin i to destination j. Let t_{ij}^k be the trade cost of shipment of commodity k from i to j, E_j^k denote expenditure on commodity k at destination j, Y_i^k the sales of commodity k at destination prices from i to all destinations. The resulting gravity equation model is as follows:

$$X_{ij}^k = \frac{E_j^k\, Y_i^k}{Y^k}\left(\frac{t_{ij}^k}{P_j^k\,\Pi_i^k}\right)^{1-\sigma_k} \tag{2.1}$$

$$\left(\Pi_i^k\right)^{1-\sigma_k} = \sum_j \left(\frac{t_{ij}^k}{P_j^k}\right)^{1-\sigma_k} \frac{E_j^k}{Y^k} \tag{2.2}$$

$$\left(P_j^k\right)^{1-\sigma_k} = \sum_i \left(\frac{t_{ij}^k}{\Pi_i^k}\right)^{1-\sigma_k} \frac{Y_i^k}{Y^k} \tag{2.3}$$

The term Π_i^k is called outward multilateral resistance, P_i^k inward multilateral resistance, and σ_k is the elasticity of substitution parameter for k. If we have the data in physical quantities (e.g. metric tons), we need to adjust the Equation (2.1) as follows:

$$X_{ij}^k = p_i^k t_{ij}^k Z_{ij}^k \text{ with} \tag{2.4}$$

$$Z_{ij}^k = \frac{E_j^k\, Y_i^k}{Y^k p_i^k}\left(\frac{1}{P_j^k\,\Pi_i^k}\right)^{1-\sigma_k} t_{ij}^{k^{-\sigma_k}}, \tag{2.5}$$

where Z_{ij}^k is the volume of export in physical quantities, p_i^k is the f.o.b. price of commodity k at the origin and t_{ij}^k is again the trade cost of shipment of commodity k.[2] Expressing Z_{ij}^k from Equation (2.4) and adding a multiplicative error term ε_{ij}^k yields

$$Z_{ij}^k = \frac{E_j^k\, Y_i^k}{Y^k p_i^k}\left(\frac{1}{P_j^k\,\Pi_i^k}\right)^{1-\sigma_k} t_{ij}^{k^{-\sigma_k}} \varepsilon_{ij}^k. \tag{2.6}$$

To complete the derivation of the gravity regression equation, we need to specify t_{ij}^k. The standard approach in the gravity literature is to relate trade costs to a set of observables such as distance, common language and the presence of contiguous borders.[3] Here we specify the trade costs as follows:

$$t_{ij}^{k^{-\sigma_k}} = e^{\left(\ln(\text{distance})^{\beta_1^k}\ \text{ownstate}^{\beta_2^k}\ \text{adjacent}^{\beta_3^k}\right)} \tag{2.7}$$

where *distance* is the bilateral distance between trading partners, *ownstate*, capturing intra-state trade, is a dummy variable equal to one when $i = j$, and *adjacent* is a dummy

1 The exposition follows Anderson and Yotov (2010).
2 Here we follow Wolf (2009).
3 For a discussion, see Anderson and Wincoop (2004).

variable equal to one if i and j have a common border. Then, substituting Equation (2.7) into Equation (2.6), we get

$$Z_{ij}^k = \frac{E_j^k\ Y_i^k}{Y^k p_i^k} \left(\frac{1}{P_j^k\ \Pi_i^k}\right)^{1-\sigma_k} e^{\left(\ln(\text{distance})^{\beta_1^k}\ \text{ownstate}^{\beta_2^k} \text{adjacent}^{\beta_3^k}\right)}\ \varepsilon_{ij}^k. \tag{2.8}$$

The estimation of Equation (2.8) presents several challenges. First, we need to take into account unobserved multilateral resistance terms. We use the exporter-industry and importer-industry fixed-effects approach, as applied by a number of authors (e.g. Hummels, 1999; Hillberry and Hummels, 2003; Coughlin and Novy, 2013). Second, we need to deal with the high number of zero bilateral trade flows and heteroskedasticity. As was noted by Santos Silva and Tenreyro (2006), the standard log-linearized gravity equation is incompatible with zero trade flow data and failing to account for heteroskedasticity leads to inconsistent estimates. To address those issues, they proposed the Poisson pseudo-maximum likelihood (henceforth PPML) estimation technique to estimate the gravity regression with the dependent variable in levels rather than logs. We estimate Equation (2.8) with PPML for 1949 and 2007 where Z_{ij}^k are physical quantities shipped within and between the U.S. states. Robust standard errors are clustered around state pair ij, following Coughlin and Novy (2013).

3. U.S. Domestic trade data

This study uses data from the 1949 U.S. Interstate Commerce Commission (ICC) carload waybill statistics and the 2007 U.S. Commodity Flow Survey (CFS). The carload-waybill data comprises a random sample of all shipments on railroads between the origin and the destination state. The ICC collected data on the quantities shipped as well as the number of shipments for five commodity groups: products of agriculture, products of forest, animals, products of mines and manufactures and miscellaneous products. We have used the commodity level data for the last category which reports 134 products, including some from every SIC 2 category.[4] The CFS is collected by the Census Bureau on behalf of the U.S. Department of Transportation and is a survey of shipments from origin to destination of manufacturing, mining, wholesale trade and selected retail establishments. The shipments were collected for eight single modes and five multiple modes of transportation.[5] The survey excludes shipments in services, crude petroleum and natural gas extraction, farm, forestry, fishery, construction, government and most of the retail sector. We have used the data for 41 commodity classes, but we have excluded agricultural products and animals to be comparable with 1949 carload waybill data.[6] The CFS records the value of shipments as well as their weight in tons.

4 The list of commodities is in the Table A1.

5 Single modes include for-hire truck, private truck, rail, shallow draft, the Great Lakes, deep draft, air (includes air and truck) and pipelines; multiple modes include parcel, truck and rail, truck and water, rail and water and others.

6 The commodity classes include: live animals and live fish, cereal grains, other agricultural products, animal feed and products, meat and fish, grains and alcohol and tobacco products, other foodstuff, alcoholic beverages, tobacco products, calcareous monumental or building stone, natural sands, gravel and crushed stones, non-metallic minerals, metallic ores and concentrates, non-agglomerated bituminous coal, gasoline and aviation fuel, fuel oils, coal and petroleum products, basic chemicals, pharmaceutical products, fertilizers, chemical products and preparations, plastic and rubber, logs and other wood in the

We also use data on intra- and interstate distances and geographical concentration indices. The distance between the U.S. states is calculated using the standard great-circle distance formula. As for intra-state distance, we use several measures: distance between the two largest cities in a state, distance between the two largest cities in a state weighted by their population, as suggested by Wolf (2000), a measure suggested by Nitsch (2000), which uses land area.[7] We do so because previous research has shown that the magnitude of the home-bias estimates can be influenced by the way the intra-state distance is measured (Hillberry and Hummels, 2003). To account for the geographical distribution of manufacturing activities, we calculate indices of geographical concentration from the 1947 U.S. Census of Manufactures.

Before we proceed with the regression analysis, it is useful to present some descriptive statistics for U.S. domestic trade. Table 1 shows domestic trade by transportation mode in 1949 and 2007, respectively. As we see in Panel A, the most prevalent transportation mode in 2007 was trucking, which accounted for >70% of the value and the weight of shipments, respectively, and for >40% of ton–miles. Railroad transport is a distant second most important mode based on the weight of shipment, a close second based on ton–miles and third based on the value of shipment. The reason that railroads seem to be almost as important as trucking in ton–miles but not in the value or weight of shipment is that railroads transported heavy goods over long distances. The distribution of domestic trade by transportation mode in 1949 is presented in Panel B. As there are no data on the value and weight of shipments, Panel B contains information on ton–miles only. Nevertheless, a comparison of ton–miles is still revealing and the picture that emerges is quite clear: railroads were by far the most important mode of transportation in 1949, accounting for almost 60% of all ton–miles while trucking was at a distant third place with <14%. Inland waterways and transportation on the Great Lakes was the second most important mode.

Maps 1 and 2 show inter-state U.S. trade by the place of origin in 1949 and 2007, respectively, expressed as a percentage of total U.S. interstate trade. We see that there are notable differences: in 1949, most interstate trade originated in the north-east while by 2007 the origins spread toward the south-east and south-west. Indeed, in 1949, >52% of the interstate trade originated in the Manufacturing Belt states while that share dropped to about 35% by 2007.[8] On the other hand, the south-east and south-

rough, wood products, pulp and newsprint paper, paper and paperboard articles, printed products, textiles and leather, non-metallic mineral products, base meals, articles of base metal, machinery, electronic and electrical equipment, motorized and other vehicles, transportation equipment, precision instruments and apparatus, furniture, miscellaneous manufactured products, waste and scrap, mixed freight.

7 An intra-state distance measure suggested by Nitsch (2000) was calculated using the formula $d_{ii}^{-\delta} = [2/3. (\text{area}_i/\pi)^{0.5}]$; the distance measured by Wolf (2000) was calculated using the formula $d_{ii} = 2*[1/(1-(P_{i,1}/(P_{i,1}+P_{i,2}))]*d_{i,12}$ where $P_{i,1}$ and $P_{i,2}$ is the population of the largest and the second largest city in a state *i* respectively, $d_{i,12}$ is the distance between the largest and the second largest city in a state i. We also used a measure suggested by Hillberry and Hummels (2003) which is based on the actual shipping distances calculated from the data on individual establishments. As this measure is available only for 2007 and the estimates are very similar to those in the article, we do not report them but they are available from the authors upon request.

8 The Manufacturing Belt states include Illinois, Indiana, Massachusetts, Michigan, Minnesota, New York, New Jersey, Ohio, Pennsylvania and Wisconsin.

Table 1. Distribution of shipments by transportation modes in the USA: 1949, 2007

Transportation mode	Values			Percent from total		
	Value of shipment ($million)	Weight of shipment (thousand tons)	Ton miles	Value of shipment	Weight of shipment	Ton miles
Panel A: 2007						
Air (incl truck and air)	124,159	1120	1370	1.14	0.01	0.05
For-hire truck	4,891,695	3,994,568	993,599	44.88	34.89	36.77
Private truck	3,370,550	4,610,793	265,909	30.93	40.27	9.84
Truck and rail	124,282	120,296	100,219	1.14	1.05	3.71
Truck and water	21,500	58,146	28,195	0.20	0.51	1.04
Parcel, U.S.P.S., courier	1,520,533	32,002	25,584	13.95	0.28	0.95
Great Lakes	239	13,833	4290	0.00	0.12	0.16
Water	88,930	305,669	108,817	0.82	2.67	4.03
Pipeline	348,073	543,169		3.19	4.74	
Deep draft	9521	21,956	7019	0.09	0.19	0.26
Shallow draft	76,955	265,011	96,205	0.71	2.31	3.56
Rail	315,788	1,468,575	1,066,065	2.90	12.83	39.45
Rail and water	6627	13,261	4808	0.06	0.12	0.18
All modes	10,898,852	11,448,399	2,702,080	100.00	100.00	100.00
Panel B: 1949						
			Ton miles (mil)			Ton miles (% from total)
Railway			535			58.52
Motor vehicles			125			13.67
Inland waterways			139			15.20
Oil pipe lines			115			12.58
Airways			0.2			0.02
All modes			914			100.00

Note: 1949 figures refer to intercity freight traffic.
Source: Historical Statistics of the United States Millennial Edition, 2006 Table Df48-58, Commodity Flow Survey 2007.

west became more important: while in 1949 only about 27% of inter-state trade originated in these regions, by 2007 that share rose to almost 50%.[9] An example of the location of manufactures producing motorized vehicles illuminates the difference between 1949 and 2007. In 1949, the main exporting states of automobiles, other vehicles and vehicle parts were almost exclusively in the Manufacturing Belt, with the exception of California. That picture had changed by 2007: although the now 'Rust-Belt' states were still among the main exporters of vehicles to other U.S. states, south-east states accounted for >20% of interstate vehicle trade.

Intra-state U.S. trade also experienced interesting changes over time. This is visible in Table 2 which shows summary statistics of the shares of intra- and interstate trade in a state's total domestic trade. We see that, on average, the intra-state trade was more prevalent in 2007 than in 1949.

9 South-east and south-west regions include the following states: Alabama, Arkansas, California, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia and West Virginia.

Map 1. U.S. Interstate trade by state of origin, 1949.

Map 2. U.S. Interstate trade by state of origin, 2007.

Before we proceed further, one limitation of the 1949 data must be highlighted. As was mentioned at the beginning of this section, the 1949 trade data are based on railroad trade only. Even though Table 1 showed that railroads were the dominant mode of freight transport at that time and the interstate highway system had not yet

Table 2. U.S. intra- and interstate trade in 1949, 2007: summary statistics

	N	Mean (Std Dev)	Min	Max
	1949			
Intra-state (%)	48	26.5 (14.9)	1.63	78.7
Interstate (%)	48	73.5 (14.9)	21.2	98.4
	2007			
Intra-state (%)	48	31.9 (17.3)	8.7	88.6
Interstate (%)	48	68.1 (17.3)	11.4	91.3

Source: Interstate Commerce Commission (1951); Commodity Flow Survey, 2007.
Note: Intra- and interstate trade is percentage of state's total domestic trade.

been built, trucking was a growing industry (Barger, 1951; Meyer et al., 1960). It served mostly local markets and was delivering predominantly highly perishable goods such as livestock, poultry and dairy products. Even though our data contain only shipments of manufacturing and miscellaneous goods, our estimates of home bias are potentially vulnerable to the omission of local shipments made by truck. We deal with this issue in the next section.

4. Results for home bias in 1949 and 2007

The gravity regression Equation (2.8) is estimated at the aggregate as well as commodity level for manufacturing in 1949 and 2007, respectively. To make the results comparable, the dependent variable is the weight of shipments. We first present the results of the estimation at the aggregate level; then we discuss commodity level estimates.[10]

4.1. Empirical results: aggregate level

Table 3 reports the PPML results for 1949 and 2007, respectively. As several studies indicated that estimates of home-bias coefficients are influenced by the choice of the intra-state distance measure (Hillberry and Hummels, 2003; Chen, 2004; Coughlin and Novy, 2013) we estimated Equation (2.8) with four internal distance measures in 2007 and three in 1949.

We see that the estimates of the distance variables are always negative and statistically significant whereas the home-bias and adjacent variables are positive and significant across all specifications.[11] The magnitude of the home-bias coefficients deserves closer attention. The estimated coefficients are, in general, smaller in Panel A

10 The commodity-level disaggregation differs between 1949 and 2007. To make sure that our results are not driven by the differences in the commodity structure, we have estimated Equation (2.8) at three different levels of aggregation: (i) total trade, (ii) trade at 2007 commodity-level aggregation and (iii) trade at original, that is different, levels of commodity-aggregation for 1949 and 2007, respectively. Here we present the results at the 2007 commodity-level aggregation. Other results are available from the authors upon request.

11 The estimates of the distance variable are, in most cases, larger than -1, which suggests a smaller role of transport costs in explaining trade patterns. This result is similar to the findings of Silva and Tenreyo (2006).

Table 3. Gravity equation with intrastate home bias, U.S. 1949, 2007

	Panel A: Manufacturing sector 1949		
	Intra-state distance measures		
	Nitsch (I)	Wolf (II)	Largest cities (III)
ln_distance	−0.90***	−0.26***	−0.59***
	(0.06)	(0.06)	(0.06)
Home_bias	0.44***	0.97***	1.07***
	(0.11)	(0.11)	(0.10)
Adjacent	0.49***	1.23***	0.81***
	(0.09)	(0.11)	(0.11)
Constant	10.57***	6.18***	8.53***
	(0.49)	(0.54)	(0.51)
N	59904	59904	59904
Export/import/commodity FE	Yes	Yes	Yes
	Panel B: Manufacturing sector 2007		
	Intra-state distance measures		
	Nitsch (I)	Wolf (II)	Largest Cities (III)
ln_distance	−1.17***	−0.39***	−0.62***
	(0.05)	(0.03)	(0.04)
Home_bias	1.52***	2.20***	2.16***
	(0.08)	(0.08)	(0.07)
Adjacent	0.27***	1.01***	0.83***
	(0.08)	(0.08)	(0.08)
Constant	8.52***	3.06***	4.62***
	(0.82)	(0.79)	(0.80)
N	59904	59904	59904
Export/import/commodity FE	Yes	Yes	Yes

Source: 1949 Carload Waybill Data, ICC (1951); The Commodity Flow Survey 2007.
Note: 1949: dependent variable is weight of shipment in tons.
2007: dependent variable is weight of shipment in short-tons (2000 pounds). *** denotes significant at 1% level.

than Panel B, although the magnitudes differ across specifications. Indeed, the size of the home-bias coefficient in 1949 ranges from 0.44 to 1.07, whereas it is between 1.52 and 2.20 in 2007. This indicates that in 2007, intra-state U.S. trade was *much more* prevalent than in 1949. These results concur with the discussion in Section 3 in which we noted an increasing tendency towards intra-state trade by 2007 (Table 2).[12]

12 For purposes of comparison, we estimated the gravity Equation (2.8) with the weight of shipment as the dependent variable. Our data sets, however, provide other measures of inter- and intra-state trade as well: the number of shipments in 1949 and the value of shipments in 2007. To check the robustness of the results in Table 3, we re-estimated the gravity Equation (2.8) with these other measures and the magnitude of the home-bias estimates in 1949 remain much lower than those for 2007. The results are available from the authors upon request.

We pointed out earlier that the carload-waybill data do not include some shipments over short distances. As a consequence, our estimates of home bias might be biased downwards. As we show that the home bias in 1949 is smaller than in 2007, we need to establish whether this could be due to downward bias in the 1949 estimate. To do this, we take advantage of two ICC studies, which estimated the freight that railroads would have carried in the absence of other modes of freight transportation.[13] The first study was done for the period 1929–1938 and calculated for all commodities an index of 'potential tons' and compared it with actual tons carried by railways.[14] That comparison yields a ratio of actual to potential tons in 1937 of 84.9%, that is, railways would have carried 15.1% more freight in the absence of other means of transport. We use this information to estimate home bias in 1949 under the assumption that all of the lost freight was the freight from intra-state trade only. Specifically, we add 15.1% of 1949 railway freight to our carload waybill data set such that the extra 15.1% are traded only *within* the U.S. states and not across them and re-estimate Equation (2.8).

The second study, conducted for the period 1949, calculates an index of 'potential tons' that railways would have carried for each of the 131 commodities. This allows us to calculate a ratio of actual to potential tons at the commodity level which then provides us with disaggregated information on the share of freight that railways lost to other modes of transportation. Again, we use this information to estimate home bias in 1949 under the assumption that all of the lost freight was from intra-state trade only. Specifically, for each commodity, we add the estimated loss of railway freight to our carload waybill data set such that the lost freight is traded only *within* the U.S. states and not across them and re-estimate Equation (2.8).

The assumption that all of the lost-trade was only intra-state trade is extreme because some of the lost shipments were made across U.S. states; hence it favours intra- over interstate trade. We do so deliberately to err on the side of home bias to see how much the absence of shipments by modes of transportation other than rail could affect our 1949 home-bias estimate. If the estimated home bias under this extreme assumption is still lower than in 2007, then our arguments hold. Table 4 shows three different home-bias estimates for each of the intra-state distance measures: lower bound 1949 is the estimate from Table 3, Panel A; 2007 estimate is from Table 3, Panel B; upper bound 1949 version 1 is the estimate with the extra 15.1% of intra-state shipments and upper bound version 2 is the estimate with extra intra-state shipments calculated for each of 131 commodities.[15] We see that even under the very extreme assumptions made above the 1949 upper bound estimates are still considerably smaller than those for 2007.

Another way of assessing how much the absence of shipments by modes of transportation other than rail could affect our 1949 home-bias estimate is to ask a question: how much we would need to increase the intra-state trade in order for the home-bias estimates were the same as in 2007? If that counterfactual increase is implausibly high, then our argument that the estimates of home-bias in 1949 are lower than those in 2007 holds. Table A4 reports the results of the exercise and we see that the

13 Interstate Commerce Commission, 'Fluctuations in Railway Freight Traffic Compared with Production', Statement 3951, November 1939; 'Fluctuations in Railway Freight Traffic Compared with Production', Statement No. 570, January 1957.

14 The concept of 'potential tons' used by the ICC (e.g. ICC, 1957, 4) is that they are the traffic in an economy with no other mode of transportation competed with railways.

15 These regressions are reported in Tables A2 and A3.

Table 4. Estimates of home bias in 1949 and 2007

	Lower bound 1949	Upper bound 1949, version 1	Upper bound 1949, version 2	2007
	Intra-state distance: Nitsch formula			
home_bias	0.45***	1.24***	1.19***	1.52***
	Intra-state distance: Wolf formula			
home_bias	0.97***	1.88***	1.82***	2.20***
	Intra-state distance: largest cities			
home_bias	1.07***	1.90***	1.85***	2.16***

Source: Lower bound 1949: Table 3, PanelA; 2007: Table 3, Panel B.
Upper Bound 1949 vs1: 1949 Carload Waybill Data, ICC (1951); Fluctuations in railway traffic. Compared with Production', ICC Statement 3951, 1939.
Upper Bound 1949 vs2: 1949 Carload Waybill Data, ICC (1951); Fluctuations in railway traffic. Compared with Production', ICC Statement No. 570, 1957. *** denotes significant at 1% level.

counterfactual increase of intra-state trade is between 78% and 85%, an unrealistically large increase to match the estimates for 2007.

We have also estimated Equation (2.8) at the commodity level for 1949 and 2007, respectively.[16] All the estimates of the home-bias variable in 2007 are positive and they are statistically significant in all but three cases. The magnitude of the estimates varies across different intra-state distance measures but the statistical significance is mostly unchanged.[17] We have ranked the magnitude of the estimated coefficients from the smallest to the largest. Overall, the ranking is relatively stable across intra-state distance measures, although with some exceptions. Specifically, 'metallic ores and concentrates', 'logs and other wood in the rough' and 'calcareous monumental or building stone' industries show rather large changes of the magnitude of the home-bias estimates across different intra-state distance measures.

Unlike the estimates for 2007, the home bias estimates for 1949 show considerable variations in magnitude, statistical significance and sign. The sign of the estimated coefficients is the most distinctive difference between the 1949 and 2007 estimates: there are many products with a negative and statistically significant home-bias effect. Commodities with statistically significant and negative home-bias estimates for all three measures of the intra-state distance include, for example, 'copper ingot', 'copper, brass, bronze', 'automobiles', 'vehicle parts', 'hardware' and 'airplanes'. Other commodities for which home bias is negative for at least one of the intra-state distance measures are, for example, 'paper articles', 'cigarettes', 'agricultural implements' and 'agricultural implements parts'. On the other hand, commodities with statistically significant but positive home-bias estimates for all three intra-state distance measures include 'fertilizers', 'gasoline', 'boots and shoes', 'bricks' and 'refrigerators'. Other commodities where home bias is positive for at least one of the intra-state distance measures include

16 These results are available from the authors on request.
17 An exception is 'calcareous monumental or building stone' industry when the estimate is significant only in one out of four cases.

'cloth', 'newsprint papers', 'acids', 'rubber', 'cement', 'wood pulp' and 'wooden containers'. There is quite a bit of variation across different intra-state distance measures, though we can identify commodity groups for which estimates do not change their statistical significance and sign.

The home-bias estimates at the commodity level can help us to understand why the magnitudes of the home-bias estimates in 1949 and 2007 presented in Table 3 are so different. Evidently, the low values of some commodity home-bias estimates in 1949 and, especially the negative ones, pull down the overall home-bias estimates in 1949 relative to 2007. Therefore, explaining the negativity of the home-bias estimates in 1949 might shed light on the reasons why the home-bias estimates are so low in 1949 relative to 2007 and also why intra-state trade was *not* so prevalent in 1949 as in 2007. The following section addresses this issue.

5. Spatial concentration and home bias

As we noted earlier, a number of authors have suggested that the spatial concentration of industries is a key determinant of home bias. Hillberry (1999) provided a comprehensive examination of the causes of home bias at the commodity level. He investigated differences in the legal and regulatory environment, multinational activity, information flow, government purchases, past transportation networks and geographical location of industries. His results showed that only geographical location can significantly explain the variation of home bias across commodities. Using the Ellison and Glaeser (1997) geographical concentration index (henceforth EG), he found a negative relationship between the spatial concentration of industries and home-bias estimates. Specifically, the estimates of home bias were low for spatially concentrated but high for spatially dispersed industries.

Hillberry and Hummels (2003) also alluded to the role of geography in explaining home bias of intra-national trade. Using commodity-flow survey data they showed that the home-bias estimate drops after excluding wholesale shipments which tend to be more localized.[18] In another study using commodity-flow survey data (Hillberry and Hummels, 2008), it was found that the location of intermediate demand explains the geographical pattern of U.S. trade. Chen (2004), using commodity trade flow data for EU countries, estimated a gravity regression with an interaction term between the home-bias dummy and the EG index.[19] She found a negative relationship between geographical concentration and the magnitude of home bias.

The phenomenon of the Manufacturing Belt suggests a variant of these arguments that builds on an insight in Wolf (1997) and might account for negative home bias. He put forward the hypothesis that 'spatial comparative advantage' is a possible explanation for domestic home bias. He suggested that if spatial clusters occur within sectors, home bias might be observed because intra-sector trade of intermediate products might take place in these clusters within states even though the distribution of the consumption of final goods was fairly even and not subject to 'excessive' local trade. Klein and Crafts (2012) showed that linkage effects and scale effects were major reasons

18 The study also controlled for multilateral resistance in the gravity regression as suggested by Anderson and van Wincoop (2003).

19 Chen (2004) also explored the role of technical barriers to trade and product-specific information costs.

for the existence of the Manufacturing Belt, which led to the spatial clustering of production of final goods that were purchased nationwide. In this case, we might expect that home bias would be negative, that is, production would be more spatially concentrated than sales of the final good. This is, of course, the classic pattern that first emerged in the late 19th century and which Chandler (1977) famously characterized as 'mass production and mass distribution'.

This argument also leads to the hypothesis that intra-national home bias will be negatively related to the EG index. To test this prediction, we examine the relationship between the spatial distribution of industries and home bias at the commodity level by using a version of EG index developed by Maurel and Sedillot (1999) calculated for 1947. In doing so, we try to understand not only why the 1949 home-bias estimate is considerably lower than that of 2007 but also how this is linked to the spatial concentration of industries and the structure of production in 1949.

5.1. Intra-national home bias, geography and the Manufacturing Belt

We use the amended version of the EG index suggested by Maurel and Sedillot (1999) as it does not require plant-level employment data, which are not available in the 1947 U.S. Census of Manufactures where only the number of plants in each industry are reported. A challenge in using the 1947 Census of Manufactures to calculate Maurel and Sedillot's EG index for commodities in the 1949 carload waybill statistics is to match 1947 industries with 1949 commodities. Fortunately, the 1947 census contains up to 4 digit SIC industries which correspond quite precisely with the commodities included in the 1949 carload-waybill statistics. Indeed, we can match 106 out of 134 commodities.[20]

An investigation of the relationship between geography and the magnitude of home-bias estimates can be conducted by expanding the regression Equation (2.8) with an interaction term between home bias and index of geographical concentration, similarly to Chen (2004). The sign and significance of the interaction term indicates whether geographically concentrated industries exhibit smaller or larger home bias. The results, presented in Table 5, show that the estimated coefficients of the interaction between home bias and geographical concentration are negative, which means that industries with small values of the home-bias coefficient have high geographical concentration and vice versa. This confirms our conjecture about the role of spatial distribution of industries, namely, that small home bias in 1949 might result from highly spatially concentrated industries which produce commodities for the rest of the USA such that interstate trade is more prevalent than intra-state trade.

So far we have established that low values of the home-bias coefficient are caused by highly spatially concentrated industries which supply their products to the entire USA. Our earlier discussion and Map 1 indicated that the main origin of U.S. interstate trade in 1949 was in the north-east and mid-west regions, also known as the Manufacturing Belt, which contained industries producing commodities for the entire USA.

To test the hypothesis that the existence of the Manufacturing Belt impacts the 1949 home-bias results, we expanded the regression Equation (2.8) by including: (i) an

20 The full list of 134 commodities and the results of the matching are available from the authors upon request.

Table 5. Gravity equation with geographical index, U.S. 1949

	Intra-state distance measures		
	Nitsch (I)	Wolf (II)	Largest cities (III)
ln_distance	−0.92***	−0.26***	−0.60***
	(0.06)	(0.05)	(0.06)
adjacent	0.50***	0.84***	1.27***
	(0.10)	(0.10)	(0.09)
home_bias	0.88***	1.53***	1.44***
	(0.15)	(0.15)	(0.18)
home_bias x EG index	−3.18***	−3.18***	−3.18***
	(0.55)	(0.55)	(0.57)
Constant	8.70***	4.12***	6.57***
	(0.53)	(0.46)	(0.49)
N	244,224	244,224	244,224
Export/import/commodity FE	Yes	Yes	Yes

Source: 1949 Carload Waybill Data, ICC (1951), U.S. Census of Manufactures 1947.
Note: The dependent variable is the weight of shipment (in tons). *** denotes significant at 1% level.

interaction between home bias and a dummy variable for a manufacturing belt state and (ii) an interaction term between home bias and a dummy variable for a state outside the Manufacturing Belt. The results are presented in Tables 6 and 7. Table 6 shows that the estimated coefficients between home bias and a manufacturing belt dummy are negative and statistically significant, which implies that home bias is smaller for trade originating in the Manufacturing Belt. As a sensitivity check, we have also interacted home bias and the geographical concentration index with the manufacturing belt dummy and the results are qualitatively the same. Table 7, on the other hand, shows that home bias is larger for states outside the Manufacturing Belt. Overall, the regression results imply that the magnitude of home bias in 1949 decreases when the trade originates in the Manufacturing Belt states and increases when the trade originates outside the Manufacturing Belt.

How does the situation in 1949 compare with that of 2007? The Manufacturing Belt had dissolved by 2007 and the production of manufactures had moved towards the south so that the Manufacturing Belt states were no longer the dominant suppliers of goods such as passenger cars or manufactured iron and steel; southern states were increasingly the producers of what had been typical Manufacturing Belt products. Indeed, while exports from Manufacturing Belt states were about 52% of all US interstate trade in 1949, they were only about 35% in 2007. This implies that while, for example, Michigan supplied the largest number of cars to the rest of the USA, states such as Kentucky or Georgia produced them as well. The spread of manufacturing production implied an increase in intra-state relative to interstate trade between 1949 and 2007. This is reflected in the sign and magnitude of the estimated home-bias coefficients at the commodity level in 2007. Unlike in 1949, none of them is negative or less than one; hence, the magnitude of home bias is smaller in 1949 than in 2007.

Table 6. Gravity equation with Manufacturing Belt dummy and geographical index, U.S.1949

	Panel A: Manufacturing Belt dummy			Panel B: Manufacturing Belt and EG index		
	Intra-state distance measures			Intra-state distance measures		
	Nitsch (I)	Largest cities (II)	Wolf (III)	Nitsch (I)	Largest cities (II)	Wolf (III)
ln_distance	−0.84***	−0.55***	−0.33***	−0.90***	−0.58***	−0.29***
	(0.06)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
adjacent	0.53***	0.82***	1.10***	0.52***	0.84***	1.22***
	(0.09)	(0.09)	(0.08)	(0.09)	(0.09)	(0.08)
home_bias	0.93***	1.59***	1.55***	0.67***	1.33***	1.28***
	(0.11)	(0.10)	(0.12)	(0.11)	(0.11)	(0.13)
home_bias × manuf. belt dummy	−0.79***	−0.90***	−1.24***			
	(0.15)	(0.16)	(0.18)			
home_bias × EG index × manuf. belt dummy				−3.08***	−3.51***	−5.00***
				(0.87)	(0.93)	(1.12)
Constant	9.72***	7.75***	6.11***	6.93***	4.80***	2.81***
	(0.46)	(0.44)	(0.48)	(0.63)	(0.57)	(0.55)
N	308,736	308,736	308,736	241,922	241,922	241,922
Export/import/commodity FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: 1949 Carload Waybill Data, ICC (1951), U.S. Census of Manufactures 1947.
Note: The dependent variable is the weight of shipment (in tons). *** denotes significant at 1% level.

Table 7. Gravity equation with outside-Manufacturing Belt dummy and geographical index, U.S.1949

	Panel A: Outside Manuf. Belt dummy			Panel B: Outside Manuf. Belt and EG index		
	Intra-state distance measures			Intra-state distance measures		
	Nitsch (I)	Largest cities (II)	Wolf (III)	Nitsch (I)	Largest cities (II)	Wolf (III)
ln_distance	−0.84***	−0.55***	−0.33***	−0.89***	−0.58***	−0.29***
	(0.06)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)
adjacent	0.53***	0.82***	1.10***	0.52***	0.85***	1.22***
	(0.09)	(0.09)	(0.08)	(0.09)	(0.09)	(0.08)
home_bias	0.14	0.69***	0.31	0.31**	0.92***	0.72***
	(0.14)	(0.15)	(0.21)	(0.12)	(0.12)	(0.16)
home_bias × outside Manuf. Belt dummy	0.79***	0.90***	1.24***			
	(0.15)	(0.16)	(0.18)			
home_bias × EG index × outside Manuf. Belt dummy				2.91***	3.23***	4.27***
				(0.56)	(0.57)	(0.59)
Constant	9.72***	7.75***	6.11***	6.92***	4.79***	2.81***
	(0.46)	(0.44)	(0.48)	(0.62)	(0.57)	(0.55)
N	308,736	308,736	308,736	241,922	241,922	241,922
Export/import/commodity FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: 1949 Carload Waybill Data, ICC (1951), U.S. Census of Manufactures 1947.
Note: The dependent variable is the weight of shipment (in tons). *** denotes significant at 1% level.

6. Conclusions

We have shown that home bias in domestic trade in the United States was considerably greater in 2007 than in 1949. Moreover, for a number of commodities in 1949 there was a negative home bias with production much more spatially concentrated than consumption. This was associated with the high share of production in the Manufacturing Belt in 1949 compared with a more even distribution in 2007.

Our results clearly indicate that the structure of production and its reflection in the spatial distribution of industrial plants underlies the pattern of home bias. Two important points follow from this. First, as earlier authors have noted, this makes it less likely that home bias entails substantial welfare losses from barriers to trade. Second, as has not been recognized before, the pattern of home bias in the mid-20th century was quite unlike that observed in recent times and reflected the very different location patterns deriving from the plant sizes, transport costs and input–output relations of an earlier technological era.

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Appendix

Table A1. List of commodities in 1949 carload waybill data

Abrasives not crude	Feed A And P Nos	Paperboard Fibrebo
Acids	Fertilizers	Plaster stucco wall
Agric imp. parts	Floor covering	Plastics
Agriculture implements	Food products	Printed matter nos
Airplanes	Food products frozen	Printing paper nos
Alcohol nos	Fuel road oils nos	Railroad equip own whls
Aluminium bar	Furnace slag	Railroad equip su on cars
Artificial Stone	Furnaces Etc	Railroad equipment parts
Athletic equipment	Furniture	Railroad track mtl iron and steel
Automobile(passengers)	Furniture parts	Refd petrol nos
Automobiles freight	Games and toys	Refractories
Autos autotrucks Ko	Gases not petroleum	Refrigerators
Bagging burlap, etc.	Gasoline	Rope cordage twine
Bags burlap cotton	Glass	Rubber goods nos
Bathroom fixtures	Glass bottles jars	Rubber crude
Beverages nos	Glassware nos	Scrap for remeltg
Blacks nos	Hardware	Scrap iron
Bldg paper roofing	Household utensils	Scrap paper rags
Bldgs houses portabl	Iron and steel borings, etc.	Sewer pipe not metal
Blog woodwk millwrk	Iron and steel pipe ftgs	Soap cleaning compos
Boots. shoe findings	Ice	Sodium products
Bricks building tile	Insecticides	Soybean oil
Bricks common	Insulating materials	Starch
Broken brick, etc.	Iron&Steel	Stoves ranges parts
Building materials	Laundry equipment	Sugar
Candy_confectionary	Lime	Sulphuric acid
Cast iron pipe ftgs	Linseed oil	Synthetic fibre
Cellulose articles	Liquors alcoholic	Syrup molasses refnd
Cement nos	Liquors malt	Tanks nos
Cement portland	Lubricating oils	Tanning material nos
Chemicals	Luggage handbags nos	Tar pitch creosote
Chinaware crockery	Machinery parts	Tires,tubes,rubbers
Cigarettes	Machines	Tools and parts
Cloth&fabric	Manufactured iron&steel	Vegetable nut oils
Container retd mty	Matches	Vehicle not motor
Containers Fibrbo Kd	Mfrs and misc nos	Vehicle parts
Containers Metal	Mftd Tobacco Nos	Vehicles motor nos
Containers nos	Military vehicles	Wallboard
Copper ingot	Molasses residual	Waste mtl nos
Copper,brass,bronze	Newspaper	Wine
Cotton cloth	Oil foots sediment	Wooden container
Cotton factory prdts.	Oils nos	Woodpulp
Cottonseed oil	Paint putty varnish	Woodware
Electrical equipment	Paper bags	Wrapping paper
Explosives	Paper articles	

Source: 1949 Carload Waybill Data, ICC (1951).

Table A2. Gravity equation with intrastate home bias, U.S.1949. Upper bound estimates vs1

	Panel A: Manufacturing		
	Intra-state distance measures		
	Nitsch (I)	Wolf (II)	Largest cities (III)
ln_distance	−0.89***	−0.21***	−0.54***
	(0.06)	(0.06)	(0.05)
home_bias	1.24***	1.88***	1.90***
	(0.10)	(0.10)	(0.08)
Adjacent	0.50***	1.28***	0.84***
	(0.09)	(0.11)	(0.11)
Constant	10.27***	5.52***	7.96***
	(0.48)	(0.52)	(0.49)
N	302,482	302,482	302,482
Export/import/commodity FE	Yes	Yes	Yes

Source: 1949 Carload Waybill Data, ICC (1951).
Note: the dependent variable is the weight of shipment (in tons). *** denotes significant at 1% level.

Table A3. Gravity equation with intrastate home bias, U.S.1949. Upper bound estimates vs2

	Panel A: Manufacturing		
	Intra-state distance measures		
	Nitsch (I)	Wolf (II)	Largest Cities (III)
ln_distance	−0.89***	−0.21***	−0.55***
	(0.06)	(0.06)	(0.05)
home_bias	1.19***	1.82***	1.85***
	(0.10)	(0.10)	(0.08)
Adjacent	0.50***	1.28***	0.84***
	(0.09)	(0.11)	(0.11)
Constant	8.75***	4.00***	6.47***
	(0.47)	(0.46)	(0.46)
N	306,432	306,432	306,432
Export/import/commodity FE	Yes	Yes	Yes

Source: 1949 Carload Waybill Data, ICC (1951).
Fluctuations in Railway Freight Traffic Compared with Production, ICC Statement No 570, 1957.
Note: the dependent variable is the weight of shipment (in tons). *** denotes significant at 1% level.

Table A4. Gravity equation with counterfactual intrastate trade, U.S.1949

	Panel A: Manufacturing		
	Intra-state distance measures		
	Nitsch (I)	Wolf (II)	Largest cities (III)
counterfactual increase of intra-state trade	85%	85%	78%
ln_distance	−0.89***	−0.19***	−0.53***
	(0.06)	(0.06)	(0.05)
home_bias	1.53***	2.21***	2.19***
	(0.10)	(0.09)	(0.08)
Adjacent	0.50***	1.29***	0.85***
	(0.09)	(0.11)	(0.11)
Constant	8.78***	3.92***	6.42***
	(0.45)	(0.44)	(0.43)
N	308,736	308,736	308,736
Export/import/commodity FE	Yes	Yes	Yes

Source: 1949 Carload Waybill Data, ICC (1951).
Note: The dependent variable is the weight of shipment (in tons).
Counterfactual increase of intra-state trade is the percentage increase in intra-state trade to yield the same home-bias estimates as in 2007. *** denotes significant at 1% level.