



Market Potential and Global Growth over the Long Twentieth Century[☆]

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ABSTRACT

We examine the evolution of market potential and its role in driving economic growth over the long twentieth century. Theoretically, we exploit a structural gravity model to derive a closed-form solution for a widely-used measure of market potential. We are thus able to express market potential as a function of directly observable and easily estimated variables. Empirically, we collect a large dataset on aggregate and bilateral trade flows as well as output for 51 countries. We find that market potential exhibits an upward trend across all regions of the world from the early 1930s and that this trend significantly deviates from the evolution of world GDP. Finally, using exogenous variation in trade-related distances to world markets, we demonstrate a significant causal role of market potential in driving global income growth over this period.

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1. Introduction

What has been the trajectory of market potential over the long twentieth century? And is there a causal relationship between market potential and global income growth? Here, we contribute to a long-standing literature along these lines by developing a structural measure of market potential which is fully comparable across countries and across time and which comes with fairly minimal data requirements. As in the preceding literature, we model market potential as a summary measure of both

external and internal demand which explicitly takes into account the costs of transaction and transport associated with the exchange of goods. But in contrast to much of the preceding literature, we seek to exploit the wide variation in the evolution of the global economy over the long twentieth century to investigate the causal role of market potential in shaping global income growth over this period.

Our goal, then, comes in assessing the relationship between globalization and growth in the long run by: (1) developing a theoretically-derived measure of market potential appropriate for historical use rather than relying on narratives derived from “data-as-given” time series such as aggregate exports, allowing us to relate globalization and growth in a more disciplined fashion; (2) collecting a new dataset on aggregate exports, bilateral trade, and GDP for 51 countries; (3) constructing our proposed measure of “structural market potential”, as well as charting and decomposing its evolution through time; and (4) exploiting exogenous variation in trade-related distances to world markets in order to determine the causal role of market potential in driving global income growth over this period.

Of course, we are far from the first to consider the theme of market potential and its role in the growth process. In the very first contribution to this literature, Harris (1954) was motivated by the question of why, with only 12% of the United States by area, the Northeast produced fully 50% of

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its manufacturing output and employed 70% of its industrial labor force in 1950. His informal model is one in which firms balance production versus trade costs in determining their location and in which the presence of deep input and output markets influence this decision. His paper also marks the first usage of the term market potential which Harris defines as “an abstract index of intensity of possible contact with markets” and is calculated as the sum of markets accessible (often proxied by income or population) to a given point over distance-to-markets from that point.

Krugman (1991, 1992) resurrected this notion of market potential but explicitly grounded it in a spatial general equilibrium model, thereby setting off an expansive body of work in the new economic geography literature. The basic structure of the Krugman model was then extended by Helpman (1998), enhancing its tractability in empirical work (e.g., Hanson 2005). In addition, Fujita et al. (1999) gave rise to the workhorse model of the new economic geography literature. Importantly, these modeling approaches rely on a common set of elements, typically in the form of CES consumption, simple production functions and monopolistically competitive firms. Symmetry in preferences and technology yield a structural link between market potential and standards of living.

For our purposes, however, the most important contribution to this literature comes from Redding and Venables (2004). Motivated by the wide dispersion in cross-country manufacturing wages and incomes, they concentrate on two mechanisms which may potentially explain such disparities: (1) the distance of countries to markets in which their output is sold; and (2) the distance of countries to markets from which capital and intermediate goods are purchased. Thus, the presence of trade costs means that more distant countries face a penalty on their sales as well as additional costs on imported inputs. As a consequence, firms in these countries can only afford to pay relatively low wages, translating into lower levels of GDP per capita. This result holds even if technologies are the same across countries.

Liu and Meissner (2015) recently considered the theme of historical market potential in the context of the Redding and Venables (2004) model. Using cross-sectional data for 27 countries in 1900 and 1910, they establish that market potential was a significant determinant of GDP per capita in the early twentieth century. They also raise the prospect that the United States did not necessarily benefit from a natural lead in market potential as its greater domestic market size was counterbalanced by its greater distance to other—in particular, European—markets. Finally, Head and Mayer (2011) consider panel evidence for the role of market potential in driving differences in GDP per capita for the period from 1965 to 2003. Thus, they are able to establish a broader consistency with the results of Redding and Venables (2004).

However, we argue that there is a complication with Redding and Venables' approach in a panel setting, which makes its use in a historical context potentially problematic. Namely, one ideally needs a full matrix of bilateral trade flows for every year, imposing a large cost in terms of data collection. This is due to the fact that the construction of market potential in Redding and Venables (2004) and Head and Mayer (2011) relies on a set of exporter and imported fixed effects pertaining to all countries in the world, based on a standard gravity model of bilateral trade. Without the full matrix of global trade flows, estimates of these fixed effects can shift substantially.¹ Our proposed solution, then, comes from exploiting a link between the model of Redding and Venables and structural gravity models that allows us to bypass exporter and importer fixed effects.

The rest of the paper proceeds as follows. Section 2 lays out the relationship between market potential and structural gravity. It does so first by revisiting the work of Redding and Venables (2004) on market potential and then by relating it to the work of Anderson and van Wincoop (2003). This results in a new solution for the measure of market potential that is less data-intensive and therefore particularly suitable for

historical settings. We refer to it variously as “structural market potential” or, simply, market potential. Section 3 introduces the underlying data, presents our new evidence on market potential over the long twentieth century, and provides a comparison to existing formulations of market potential. Section 4 first relates our new measure to global growth in the context of standard wage equations drawn from the existing literature and then exploits variation in trade-related distances to world markets in order to establish a causal relationship between market potential and global income growth. Finally, Section 5 concludes.

2. Market potential and structural gravity

We first outline the basic setup of the Redding and Venables (2004) new economic geography model. We then relate it to the structural gravity framework by Anderson and van Wincoop (2003). As a departure from the existing literature, this allows us to derive an analytical solution for the market potential measure mainly in terms of directly observable and easily estimated variables.

2.1. The new economic geography model

Redding and Venables (2004) propose a new economic geography model with multiple countries. Symmetric firms in the manufacturing sector operate under monopolistic competition, and each firm produces a differentiated variety that is used both in consumption and as an intermediate good. Preferences and production are described by a CES aggregator with a common elasticity of substitution ($\sigma > 1$),

$$U_j = \left(\sum_{i=1}^N n_i c_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}, \quad (1)$$

where U_j is utility in country j , c_{ij} is consumption of a symmetric variety imported from country i , n_i denotes the number of varieties in country i , and N is the total number of countries. The price index P_j is given as the dual to the U_j quantity aggregator.

Nominal demand in country j added over all individual varieties from country i follows as

$$x_{ij} = n_i p_{ij} c_{ij} = n_i p_{ij}^{1-\sigma} y_j p_j^{\sigma-1}, \quad (2)$$

where y_j is the income of country j . Redding and Venables (2004) refer to the term $y_j p_j^{\sigma-1}$ as the *market capacity* of country j , $m_j \equiv y_j p_j^{\sigma-1}$, since it determines consumers' demand in that country for an individual variety with given a price p_{ij} . They employ the typical iceberg trade cost assumption so that the destination country price p_{ij} depends multiplicatively on the factory price p_i in origin country i and a bilateral trade cost factor $t_{ij} \geq 1$ with $p_{ij} = t_{ij} p_i$. Furthermore, they assume that trade costs are bilaterally symmetric, i.e., $t_{ij} = t_{ji}$.²

Apart from the demand-side aspect captured by market capacity, the right-hand side of eq. (2) also contains supply-side variables in the form of $n_i p_i^{1-\sigma}$, net of bilateral trade costs t_{ij} . Redding and Venables (2004) refer to this term as the *supply capacity* of country i , $s_i \equiv n_i p_i^{1-\sigma}$. It consists of an extensive margin measure n_i for the number products originating in i as well as their price competitiveness embodied by p_i . Redding and Venables (2004) provide further details for the supply side of the model. For instance, they impose a Cobb-Douglas technology with an immobile factor (e.g., labor), an internationally mobile factor (e.g., capital), and a composite intermediate good with price P_i . They introduce increasing returns by way of a fixed input requirement.³ It turns out, however, that the supply-side details are not essential for

¹ For instance, see Anderson and van Wincoop (2003) who obtain different estimates for a two-country model with US and Canadian data only and a multi-country model that includes observations for 20 additional countries.

² In Appendix I, we show that our main insights go through even if trade costs are bilaterally asymmetric. We also account for trade imbalances at the aggregate level by allowing income and expenditure to deviate, based on Anderson and van Wincoop (2004).

³ The full model is explored in detail by Fujita, Krugman, and Venables (1999, chapter 14).

the aggregate gravity relationship that emerges from the model as the basis for the empirical analysis.⁴

Given the above structure of the economy and the expression for bilateral trade flows in eq. (2), how can one summarize what Harris (1954) first described as “the intensity of possible contacts with markets”? Redding and Venables (2004) proceed to define *market access* of country *i* as the trade cost-weighted sum of the market capacities of all partner countries. The resulting measure MA_i captures the strength, or intensity, of demand faced by suppliers from country *i*:

$$MA_i = \sum_{j=1}^N t_{ij}^{1-\sigma} m_j. \tag{3}$$

Analogously, *supplier access* of country *j* is defined as the trade-cost weighted sum of the supply capacities of all partner countries. This measure SA_j captures the availability of supply faced by customers in country *j*⁵:

$$SA_j = \sum_{i=1}^N t_{ij}^{1-\sigma} s_i. \tag{4}$$

2.2. Exploiting the link with structural gravity

Formally, we can frame the setup outlined above as part of the class of trade-separable general equilibrium models (see Anderson and van Wincoop 2004 for details). Here, separability refers to the fact that the allocation of bilateral trade flows is determined independently of the output structure. In its simplest form, we can think of the model as a one-sector manufacturing economy in which expenditure equals the value of output and income. As a budget accounting identity, the spending by country *j* on imports x_{ij} is linked to all possible origin countries *i* (including the domestic market) such that it adds up to the income of country *j*, i.e., $\sum_i x_{ij} = y_j$. We also impose market-clearing such that

the value of all production originating in country *i* equals the exports to the destination markets *j*, i.e., $\sum_j x_{ij} = y_i$. Given this structure and

the assumption of balanced trade, we can apply the insights of Anderson and van Wincoop (2003) who solve for the structural gravity equation as

$$x_{ij} = \frac{y_i y_j}{y^W} \left(\frac{t_{ij}}{P_i P_j} \right)^{1-\sigma}, \tag{5}$$

where y^W denotes global income given by the sum of the incomes of all countries.⁶ The price index, or multilateral resistance variable, is given by

$$P_i^{1-\sigma} = \sum_{j=1}^N P_j^{\sigma-1} \frac{y_j}{y^W} t_{ji}^{1-\sigma}.$$

The price indices aggregate the import prices over all origin countries. P_j is also a key component of country *j*'s market capacity m_j , but it is not directly observable in the data.⁷ Following Novy (2013), we use the

structural gravity eq. (5) to solve for P_j . That is, we form the analogous gravity equation for domestic trade x_{jj} and then rearrange to obtain

$$P_j^{\sigma-1} = \left(t_{jj}^{\sigma-1} \frac{x_{jj}/y_j}{y_j/y^W} \right)^{\frac{1}{\sigma}}. \tag{6}$$

It follows that we can express market capacity as

$$m_j = y_j P_j^{\sigma-1} = \left(t_{jj}^{\sigma-1} x_{jj} y^W \right)^{\frac{1}{\sigma}}. \tag{7}$$

We insert this expression for m_j back into gravity eq. (5) to arrive at

$$x_{ij} = \frac{y_i}{y^W} \left(\frac{t_{ij}}{P_i} \right)^{1-\sigma} m_j,$$

also noting that exports from *i* to *j* from eq. (2) can be rewritten as

$$x_{ij} = n_i (t_{ij} p_i)^{1-\sigma} y_j P_j^{\sigma-1} = s_i t_{ij}^{1-\sigma} m_j. \tag{8}$$

By combining the last two expressions and rearranging we obtain

$$s_i = \frac{y_i P_i^{\sigma-1}}{y^W} = \frac{m_i}{y^W} = \left(\frac{t_{ii}^{\sigma-1} x_{ii}}{y^W} \right)^{\frac{1}{\sigma}}. \tag{9}$$

We can then use the expressions for m_j and s_i to simplify the market and supplier access terms in eqs. (3) and (4). Using $t_{ij}^{1-\sigma} m_j = x_{ij}/s_i$ from eq. (8), inserting this into the expression for MA_i and using market-clearing, we obtain

$$MA_i = \sum_{j=1}^N t_{ij}^{1-\sigma} m_j = \frac{1}{s_i} \sum_{j=1}^N x_{ij} = \frac{y_i}{s_i}. \tag{10}$$

Similarly, we use $t_{ij}^{1-\sigma} s_i = x_{ij}/m_j$ from eq. (8), insert it into the expression for SA_j and use the accounting identity to obtain

$$SA_j = \sum_{i=1}^N t_{ij}^{1-\sigma} s_i = \frac{1}{m_j} \sum_{i=1}^N x_{ij} = \frac{y_j}{m_j}. \tag{11}$$

We note that the expressions for MA_i and SA_j no longer involve summation over trading partners. Finally, we combine eqs. (7), (9) and (10)–(11) to summarize our derivation as

$$MA_i = \frac{y^W}{\left(t_{ii}^{\sigma-1} \frac{x_{ii}/y_i}{y_i/y^W} \right)^{\frac{1}{\sigma}}} \equiv MP_i, \tag{12}$$

$$SA_i = \frac{1}{\left(t_{ii}^{\sigma-1} \frac{x_{ii}/y_i}{y_i/y^W} \right)^{\frac{1}{\sigma}}}. \tag{13}$$

Thus, MA_i and SA_i are proportional since $MA_i = y^W SA_i$.⁸ We define market potential MP_i as our measure MA_i as in eq. (12).

All else being equal, MA_i increases in global income. Intuitively, if the global economy grows, demand for individual country *i*'s output rises. In contrast, SA_i decreases since the growth of production in the world represents more competition and thus a decline in relative supply capacity. Not surprisingly, growing y_i increases both market and supplier access since it represents both rising availability of supply to customers elsewhere as well as rising demand for foreign products. Higher domestic trade costs t_{ii} work in the opposite direction since

⁴ For instance, the supply side could be further simplified by removing the capital input or, in the extreme case, by setting up an endowment economy with an Armington structure. Also see Head and Mayer (2011, section 2.1) on the various supply-side structures consistent with the aggregate gravity relationship. It is well-known that similar aggregate relationships arise from the models of Eaton and Kortum (2002), Chaney (2008), and Melitz and Ottaviano (2008).

⁵ Redding and Schott (2003) use the same definitions of market and supplier access.

⁶ Note that due to bilateral trade cost symmetry the outward and inward multilateral resistance terms coincide. This assumption can be relaxed. See Appendix I where we allow for bilaterally asymmetric trade costs and also for trade imbalances at the aggregate level.

⁷ Even if appropriate price indices were available, they likely would not include non-pecuniary trade cost components such as informational barriers.

⁸ In Appendix I when we allow for trade imbalances, we derive a closed-form expression for the geometric average of market and supplier access measures in equations (12) and (13) as a function of observable variables. Donaldson and Hornbeck (2016) refer to market access as “firm market access” and to supplier access as “consumer market access.” They also show that the two measures are proportional.

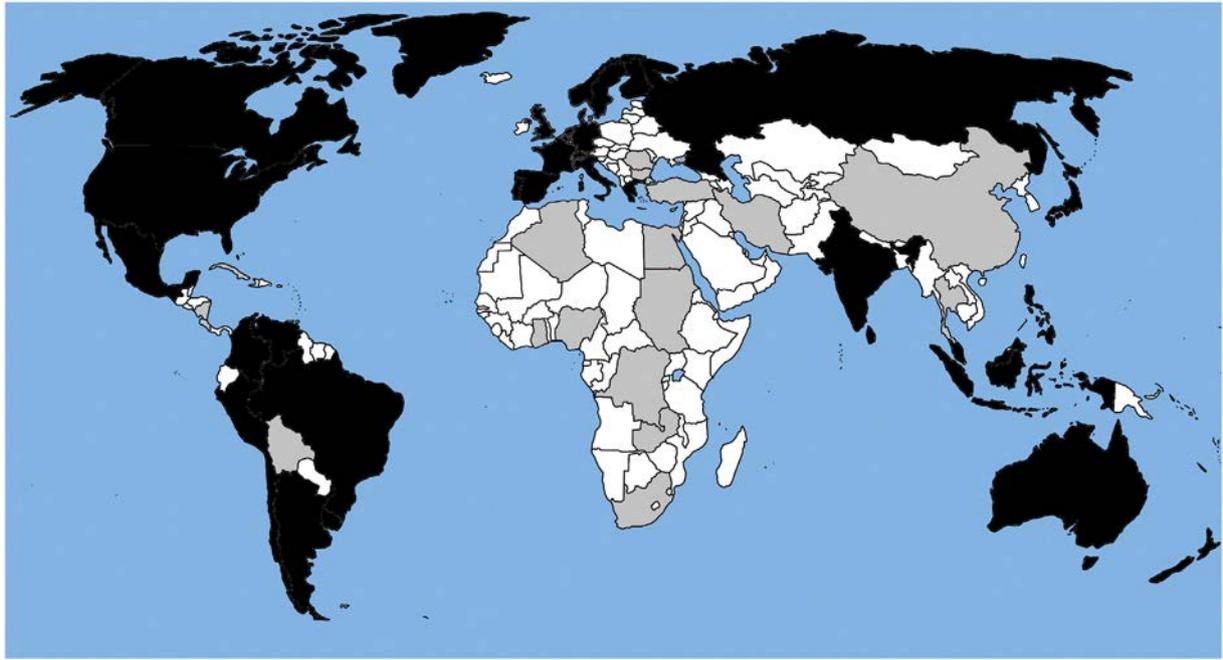


Fig. 1. Sample Countries Notes: The sample is comprised of 33 countries from 1910 (depicted in black above) and 18 countries from 1950 (depicted in grey above).

they hamper the domestic economy. We can think of t_{ii} as the cost of reaching domestic customers and sourcing domestic supply. The role of domestic trade flows x_{ii} is perhaps less obvious to understand. Holding output constant, due to market-clearing a rise in x_{ii} means less trade with foreign countries, which implies that bilateral trade costs t_{ij} must have risen. A rise in bilateral trade costs is associated with more isolation from global markets, which in turn hurts demand prospects as well the ability to obtain the supply of goods emerging from partner countries.

We draw two conclusions for our empirical analysis. First, since the market and supplier access measures are proportional, for a given cross-section they do not contain independent information. Therefore, we proceed with a single measure corresponding to the expression for market access in (12). We variously call it “structural market potential”, or, simply, market potential (MP_i).

Second, in contrast to the previous literature, we do not necessarily require estimates of or information on bilateral trade costs across countries to compute our market potential expression (12). Instead, it is a simple function of variables related to the domestic economy and a global constant.⁹ Moreover, the variables in eq. (12) are for the most part given by the data. That is, income y_i as well as global income y^W are directly observable while domestic trade flows x_{ii} can be constructed from the data. Domestic trade costs scaled by the elasticity of substitution, $t_{ii}^{\sigma-1}$, can be constructed based on estimates from a standard gravity regression using domestic trade cost proxies such as internal distance as we do here (details below).

Finally, note that we can also express market access as a function of the price index by substituting eq. (6). It follows

$$MA_i = MP_i = \frac{y^W}{P_i^{\sigma-1}} \quad (14)$$

and subsequently $SA_i = P_i^{1-\sigma}$.¹⁰ Despite its simplicity, the disadvantage of this expression is that the price index, or multilateral resistance variable, is not directly observable in the data.

⁹ In the empirical section and in Appendix II, we compare our measure of market potential to those traditionally estimated and then constructed with bilateral trade data, in particular Harris (1954) and Redding and Venables (2004).

¹⁰ This result on supplier access also holds in Redding and Venables (2004).

3. Data and empirics

3.1. The dataset

We collected a large annual dataset for 33 countries over the period from 1910 to 2010 which is comprised of aggregate exports and GDP and for an additional 18 countries from 1950 to 2010. We chose to begin data collection in 1910 in order to maximize the cross-section of countries at our disposal. This data includes newly collected trade observations, in particular, for the periods spanning the World Wars. We provide details on our sources in Appendix III while Fig. 1 summarizes the sample graphically. Countries in black ($n = 33$) are those for which the full complement of output and trade data is available from 1910 while those in grey ($n = 18$) are those for which consistent data is available only from 1950. The sample countries represent roughly 75% of world GDP in 1910, roughly 85% of world GDP in 1950, and roughly 90% of world GDP in 2010.

3.2. Constructing market potential

We construct our preferred measure of market potential as given in eq. (12). This approach does not require estimation of the entire term as we simply insert the data directly into the right-hand side expression. Thus, the data on income y_i and global income y^W are readily available. We construct domestic trade as the difference between income and total exports, $x_{ii} = y_i - x_i$, where x_i denotes total exports. As income is measured as GDP and is cast in value-added terms, it is in principle not consistent with exports as a gross-value measure. However, as a robustness check, we are able to use total gross manufacturing production instead of GDP for the years from 1980 to 2006. This leaves our main results materially the same, a point we discuss in fuller detail in Appendix II.¹¹

¹¹ We also refer to Jacks, Meissner and Novy (2011, Appendix B) who consider two opposing effects. Gross output is, by construction, larger than the corresponding value added, which may lead to an underestimation of domestic trade flows if GDP is used instead of gross output. But GDP also includes services that are typically not covered by trade data, which would lead to an overestimation of domestic trade flows. The resulting measures of domestic trade are highly correlated in the data presented there covering the period from 1970 to 2000.

Lacking any convenient source of domestic trade costs, t_{ij} , their measure requires an assumption about the trade cost function. We follow the literature in imposing the common log-linear trade cost function that contains distance as a key element with an associated elasticity of ρ . In addition, we allow for a contiguity indicator variable, $contig_{ij}$, that takes on the value of 1 if countries i and j share a land border.¹² This indicator variable also takes on the value of 1 for domestic trade (whenever $i = j$). We can summarize our trade cost function as:

$$\ln(t_{ij}) = \rho \ln(dist_{ij}) + \xi contig_{ij}. \quad (15)$$

Since the market potential measure requires domestic trade costs scaled by the trade elasticity, we generate $t_{ij}^{\sigma-1} = dist_{ij}^{\rho(\sigma-1)} \exp(\xi(\sigma-1) contig_{ij})$.

We obtain time-varying distance and border coefficients by running annual gravity regressions by PPML (Fally 2015; Santos Silva and Tenreiro 2006). In particular, we use the specification

$$x_{ij} = \exp[(1-\sigma) \ln(t_{ij}) + \alpha_i + \alpha_j] + \varepsilon_{ij},$$

where we substitute our trade cost function (14) for t_{ij} . The variables α_i and α_j represent exporter and importer fixed effects that capture the income and price index terms in gravity eq. (5), and ε_{ij} is an error term. We use a large sample of 644 bilateral trade flows—primarily drawn from the 33 countries indicated in black in Fig. 1—that is balanced over time, including observations for domestic trade flows x_{ii} . The estimation results, not reported in detail here for considerations of space, follow those typically obtained in the literature: the distance elasticity is close to unity, averaging -1.2 across years; and the contiguity coefficient averages $+1.4$.¹³

As a caveat, we stress that a shortcoming of the measure for t_{ij} is that a number of components that arguably matter for domestic trade costs, such as domestic infrastructure, are left out. Given that the distance and contiguity measures do not change over time, the changes in domestic trade costs are driven by time-varying gravity coefficients. It would be preferable to have a more detailed, country-specific time-varying measure of domestic trade costs, but limited data availability poses restrictions in that regard. Measuring domestic trade costs is an active area of research (e.g., Ramondo et al. 2016), and better measures might improve market potential measures such as ours in the future.

Fig. 2a shows the average of the log values of market potential for two samples, indexed to a value of 100 in 1950. The first sample is comprised of all 33 countries for which we have a complete set of aggregate export and GDP data from 1910. The second sample is comprised of the same plus the 18 countries for which we have a complete set of aggregate export and GDP data from 1950. While Fig. 1 might suggest that there may be non-random sample selection across the start dates of 1910 and 1950, Fig. 2a indicates this is likely a non-issue as the correlation between the two series is in excess of 0.99. In general, there is a clear upward trend driven by the growth of the world economy, with periods of global depression and recession in the early 1930s, the early 1980s, the early 1990s, and the late 2000s registering as troughs in the series. Underlying these global patterns is substantial heterogeneity with large and persistent—albeit unreported—differences in the levels of market potential across continents, e.g., Latin versus North America or Asia versus Europe.

At the same time, Fig. 2a plots the log value of world GDP, also indexed to a value of 100 in 1950. We do so to assuage concerns that our measure of market potential captures nothing more than the evolution of world economic activity over the long twentieth century. For sure, the various series for market potential and world income exhibit

a somewhat similar upward trajectory, but it is clear from Fig. 2a that there is very little variation in world income growth from year to year. In contrast, our measures of market potential register significant divergence from world income. And it is precisely this variation which we will use below to identify the causal effect of market potential on economic growth at the individual country level.

Based on eq. (14), we can also extract and plot the implied price index P_i by removing world income from the market potential measure. Here, we assume a value for the elasticity of substitution of $\sigma = 5$. In Fig. 2b, we plot this implied price index for two key economies, India and the United Kingdom, normalized to 100 in the year 1910. How should we interpret this implied price index? Consider the following benchmark case. If trade costs did not change and the world experienced uniform income growth across all countries, then the price indices would not change.¹⁴ In that case, market potential would follow exactly the same trend as global income over time. By contrast, higher trade cost levels serve to increase these price indices. This is precisely what we observe from 1910 to 1930, reflecting rising protectionism in the interwar period. More specifically, the price index rose by 92% for India and 70% for the United Kingdom. This rise is then followed by falling price indices, reflecting a long-run trend of declining trade barriers and increasingly open economies. Overall, the implied price indices can be interpreted as an inverse proxy of our “structural market potential” measure. We stress that these price indices are not the same as conventional consumer price indices (and therefore not directly observable) since they may also capture non-pecuniary trade frictions such as information barriers (see Anderson and van Wincoop 2003).

In this vein, we note that there is significant variation in market potential—particularly in relative terms—across individual countries. As an example, Fig. 3 speaks to this issue by considering the trajectories of the log of market potentials for India and the United Kingdom over the long twentieth century. There, it is apparent that while much of the variation in the two series is shared in common—again, driven by the evolution of world income—there is still scope for differential rates of growth in market potential in the long run. This is seen most clearly in the ratio of the two series (UK:IND). It rises up to 1930 when the United Kingdom’s lead attains its maximum and then consistently falls into the present day where Indian and UK market potential stand nearly at par.¹⁵

To further our understanding of the underlying spatial correlations, we compute Moran’s I for various years. This measure takes on a value of -1 in the case of perfect dispersion (negative spatial autocorrelation), a value of close to 0 in the case of random spatial arrangement, and a value of $+1$ in the case of perfect positive spatial correlation. We compute Moran’s I for the logarithmic values of our market potential measure for the sample from 1950 ($n = 33$), and also for logarithmic GDPs as a comparison.¹⁶ We follow the common approach of giving a weight of 1 to neighbors in the spatial weights matrix and a weight of 0 otherwise (i.e., we use the contiguity indicator variable in the spatial weights matrix).

The resulting values of Moran’s I for log market potential are 0.94, 0.94, and 0.88 for the years 1950, 1980, and 2010, respectively. The corresponding values of Moran’s I for log GDP are 0.59, 0.53, and 0.51. We make two observations. First, market potential is more strongly spatially correlated than GDP. This finding is intuitive given that many large economies tend to be spatially clustered, e.g., in Western Europe.

¹² Redding and Venables (2004), for instance, use the same trade cost function. We refer to the Appendix III for details on the distance variable.

¹³ In comparison, Redding and Venables (2004, Table 1) yield broadly similar results. They obtain a distance elasticity of around -1.5 and a contiguity coefficient of around $+1.0$.

¹⁴ Formally, in the structural gravity model trade flows and income are homogeneous of degree zero with respect to trade costs. Uniform income growth would not affect the x_{ij}/y_i and y_j/y^W ratios in equations (6) and (12).

¹⁵ We also examine the cross-sectional distributions of market potential and GDP. They are rather similar although the variance is slightly smaller for market potential. We do not find any discernible trend over time (no convergence nor divergence). We therefore conclude that the cross-sectional distributions of market potential and GDP do not evolve in a systematic way over time.

¹⁶ Some GDP data are missing prior to 1950, which is why we concentrate on the period from 1950.

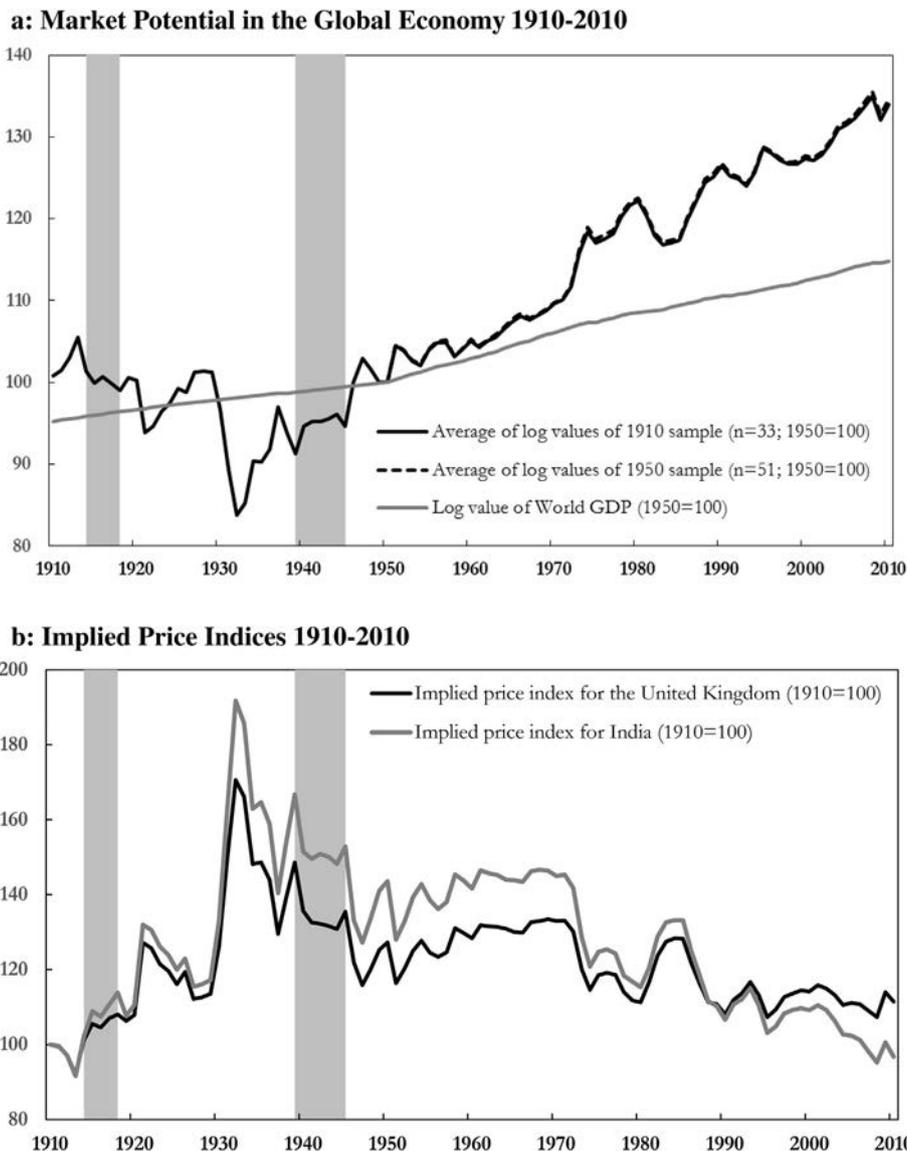


Fig. 2. a: Market Potential in the Global Economy, 1910–2010. *Notes:* This figure plots the averages of the logarithmic values of the “structural market potential” measures of countries in two samples, indexed to a value of 100 in 1950. The first sample (solid line) comprises the 33 countries for which the full set of output and trade data are available from 1910. The second sample (dashed line) comprises the 51 countries for which the full dataset is available from 1950, thus adding 18 countries in that year. For the sake of comparison this figure also plots the logarithmic value of world GDP, indexed to value of 100 in 1950. See Fig. 1 for an overview of the countries and Appendix III for a description of the data sources. The market potential measures are constructed based on eq. (12). See section 3.2 for details. The shaded areas indicate the World Wars. **Fig. 2b:** Implied Price Indices, 1910–2010. *Notes:* This figure plots the implied price indices for India and the United Kingdom, indexed to a value of 100 in 1910. They are constructed based on eq. (14) under the assumption of an elasticity of substitution of $\sigma = 5$. See section 3.2 for details. The shaded areas indicate the World Wars.

Second, the degree of spatial correlation declines over time but only in a minor way. This finding can be explained, for instance, by the shift of global economic power away from Europe and North America towards Asia.

3.3. A comparison to Redding and Venables (2004) and Harris (1954)

The previous literature constructs market and supplier access measures (3) and (4) by estimating eq. (8) for x_{ij} where supply capacity s_i and market capacity m_j are taken as exporter and importer fixed effects, respectively. Redding and Venables (2004) follow this procedure for a single cross-section in 1994. Head and Mayer (2011) have panel data for the period from 1965 to 2003 and estimate the fixed effects year by year. The use of exporter and importer fixed effects implies a specific normalization due to the omitted exporter/importer category. For instance, Redding and Venables (2004) omit the exporter fixed effect

for the United States as a normalization and also omit the constant in their specification such that no importer fixed effect has to be dropped. In contrast, our method of constructing market potential through eq. (12) does not directly rely on exporter and importer fixed effect estimates and thus avoids the year-by-year normalization. While we readily acknowledge that Redding and Venables were only concerned with market potential across the countries of the world at a given point of time, one benefit of our measure is that it allows us to more consistently compare levels of market potential over time.¹⁷

Here, we follow Redding and Venables (2004) in proxying bilateral trade costs t_{ij} by bilateral distance and a contiguity dummy as in trade

¹⁷ Alternatively, one could use Redding and Venables' formulation in a panel context by constraining the estimating equation such that the sum of the exporter fixed effects and the sum of the importer fixed effects are normalized to zero. We thank one of our referees for raising this point.

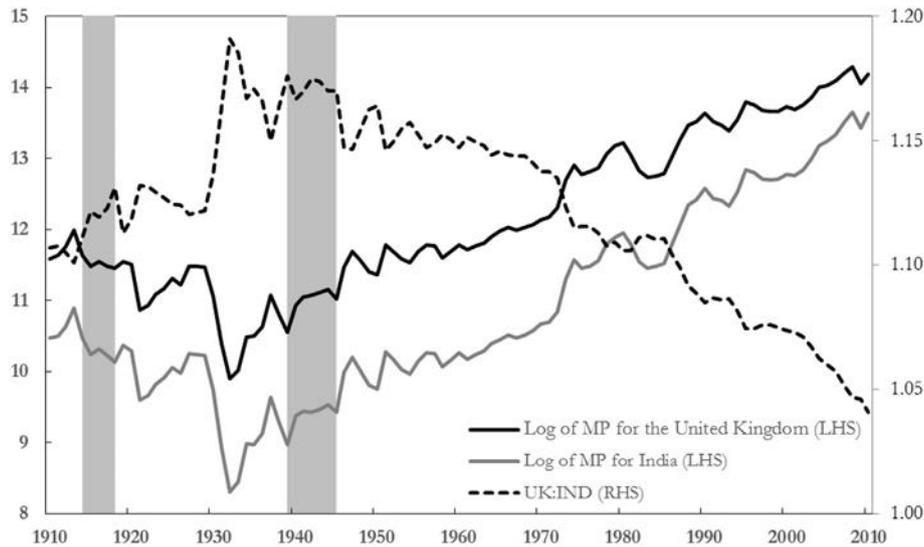


Fig. 3. Differential Growth in Market Potential, 1910–2010. Notes: The solid lines plot the logarithmic values of the “structural market potential” measures for India and the United Kingdom over the period from 1910 to 2010 (left-hand scale). The market potential measures are constructed based on eq. (12). See section 3.2 for details. The dashed line depicts the ratio of the measure for the United Kingdom over the measure for India (right-hand scale). The shaded areas indicate the World Wars.

cost function (15). Based on eq. (3) we then construct market access by adding up trade cost estimates for each bilateral trade relationship as

$$M\hat{A}_i = \sum_{j=1}^N \exp(\alpha_j)^{\lambda_j} dist_{ij}^{(1-\sigma)\hat{\rho}} \exp((1-\sigma)\hat{\xi} contig_{ij}), \quad (16)$$

where α_j 's denote importer fixed effects and λ_j 's their respective coefficients. The hats indicate coefficients that we estimate through annual OLS gravity regressions as in Redding and Venables (2004).

Fig. 4 follows Fig. 3 by considering the trajectories of the log values of the market access measure, $M\hat{A}_i$, for India and the United Kingdom for the period from 1910 to 2010. As in Fig. 3, there is a fairly consistent, upward trend throughout the second half of the twentieth century and the first decade of the 21st century. However, in Fig. 4, we also observe two sharp increases in market access during the first half of the twentieth century to the extent that the average (log) values for market access for the United Kingdom in 1919 and 1946 exceed those for 2010. Taken purely at face value, this would seem to be an implausible result given what we know about global macroeconomic history, in particular the role of the World Wars in disrupting global trade flows (Jacks et al. 2011). There is also the related issue that the relative value, UK:IND, is remarkably flat, hovering around a value of 1.05 throughout the long twentieth century. Thus, while the approach of Redding and Venables (2004) is very useful for a given cross-section of data, our results suggest caution in blindly using it in repeated cross-sections particularly during periods when international trade flows are heavily distorted by global conflict. For our purposes of both charting and understanding the trajectory of market potential over the long twentieth century, we therefore prefer the measures presented in Figs. 2a and 3.¹⁸

At the same time, in empirical applications, market potential is more often than not measured along the lines of Harris' (1954) original formulation. For any particular country, this amounts to the summation

across all possible trading partners of the ratio of their GDPs over their respective distances from the reference country, or:

$$MP_i^{Harris} = \sum_{j \neq i}^N \frac{y_j}{dist_{ij}}.$$

Fig. 5 depicts this calculation for India and the United Kingdom from 1910 to 2010. The resulting series are characterized by a very smooth long-run trend and consequently very little variability, and especially for the period after 1950. Thus, for our purposes of understanding the relationship between economic growth and market potential over the long twentieth century, we again prefer the measures based on structural gravity presented in Figs. 2a and 3.

We can more formally characterize the relationship between our market potential measure based on the structural gravity model and the Harris measure. When we insert the expression for the multilateral resistance price index from section 2.2 into our measure from eq. (14), we obtain

$$MP_i = \sum_{j=1}^N P_j^{\sigma-1} \frac{y_j}{t_{ji}^{\sigma-1}}.$$

Comparing this expression to the Harris measure above, we see three differences. First, the trade cost function underlying the Harris measure uses bilateral distance with a unitary trade elasticity as the only trade cost component. In our trade cost function (15), this would correspond to the parameter values $\rho = 1/(\sigma-1)$ and $\xi = 0$. Second and more importantly, the Harris measure is inconsistent with theory since it implicitly assumes $P_j = 1$ for all countries. Thus, general equilibrium and price index effects are ignored although they are empirically important, as seen in Fig. 2b. Third, the Harris measure abstracts from any domestic component of market potential, i.e., zero weight is given to the domestic economy. Necessarily, this is problematic as domestic trade costs are not uniform across countries and the share of domestic trade tends to be very high for most economies.

3.4. Decomposing the growth of market potential over time

We believe it also may be instructive to understand the underlying drivers of the change in market potential over time. For that purpose,

¹⁸ We refer the reader to Appendix II which plots cross-sectional results based on the Redding and Venables method for various years. There, we also demonstrate that market access and supplier access are tightly related to each other, as implied by our theoretical results in equations (12) and (13). We also report results based on the Redding and Venables method for an alternative normalization that constrains the sums of exporter and importer fixed effects to zero.

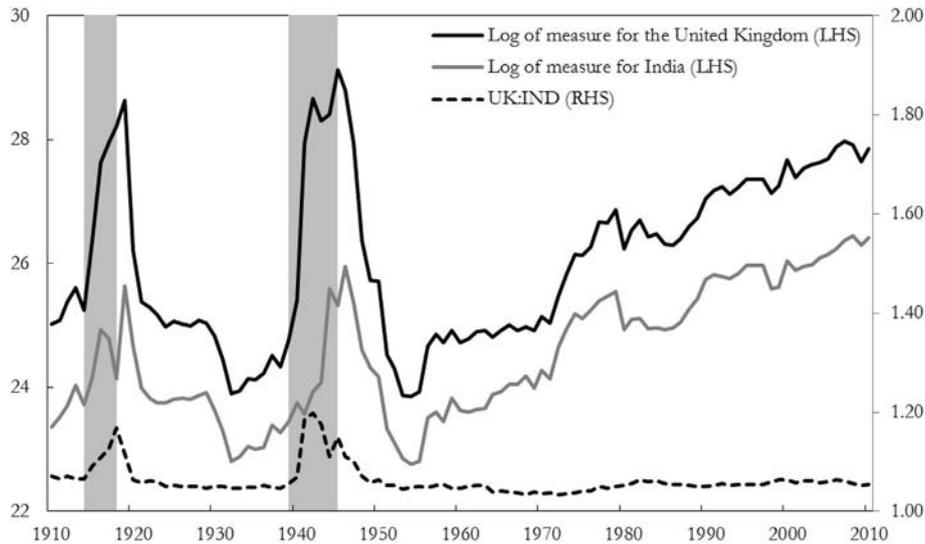


Fig. 4. Differential Growth in the Redding and Venables Measure, 1910–2010. *Notes:* The solid lines plot the logarithmic values of the market access measures for India and the United Kingdom, constructed based on Redding and Venables (2004) over the period from 1910 to 2010. See section 3.3 for details. The dashed line depicts the ratio of the measure for the United Kingdom over the measure for India (right-hand scale). The shaded areas indicate the World Wars.

we take logarithms and differences of eq. (12) to decompose the growth of market potential into four elements:

$$\Delta \ln(MP_i) = \frac{1}{2} \left[\Delta \ln \left(\frac{y_i}{y^W} \right) - \Delta \ln(t_{ii}^{\sigma-1}) - \Delta \ln \left(\frac{x_{ii}}{y_i} \right) + \Delta \ln(y^W) \right] \quad (17)$$

The three elements in the square brackets are specific to country *i*. The first element represents the growth of this country's share of global income. The second represents the growth of this country's domestic trade costs, scaled by the elasticity of substitution, which is associated with a decline in market potential. The third element represents the growth of this country's domestic trade share. This can be seen as an inverse measure of openness. If bilateral trade costs with other countries go up, then the domestic trade share increases. It is also associated with a decline in market potential. Finally, the fourth element represents the overall growth in global income, which is common to all countries.

To understand the decomposition in eq. (17), it is useful to consider the hypothetical benchmark of income growing by the same uniform rate across all countries. In that case, the income and domestic trade shares in the square brackets would not change, and market potential would be driven exclusively by overall global income growth through the last term. If one country grew faster than the otherwise uniform rate, its market potential would rise more quickly than elsewhere.

In Table 1, we present the results of decomposition (17), constructing the right-hand side variables as described in section 3.2. We use our sample of 33 countries that we group by five regions (Asia, Australia/New Zealand, Europe, Latin America, and North America). We present a decomposition for the full period from 1910 to 2010 as well as separate decompositions for the periods from 1910 to 1960 and from 1960 to 2010.

Overall, market potential grew by 305% across countries on average over the full period. Perhaps not surprisingly, this growth is rather similar across regions as global income growth serves as a common factor in driving market potential. However, this comparison of 1910 versus 2010 heavily masks important differences across sub-periods. In

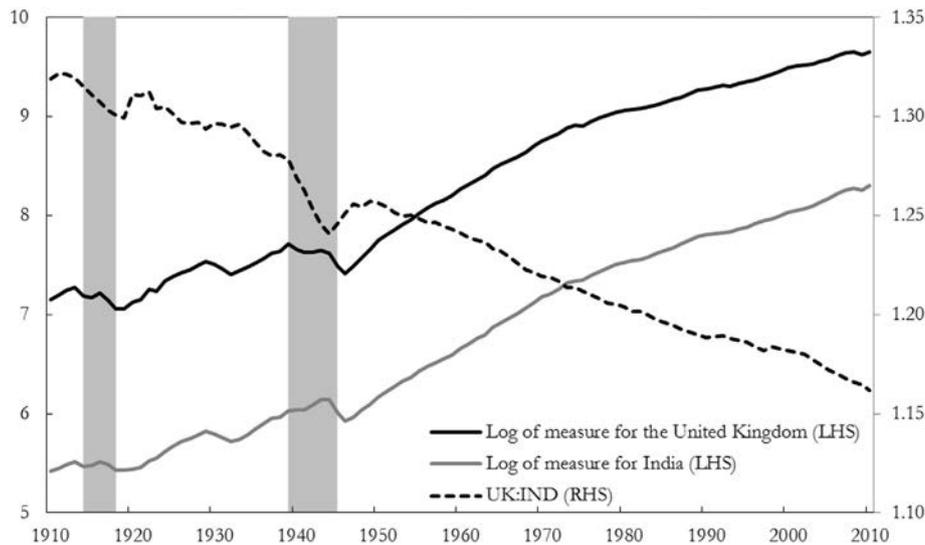


Fig. 5. Differential Growth in the Harris Measure, 1910–2010. *Notes:* The solid lines plot the logarithmic values of the market potential measures for India and the United Kingdom, constructed based on Harris (1954) over the period from 1910 to 2010. See section 3.3 for details. The dashed line depicts the ratio of the measure for the United Kingdom over the measure for India (right-hand scale). The shaded areas indicate the World Wars.

Table 1
Decomposition of Changes in Market Potential.

		Average growth in market potential	Contribution of growth in y_i/y^W	Contribution of decline in t_{ii}	Contribution of growth in x_{ii}/y^W	Contribution of growth in y^W
1910–2010	Full sample (n = 33)	305%	= -5%	+ 26%	+ 6%	+ 282%
	Asia (n = 6)	328	= 19	+ 27	+ 1	+ 282
	Australia/NZ (n = 2)	335	= 13	+ 29	+ 11	+ 282
	Europe (n = 15)	280	= -27	+ 24	+ 11	+ 282
	Latin America (n = 8)	336	= 34	+ 27	+ -8	+ 282
	North America (n = 2)	325	= 11	+ 31	+ 2	+ 282
1910–1960	Full sample (n = 33)	22%	= -5%	+ -97%	+ -3%	+ 127%
	Asia (n = 6)	4	= -24	+ -98	+ -1	+ 127
	Australia/NZ (n = 2)	26	= 6	+ -106	+ -2	+ 127
	Europe (n = 15)	26	= -11	+ -87	+ -3	+ 127
	Latin America (n = 8)	36	= 22	+ -100	+ -12	+ 127
	North America (n = 2)	25	= 12	+ -113	+ -1	+ 127
1960–2010	Full sample (n = 33)	286%	= -1%	+ 126%	+ 8%	+ 155%
	Asia (n = 6)	313	= 37	+ 118	+ 4	+ 155
	Australia/NZ (n = 2)	309	= 7	+ 134	+ 13	+ 155
	Europe (n = 15)	261	= -16	+ 121	+ 16	+ 155
	Latin America (n = 8)	300	= 12	+ 129	+ 4	+ 155
	North America (n = 2)	301	= 0	+ 144	+ 2	+ 155

Notes: All numbers are in percent, rounded to integers, and weighted by income shares in the initial year of the period (for the full sample or within regions, respectively).

particular, countries experienced only very moderate growth in market potential prior to 1960. This was a period marked by isolationism and war with an associated rise in trade costs as well as domestic trade shares (see Jacks et al. 2011). In contrast, the period after 1960 was characterized by sizeable (positive) contributions to the growth in market potential stemming from declining trade costs and increasing openness. In particular, Asia experienced above-average growth in market potential due to its expanding share of global income while the opposite was the case for Europe.

4. Wage equation regressions

Here, we return to one of the motivating questions for this paper, namely whether there is a causal relationship between market potential and global income growth. In what follows, we first establish that our new measure of “structural market potential” delivers results from so-called wage equation regressions which are consistent with those found in Redding and Venables (2004) and Hanson (2005) among others. However, in their work, the expression for market access is conveniently separable into two constituent components, domestic and foreign market access. Thus, the latter of these two strips away any domestically-determined elements of demand. This contrasts with our measure of “structural market potential” which will clearly be endogenous in light of the presence of domestic output in eq. (12). In order to break this mechanical link in between income (per capita) and market potential, we then use exogenous variation in trade-related distances to world markets as an instrument, finding an economically and statistically significant role for market potential in driving global income growth over the long twentieth century.

4.1. Wage equation regressions in levels

An appropriate starting point is provided by Redding and Venables (2004). In their work, they derive what is known as a wage equation, i.e., an equation that structurally relates the price of the immobile factor of production (or wage) to a country's market access/market potential. Based on their model, the same wage equation would arise in our context.

Redding and Venables demonstrate a strong association between GDP per capita (their proxy for wages) and both domestic and foreign market access in the cross-section. This association remains even after conditioning on a large number of covariates and controlling for potential endogeneity. Head and Mayer (2011) run an analogous set of panel regressions, finding results consistent with those of Redding and Venables. However, with our new measure of structural market potential, it is an open question whether this empirical regularity remains intact.

Table 2 first tries to establish the simple association between the log of GDP per capita and the log of market potential. Standard errors are clustered on countries here—and in all regressions—to control for within-country serial correlation of arbitrary form.¹⁹ The coefficient reported in column (1) is precisely estimated and comparable in magnitude to that reported by both Redding and Venables (2004) and Head and Mayer

¹⁹ To account for the fact that our measure of market potential is a generated regressor, standard errors could conceivably be bootstrapped. However, doing so would not be straightforward – both for OLS but especially for IV regressions – as our measure of market potential varies at the country-year level whereas it is based on coefficients from a gravity model estimated year-by-year at the country-pair level. Since we are more concerned with within-country serial correlation than the potential measurement error induced by the inclusion of a generated regressor and since the coefficients from the gravity regressions are tightly estimated, we therefore report clustered standard errors instead.

Table 2
Wage Equation Regressions in Levels.

Dependent variable: Log of GDP per capita						
	(1)	(2)	(3)	(4)	(5)	(6)
Log of market potential	0.4094	0.7703	0.5763	0.5778	0.6490	0.6944
standard error	0.0344	0.1222	0.1345	0.1350	0.1437	0.1567
t-statistic	11.92	6.30	4.29	4.28	4.52	4.43
p-value	0.00	0.00	0.00	0.00	0.00	0.00
Country and time FEs?		X	X	X	X	X
Balanced sample?			X	X	X	X
World Wars excluded?				X	X	X
Averaged over five years?					X	
Averaged over ten years?						X
Observations	4431	4431	3333	2772	495	231
R-squared	0.38	0.94	0.95	0.95	0.96	0.96

Notes: The dependent variable in all regressions is the log of GDP per capita, and the independent variable is the log of the market potential variable detailed in section 2.2 and expressed in eq. 12. All regressions are estimated by OLS. Standard errors are clustered on countries in all specifications. Column (3) only considers the set of 33 countries for which a full set of data is available on both GDP per capita and market potential from 1910 to 2010. Column (4) excludes the years from 1914 to 1919 and from 1939 to 1949. Columns (5) and (6) average GDP per capita and market potential over non-overlapping five- and ten-year periods, respectively.

(2011). Of course, there are many other potential determinants of GDP per capita, and the specification in column (2) thus controls for both common patterns over time and fixed, unobserved country-level characteristics. This estimation then relies upon variation within countries over time which is not determined by global shocks or trends such as the evolution of world GDP over time. That the coefficient actually increases in magnitude is a reassuring sign of our measure's salience.

The next two columns repeat the regression for different samples. The full sample in columns (1) and (2) includes 33 countries with observations on market potential and GDP per capita from 1910 to 2010 and 18 countries with observations on market potential and GDP per capita from 1950 to 2010. A brief review of Fig. 1 suggests the former are predominantly developed nations in North America and Western Europe while the latter are mainly developing nations in Africa and Asia. Column (3), which is based on the balanced sample dating from 1910 only, shows a point estimate which is smaller than that in column (2) but which is still highly statistically significant. Given the countries that join the sample in 1950 and that are part of the sample for column (2), this might suggest that the link between market potential and GDP per capita may have become stronger over time and/or is stronger for developing nations. Column (4) excludes observations spanning the two World Wars, specifically the years from 1914 to 1919 and from 1939 to 1949. These observations may be problematic if these years entailed a breakdown in normal economic relationships or suffered a deterioration in terms of data quality. The magnitude of the elasticity between GDP per capita and market potential is virtually unaffected. In any case, we still favor the results in column (4) as it addresses the most serious concerns related to sample selection across countries and years and data quality.

The final two specifications average our measures of market potential and GDP per capita over (non-overlapping) five- and ten-year periods, respectively, and represent our preferred specifications. This approach of aggregating over time can be thought of as reducing the role of measurement error in particular years as well as diminishing the potential role of domestic and global business cycles in driving the results. Across columns (5) and (6), the values of the coefficients are stable and broadly similar to column (4), again pointing to a tight—but not necessarily causal—relationship between levels of GDP per capita and market potential throughout the long twentieth century.

4.2. Wage equation regressions in differences

Table 3 follows the regressions of Table 2 but considers a different set of dependent and independent variables. Instead of considering

Table 3
Wage Equation Regressions in Differences.

Dependent variable: Change in log of GDP per capita						
	(1)	(2)	(3)	(4)	(5)	(6)
Change in log of MP	0.0885	0.2835	0.2607	0.2156	0.3148	0.6719
standard error	0.0089	0.1218	0.1350	0.0854	0.1678	0.1997
t-statistic	9.99	2.33	1.93	2.52	1.88	3.36
p-value	0.00	0.02	0.06	0.02	0.07	0.00
Time FEs?		X	X	X	X	X
Balanced sample?			X	X	X	X
World Wars excluded?				X	X	X
Averaged over five years?					X	
Averaged over ten years?						X
Observations	4380	4380	3300	2739	495	231
R-squared	0.10	0.24	0.25	0.27	0.33	0.38

Notes: The dependent variable in all regressions is the change in the log of GDP per capita, and the independent variable is the change in the log of the market potential variable detailed in section 2.2 and expressed in eq. 12. All regressions are estimated by OLS. Standard errors are clustered on countries in all specifications. Column (3) only considers the set of 33 countries for which a full set of data is available on both GDP per capita and market potential from 1910 to 2010. Column (4) excludes the years from 1914 to 1919 and from 1939 to 1949. Columns (5) and (6) average GDP per capita and market potential over non-overlapping five- and ten-year periods, respectively.

the logs of GDP per capita and market potential, we follow Hanson (2005) by estimating the wage equation in log differences. This allows us to better account for potential serial correlation in the specifications of Table 2 and is closer in spirit to this paper's theme of economic growth and market potential. Comparing Table 3 to Table 2 across the various specifications in columns (1) through (6) reveals that the estimated elasticities remain statistically significant. However, they are smaller in magnitude, suggesting a plausible role for country-level, time-varying omitted variables in driving the earlier results.

With respect to the specifications in columns (5) and (6) in Table 3 compared to those in Table 2, the results are more encouraging in this regard. The point estimates in Table 3 are smaller in magnitude as before, but they are statistically indistinguishable from those in Table 2. Honing in on our preferred specification in column (6), the results suggest that every percent change in market potential was matched with a roughly 0.65% change in GDP per capita. Taking this result at face value suggests that a significant share of global growth over the long twentieth century could be attributed to changes in market potential in the long run.

4.3. Wage equation IV regressions

Of course, there are good reasons why these results should be approached with caution. Above all, there is clear endogeneity in any wage equation regression given the way our measure of market potential is constructed in eq. (12) as a function of domestic output. Facing a similar problem, Redding and Venables (2004) as well as Head and Mayer (2011) instrument market potential with measures of geographic centrality, namely a country's distance from Belgium, Japan, and the United States. Naturally but unfortunately, such measures do not vary over time, a condition which underlies many other possible instruments for market potential.

Faced with this prospect, we instead draw inspiration from a series of papers by Feyrer (2009a, 2009b). In Feyrer (2009b), the author begins with the observation that historically the vast majority of international trade by value has been conducted via sea routes and that to this day the vast majority of international trade by physical volumes continues to be conducted in this manner. However, presently, a very large share—upwards of 40%—of international trade by value is conducted via air routes as improvements in aircraft technology and logistics have enhanced the air industry's importance in this regard. Thus, over time countries with shorter air routes to its trading partners relative to its sea routes (e.g., India) have benefited more from this exogenous

technological change than those with relatively similar air and sea routes (e.g., Canada). As Feyrer notes, “[such] heterogeneity can be used to generate a geography based instrument for trade that varies over time.”

In a similar vein, Feyrer (2009a) exploits the shock to the global economy embodied by the closure of the Suez Canal from 1967 to 1975. While many trade routes remained unaffected, some did not and found the distances separating markets increasing significantly. For instance, Feyrer reports that India nearly led the pack with a 30.6% increase in its trade-weighted distance to foreign markets while a country like Canada only experienced a 0.2% increase. Using this exogenous variation in distance over time, Feyrer goes on to separately estimate the effect of distance on trade and the effect of trade on income.

Here, we combine both approaches. In particular, we use the great circle distances from the CEPII GeoDist database (see Appendix III) to represent distances on air routes to Japan, the United Kingdom, and the United States, critical nodes of the world economy throughout the long twentieth century. We also collect the corresponding distances for sea routes reported in Philip (1935). Conveniently, this source also delineates which sea routes utilized the various major canals of the world, e.g., the Kiel, the Panama, and the Suez.²⁰ This information allows us to incorporate changes in the distances of sea routes introduced by the various closures and openings of these canals over the period from 1910 to 2010.²¹ The final step is in constructing a series on the share of US imports by value which are transported by air over this period based on Hummels (2007) and various reports of the International Air Transport Association.

Thus, our three proposed instruments for market potential in the wage regression are the following, time-varying measures of effective distance to major world markets for country *i*:

$$\begin{aligned} \text{Effective distance}_{i,Japan,t} &= \alpha_t * \text{Air distance}_{i,Japan} + (1 - \alpha_t) * \text{Sea distance}_{i,Japan,t} \\ \text{Effective distance}_{i,UK,t} &= \alpha_t * \text{Air distance}_{i,UK} + (1 - \alpha_t) * \text{Sea distance}_{i,UK,t} \\ \text{Effective distance}_{i,US,t} &= \alpha_t * \text{Air distance}_{i,US} + (1 - \alpha_t) * \text{Sea distance}_{i,US,t} \end{aligned}$$

where α is the share of US imports by value transported by air and where we exclude Japan, the United Kingdom, and the United States from our sample.

Table 4 reports the results of this exercise using 4128 annual observations for GDP per capita and market potential (our original sample of 4431 observations minus the 303 observations associated with Japan, the United Kingdom, and the United States). The top panel of column (1) represents the first stage regression results. In order of magnitude, effective distances to the United States, then Japan, and finally the United Kingdom all register as statistically significant. Quantitatively, these three instruments explain a significant amount of the variation in our measure of market potential, with the R-squared of the regression registering a healthy 0.25. The regression also passes a standard test of joint significance (Angrist-Pischke F test) where the null hypothesis is that the endogenous regressors are jointly insignificant and a standard test of under-identification (Angrist-Pischke underid. test) where the null hypothesis is that any particular endogenous regressor is unidentified.

The bottom half of column (1) represents the second stage regression results. There, the elasticity between market potential and GDP per capita is estimated to be 0.41, or about half the size of the equivalent estimate reported in column (2) of Table 2. However, this elasticity is precisely estimated and, in combination with the fixed effects, captures a majority of the variation in GDP per capita across space and time.

²⁰ Conveniently, this source also delineates the chief ports connecting various countries of the world. For Japan and the United Kingdom, the designation of the chief port is obvious (i.e., Yokohama and London, respectively). For the United States, given its orientation between two oceans, the chief port varies in between New York City and San Francisco.

²¹ For our sample, the most significant events in this regard are the closure of the Kiel Canal during the World Wars, the opening of the Panama Canal in 1914, and the closure of the Suez Canal from 1967 to 1975.

Table 4
Wage Eq. IV Regressions.

Dependent variable: Log of market potential					
FIRST STAGE	(1)	(2)	(3)	(4)	(5)
Log of distance to Japan	-2.7141	-3.4613	-3.2995	-3.5632	-3.8117
standard error	0.5153	0.6925	0.6306	0.7486	0.8054
t-statistic	-5.27	-5.00	-5.23	-4.76	-4.73
p-value	0.00	0.00	0.00	0.00	0.00
Log of distance to United Kingdom	-2.5495	-1.9161	-1.8298	-1.8644	-2.3047
standard error	0.9570	1.1829	1.0890	1.2035	1.2174
t-statistic	-2.66	-1.62	-1.68	-1.55	-1.89
p-value	0.01	0.12	0.10	0.13	0.07
Log of distance to United States	-7.8370	-9.9547	-9.0322	-9.3225	-9.4340
standard error	3.7579	4.0672	3.9770	3.7788	3.2743
t-statistic	-2.09	-2.45	-2.27	-2.47	-2.88
p-value	0.04	0.02	0.03	0.02	0.01
First-stage uncentered R-squared	0.25	0.25	0.25	0.27	0.34
Angrist-Pischke F test (p-value)	49.35 (0.00)	55.59 (0.00)	55.10 (0.00)	43.28 (0.00)	41.83 (0.00)
Angrist-Pischke underid. Test (p-value)	151.26 (0.00)	172.63 (0.00)	171.14 (0.00)	134.93 (0.00)	131.08 (0.00)
Dependent variable: Log of GDP per capita					
SECOND STAGE	(1)	(2)	(3)	(4)	(5)
Log of market potential (instrumented)	0.4116	0.4664	0.4502	0.4225	0.4386
standard error	0.0275	0.0197	0.0186	0.0211	0.0230
t-statistic	14.99	23.72	24.18	19.99	19.03
p-value	0.00	0.00	0.00	0.00	0.00
Country and time FEs?	X	X	X	X	X
Balanced sample?		X	X	X	X
World Wars excluded?			X	X	X
Averaged over five years?				X	
Averaged over ten years?					X
Observations	4128	3030	2520	450	210
R-squared	0.73	0.78	0.80	0.85	0.85
Hansen J statistic (p-value)	1.49 (0.47)	2.16 (0.34)	1.87 (0.39)	3.02 (0.22)	2.50 (0.29)

Notes: The dependent variable in the second stage of all regressions is the log of GDP per capita, and the independent variable is the instrumented value of the log of the market potential. Instrumented values are derived from the first stage using the logged effective distances to Japan, the United Kingdom, and the United States as described in section 4.3. Standard errors are clustered on countries in all specifications. Column (2) only considers the set of 33 countries for which a full set of data is available on both GDP per capita and market potential from 1910 to 2010. Column (3) excludes the years from 1914 to 1919 and from 1939 to 1949. Columns (4) and (5) average GDP per capita and market potential over non-overlapping five- and ten-year periods, respectively.

Furthermore, the second stage passes a standard test of over-identification (Hansen J statistic) where the null hypothesis is that the included instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimating equation.

Again, we replicate the same set of results as in previous tables by using full versus restricted samples (columns (1) versus (2) and (3)) and by averaging dependent and independent variables over increasingly large periods of time (columns (4) and (5)). All of the coefficients are precisely estimated, fall within the range of 0.41 and 0.47, and are smaller than their OLS counterparts, suggesting a potential role for endogeneity in driving our previous results. At the same time, across all specifications a significant portion of the variation in GDP per capita is explained by the instrumented version of our market potential variable.

Naturally, standard concerns regarding the exogeneity of our instruments and the exclusion restriction may remain. We therefore prefer to interpret these results as suggestive and not definitive. Nevertheless, they add to a growing body of literature that provides evidence of causal effects arising from changes in market potential. Apart from Feyrer (2009a, 2009b), this literature includes the contributions by Hanson

and Xiang (2004) who examine home market effects in the exports of OECD countries across industries as well as Redding and Sturm (2008) who exploit the division of Germany after World War II and its subsequent reunification.

5. Conclusion

We develop a new approach to the old notion of market potential. Developing a structural gravity model of trade, we show that market potential can be expressed as a function of directly observable variables such as domestic trade flows and output and easily estimated proxies for domestic trade costs. We derive this expression by solving for multilateral resistance price indices across countries. These indices indirectly capture bilateral trade costs and therefore contain variation that is essential for computing market potential. Our approach has two key advantages. First, our measure is straightforward to compute. As we do not need to add up exporter and importer fixed effect coefficients, it offers an alternative to the more onerous construction of traditional market potential measures. Second, our measure of market potential naturally lends itself to comparisons over time, not only in the cross-section.

On the empirical side, we construct market potential measures for 51 countries over the period from 1910 to 2010. We find that market potential exhibits an upward trend across all regions of the world from the early 1930s and that this trend significantly deviates from the evolution of world GDP. Finally, we also show that our measure of market potential is closely associated with average incomes, both in the cross-section and over time and across various specifications. Most importantly, we exploit exogenous variation in trade-related distances to world markets generated from changes in logistics and transport technology along with geopolitical events in order to assign a causal role for market potential in driving global income growth over this period.

Appendix I: Asymmetric trade costs and trade imbalances

Suppose we relax the assumption of bilaterally symmetric trade costs in section 2 and allow for bilaterally asymmetric trade costs such that $t_{ij} \neq t_{ji}$. This is consistent with the notion of bilateral trade imbalances. In addition, we also account for trade imbalances at the aggregate country level by allowing income y_i to deviate from expenditure e_j . In that case, the more general structural gravity equation from Anderson and van Wincoop (2004) applies

$$x_{ij} = \frac{y_i e_j}{y^W} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}$$

where Π_i and P_j denote the outward and inward multilateral resistance terms. At the global level, we have $y^W = e^W$.

The nominal demand expression in eq. (2) becomes

$$x_{ij} = n_i p_{ij}^{1-\sigma} e_j P_j^{\sigma-1}$$

where we substitute e_j for y_j . Similarly, the expression for market capacity in eq. (7) becomes

$$m_j = e_j P_j^{\sigma-1}$$

Eq. (8) continues to hold, and the preceding expression becomes

$$x_{ij} = \frac{y_i}{y^W} \left(\frac{t_{ij}}{\Pi_i} \right)^{1-\sigma} m_j$$

Combining these two expressions yields

$$s_i = \frac{y_i \Pi_i^{\sigma-1}}{y^W}$$

However, unlike in eq. (9) we cannot express s_i as a function of domestic trade costs (t_{ii}), domestic trade (x_{ii}), and global income (y^W). Neither is this possible for m_i as in eq. (7). Instead, using eq. (8), we can express their product as

$$s_i m_i = t_{ii}^{\sigma-1} x_{ii}$$

The expression for market access in eq. (10) continues to hold. The expression for supplier access in eq. (11) is now based on the revised budget accounting identity

$$\sum_{i=1}^N x_{ij} = e_j$$

where we substituted e_j for y_j . We thus obtain

$$SA_i = \frac{e_i}{m_i}$$

We can therefore write the geometric average of market and supplier access as

$$(MA_i SA_i)^{\frac{1}{2}} = \left(\frac{y_i e_i}{s_i m_i} \right)^{\frac{1}{2}} = \left(\frac{y_i e_i}{t_{ii}^{\sigma-1} x_{ii}} \right)^{\frac{1}{2}}$$

where we use the expression for the product $s_i m_i$ from above. We note that in the case of no aggregate imbalances as in the main text (i.e., in the case where y_i equals e_i), the same expression for the geometric average would hold. This can be derived by combining eqs. (12) and (13).

Similar to eq. (14), an alternative representation of market and supplier access can be achieved in terms of (unobservable) price indices. Using the expression for s_i above for market access in eq. (10) yields

$$MA_i = \frac{y^W}{\Pi_i^{\sigma-1}}$$

For supplier access, the market capacity expression above implies

$$SA_i = \frac{1}{P_i^{\sigma-1}}$$

Unlike in eq. (6), we cannot separately express the outward and inward multilateral resistance terms Π_i and P_i in terms of observable variables. The gravity equation for domestic trade flows can only be rearranged for the product of these two price indices, i.e.,

$$(\Pi_i P_i)^{\sigma-1} = t_{ii}^{\sigma-1} \frac{x_{ii}/e_i}{y_i/y^W}$$

To illustrate whether aggregate trade imbalances matter quantitatively, we use the trade in goods and services balance for the United Kingdom, downloaded from the Office for National Statistics. The series starts in the year 1955. The largest trade deficit was recorded in 1974 at 4.4% of GDP, and the largest surplus was recorded in 1981 at 2.6% of GDP. Fig. A1 plots the geometric average of market and supplier access (in logarithms) based on the above formula, normalized to 100 in 1955. The black line assumes balanced trade and corresponds to the market potential measure used elsewhere throughout the paper. The grey line incorporates the data on trade imbalances. As the figure shows, the deviations between the two series are miniscule. Therefore, we conclude that trade imbalances are unlikely to change our measure of market potential in an economically meaningful way.

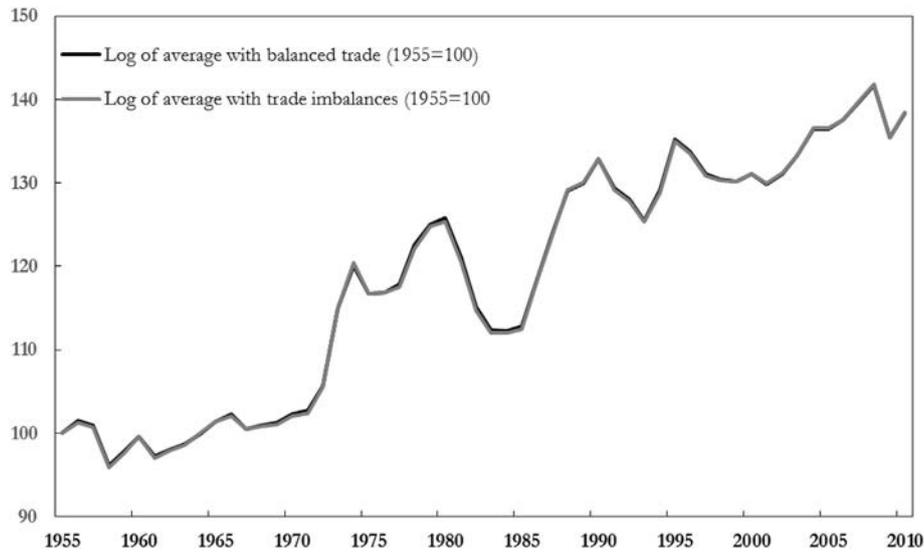


Fig. A1. Average Market and Supplier Access for the UK, 1955–2010. *Notes:* This figure plots the geometric average of UK market and supplier access (in logarithms) over the period from 1955 to 2010 assuming balanced trade (in black) and accounting for trade imbalances (in grey). See the text above for details.

In addition, we investigate bilateral trade cost asymmetries empirically by taking into account, as suggested by [Waugh \(2010\)](#), that bilateral trade costs from poor to rich countries might be higher than in the opposite direction. Using the TradeProd dataset (see Appendix II), we introduce a “distance gap” between rich and poor countries assuming (hypothetically) that bilateral distance is higher by 20% from poor to rich countries and simulating trade flows accordingly. We define rich countries as OECD members in the year 2000. We then recompute market and supplier access measures through the Redding-Venables method but find hardly any difference quantitatively.

Appendix II: Further comparisons to Redding and Venables (2004)

In this appendix, we further study the relationship between the market access measure based on [Redding and Venables \(2004\)](#) and the market potential measure in eq. (12). In Fig. A2, we plot the logarithmic values of the two measures against each other for various years, using our smaller sample of 33 countries until 1949 and the full sample of 51 countries from 1950. The correlation between the two measures is 0.73 in 1910, 0.64 in 1950, and 0.73 in 2010 while the correlation for the full sample (all years) is 0.60. This slightly weaker relationship is driven by a lower value of 0.38 during the World Wars (please refer to [Figs. 3](#)

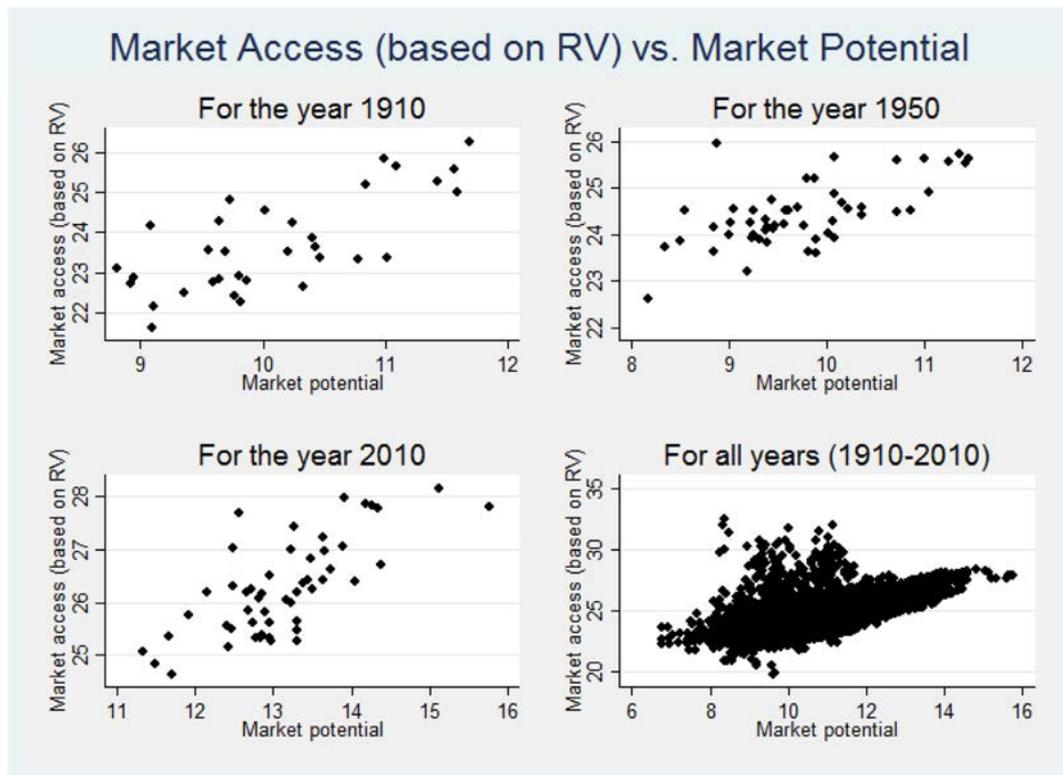


Fig. A2. Market Access vs. Market Potential. *Notes:* This figure plots the market access measure based on [Redding and Venables \(2004\)](#) against the market potential measure (both logarithmic). See the text above for details.

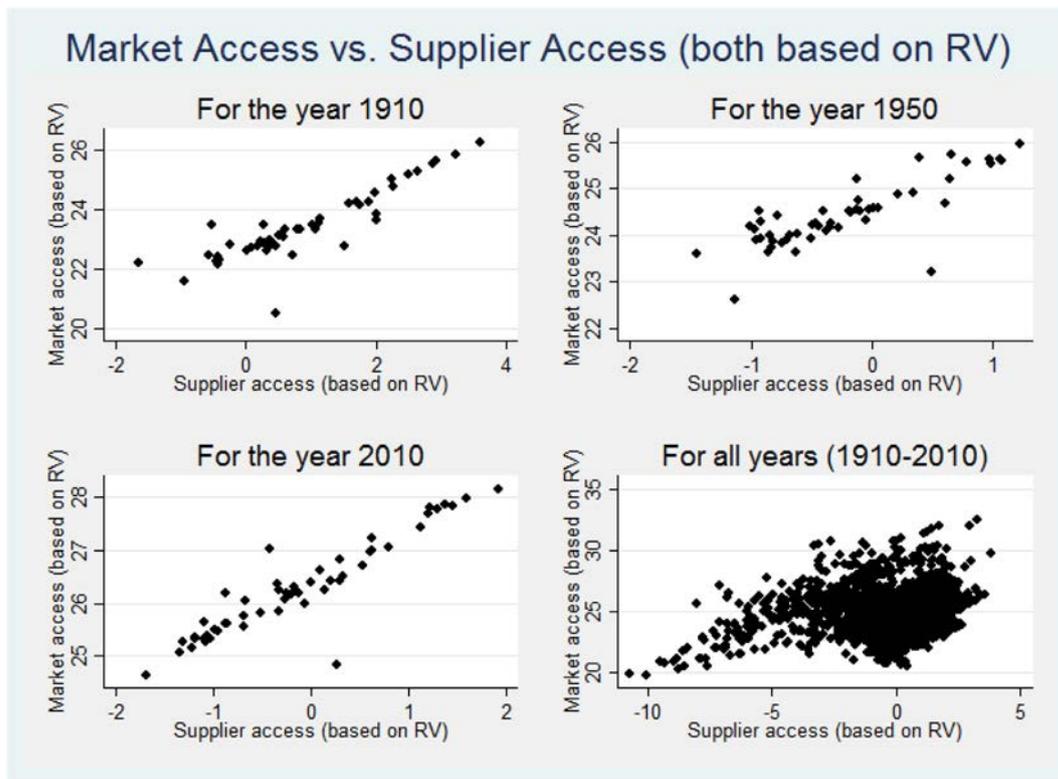


Fig. A3. Market Access vs. Supplier Access. *Notes:* This figure plots the market access and supplier access measures based on Redding and Venables (2004) (both logarithmic). See the text above for details.

and 4 and the corresponding explanation in the main text in this regard). Overall, the two measures are fairly closely related even though they are derived in very different ways.

In Fig. A3, we examine the relationship between market access and supplier access. Our structural gravity model suggests that those two measures are proportional (see eqs. 12 and 13 in the main text). Does this relationship also hold when these two measures are derived

based on the Redding and Venables (2004) approach? Fig. A3 plots these two measures (in logarithms) for various years. The correlations in the years 1910, 1950, and 2010 are 0.88, 0.81, and 0.93, respectively. Given that theory suggests proportionality in levels, we should find a slope of 1 in a log-linear regression of market access on supplier access. For the year 2010, we estimate a coefficient of 0.93 that is not significantly different from 1. For the years 1910 and 1950, we estimate

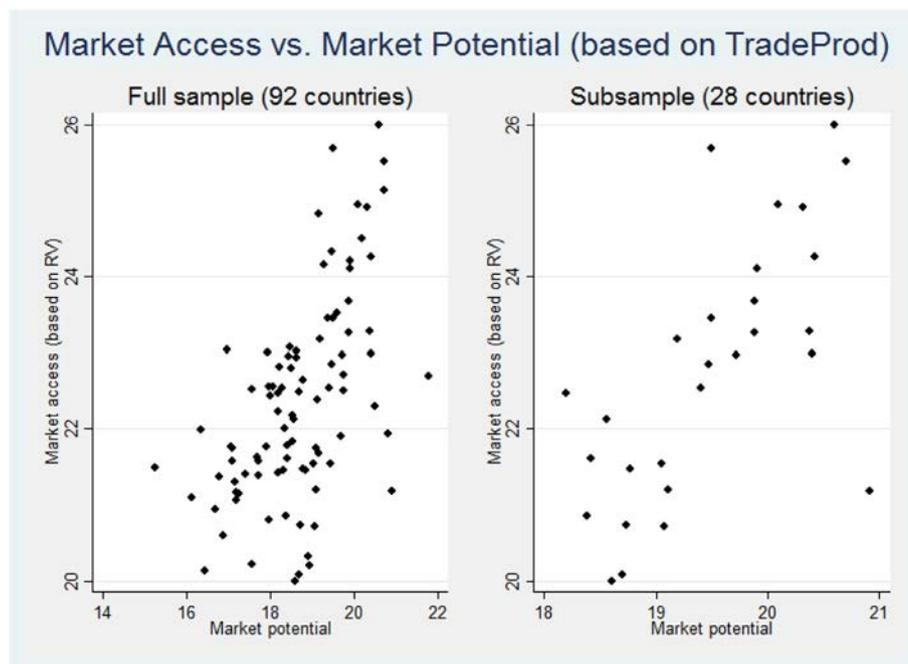


Fig. A4. Market Access vs. Market Potential (Based on TradeProd). *Notes:* This figure plots the market access measure based on Redding and Venables (2004) against the market potential measure (both logarithmic) using the TradeProd sample. See the text above for details.

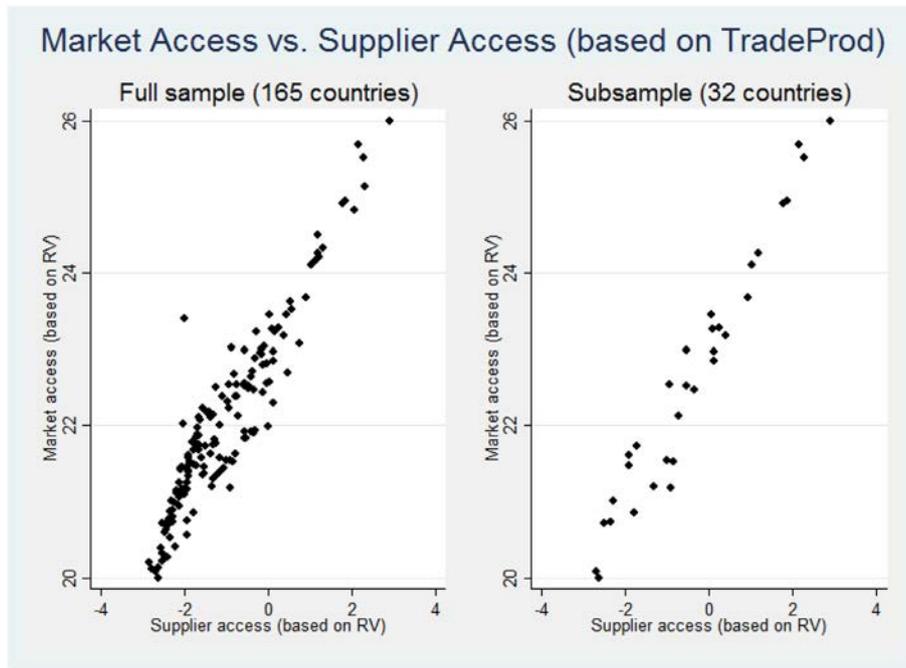


Fig. A5. Market Access vs. Supplier Access (Based on TradeProd). *Notes:* This figure plots the market access and supplier access measures based on Redding and Venables (2004) (both logarithmic) using the TradeProd sample. See the text above for details.

coefficients of 0.88 and 0.85, both of which are (barely) statistically different from 1. If we pool all observations and include year dummies to allow for changing intercepts over time, we estimate a slope coefficient of 0.90 (with a standard error of 0.007). However, for later years in the sample the slope tends to be statistically indistinguishable from 1. Overall, we conclude that market access and supplier access are reasonably tightly linked in a way suggested by theory. It is possible that inferior data quality in earlier years renders the relationship less robust.

Furthermore, we study a different, more comprehensive dataset to corroborate the relationship between the measures of Redding and Venables (2004) and the measure proposed in our paper. More specifically, we work with the TradeProd dataset that is available for download from CEPII for the years from 1980 to 2006. As we are

mainly interested in cross-sectional comparisons, we choose a single year, the year 2000. This dataset has two main advantages. First, it comprises many more countries than our historical dataset. In fact, we can work with 165 countries reporting bilateral trade flows. The dataset contains 25,928 observations out of a maximum possible of $165 \times 165 = 27,225$ observations (where the remaining observations are missing). About 30% of the sample (8131 observations) are zero trade flows, which is standard for an aggregate dataset of this size. In comparison, our historical sample with 33 countries has only 644 observations per cross-section.

Second, the TradeProd dataset does not rely on value-added GDP data. Instead, we can use gross production data that we aggregate for all manufacturing industries with matching trade flows. Most

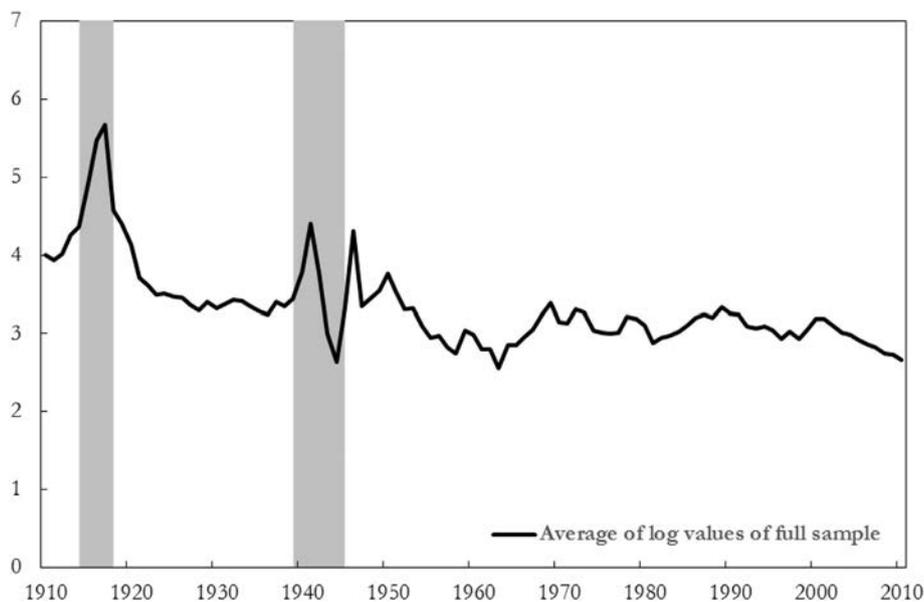


Fig. A6. Market Access with Normalized Fixed Effects *Notes:* This figure plots the average of logarithmic values of market access across countries over the period from 1910 to 2010, using the full sample of 51 countries. Market access is calculated using the basic methodology underlying Redding and Venables (2004), but with a different normalization where the sums of exporter and importer fixed effects are constrained to zero. See the text for details.

importantly, domestic trade flows (“internal flows”) are the value of gross production minus the value of gross total exports.

We follow the procedure outlined in section 3.2 to construct our market potential measure based on the structural gravity model and eq. (12). That is, we estimate a PPML gravity regression with logarithmic distance and a contiguity dummy as the trade cost components. The estimated coefficients are -0.93 and 1.49 , respectively (both significant at the 1% level) and therefore similar to the coefficients we obtain using our historical sample. We are able to obtain market potential measures for 92 countries (for other countries, data on domestic production and domestic trade flows are missing).

We also construct the market and supplier access measures based on the Redding–Venables method. This results in market and supplier access measures for 165 countries. We note that these measures do not depend on GDP or production data since they are constructed based on exporter and importer fixed effects which absorb any country-specific variables.

In Fig. A4 we plot the relationship between the market access measure based on Redding and Venables (2004) and the market potential measure based on eq. (12). This figure is analogous to Fig. A2 (all variables are in logarithms). The panel on the left-hand side plots the two measures for the maximum number of 92 countries. Their correlation is 0.56. In the panel on the right-hand side, we restrict the sample to only those countries that are also part of our historical sample. These are 28 countries as opposed to 33 countries due to missing data for five countries (Belgium, Greece, Peru, the Philippines, and Venezuela). The correlation is now 0.67. This compares to a slightly lower correlation of 0.54 for the exact same set of countries in the year 2000 in our original dataset. Therefore, we conclude that as in Fig. A2, the two measures are reasonably well-related. Furthermore, it appears that for the directly comparable set of 28 countries, the relationship is actually stronger when we use the TradeProd dataset.

In addition, we use the more comprehensive TradeProd dataset to study the relationship between market access and supplier access in the Redding and Venables (2004) model. In Fig. A5 (analogous to Fig. A3), we plot these two measures for the largest possible sample (the panel on the left-hand side) and the sample that most closely corresponds to our historical dataset (the panel on the right-hand side with 32 countries due to missing data for Belgium). The correlations are 0.93 and 0.97, respectively. We interpret this as strong evidence that the market access and supplier access measures are related as predicted by the structural gravity model.

Finally, we revisit the issue of the normalization implicit in the Redding and Venables approach. As described in section 3.3, Redding and Venables (2004) omit the exporter fixed effect for the United States as a normalization and also omit the constant in their specification so that no importer fixed effect has to be dropped. As an alternative, we choose a different normalization. We constrain the sum of exporter fixed effects to be equal to zero and the sum of importer fixed effects to be equal to zero. Given this normalization, the regression constant is separately identified. This particular normalization might be more convenient for time-series analysis when we examine repeated cross-sections.

The construction of market access and supplier access involves the use of estimated exporter and importer fixed effects, respectively (see eqs. 17 and 18 in Redding and Venables 2004). The resulting measures for MA_i and SA_i continue to be strongly related. Their correlations stand at 0.99 for the year 1910, 0.89 for 1950, and 0.97 for 2010. The intuition is that when their sums are constrained, exporter and importer fixed effects are highly correlated across countries. For example, the French exporter and importer fixed effects are very similar. The intercepts of the annual regressions (not reported here) capture an upward trend which is similar to the log value of world GDP as in Fig. 2a but not as smooth.

In Fig. A6, we plot the average of logarithmic values of market access across countries for the period from 1910 to 2010, using the full sample

of 51 countries and with the sums of exporter and importer fixed effects constrained to zero. Unlike in Fig. 2a where we plot the market potential measure based on the structural gravity model, average market access in Fig. A6 does not exhibit an upward trend. This is to be expected as the intercepts in the underlying regressions capture common movement over time by construction.

We make note of the spikes during the war years which are driven by many countries showing enormous increases in market access (for instance Canada, France, the United Kingdom, and the United States) when we apply the Redding and Venables method. This mirrors the results in Fig. 4 for the case of the United Kingdom and India. The reason is that trade patterns were more driven by military and strategic concerns during the war years than those implied by standard models. Trade cost coefficients as well as fixed effect coefficients tend to be more extreme in absolute value, thus leading to more extreme values of market access (refer to eq. 16 to see how those coefficients enter the calculation for MA_i).

Appendix III: Data sources

Aggregate exports and bilateral trade: Trade figures were converted into real 1990 US dollars using the US CPI deflator in Officer, Lawrence H. 2015, “The Annual Consumer Price Index for the United States, 1774–2014” and the following sources:

Annuaire Statistique de la Belgique. Brussels: Ministère de l'intérieur.
Annuaire Statistique de la Belgique et du Congo belge. Brussels: Ministère de l'intérieur.

Annual Abstract of Statistics. London: Her Majesty's Stationery Office.
 Barbieri, Katherine. 2002. *The Liberal Illusion: Does Trade Promote Peace?* Ann Arbor: University of Michigan Press.

Bloomfield, Gerald T. 1984. *New Zealand, A Handbook of Historical Statistics*. Boston: G.K. Hall.

Canada Yearbook. Ottawa: Census and Statistics Office.

Confederación Española de Cajas de Ahorros. 1975. *Estadísticas Básicas de España 1900–1970*. Madrid: Maribel.

Direction of Trade Statistics. Washington: International Monetary Fund.

Historisk Statistik för Sverige. 1969. Stockholm: Allmänna förl.

Johansen, Hans Christian. 1985. *Dansk Historisk Statistik 1814–1980*. Copenhagen: Gyldendal.

Ludwig, Armin K. 1985. *Brazil: A Handbook of Historical Statistics*. Boston: G.K. Hall.

Mitchell, Brian R. 2003a. *International Historical Statistics: Africa, Asia, and Oceania 1750–2000*. New York: Palgrave Macmillan.

Mitchell, Brian R. 2003b. *International Historical Statistics: Europe 1750–2000*. New York: Palgrave Macmillan.

Mitchell, Brian R. 2003c. *International Historical Statistics: The Americas 1750–2000*. New York: Palgrave Macmillan.

National Bureau of Economic Research–United Nations World Trade Data.

Statistical Abstract for British India. Calcutta: Superintendent Government Printing.

Statistical Abstract for the British Empire. London: Her Majesty's Stationery Office.

Statistical Abstract for the Colonies. London: Her Majesty's Stationery Office.

Statistical Abstract for the Principal and Other Foreign Countries. London: Her Majesty's Stationery Office.

Statistical Abstract for the Several Colonial and Other Possessions of the United Kingdom. London: Her Majesty's Stationery Office.

Statistical Abstract for the United Kingdom. London: Her Majesty's Stationery Office.

Statistical Abstract of the United States. Washington: Government Printing Office.

Statistical Abstract Relating to British India. London: Eyre and Spottiswoode.

Statistical Yearbook of Canada. Ottawa: Department of Agriculture, Statistics Bureau Management and Coordination Agency. 1987. *Historical Statistics of Japan*, vol. 3. Tokyo: Japan Statistical Association. Statistisches Reichsamt. 1936. *Statistisches Handbuch der Weltwirtschaft*. Berlin.

Statistisk Sentralbyrå. 1978. *Historisk statistikk*. Oslo.

Tableau général du commerce de la France. Paris: Imprimeur royale.

Tableau général du commerce et de la navigation. Paris: Imprimeur nationale.

Tableau général du commerce extérieur. Paris: Imprimeur nationale.

Year Book and Almanac of British North America. Montreal: John Lowe.

Year Book and Almanac of Canada. Montreal: John Lowe.

Distance: Taken from the CEPII GeoDist database available at www.cepii.fr. Bilateral distance is measured as the distance between the most populous cities/agglomerations in each country using the great circle formula. Domestic distance is measured based on a country's surface area with the formula $0.67^* (\text{area}/\pi)^{0.5}$ where area is measured in square kilometers. Details are provided in Mayer, T. and S. Zignago (2011), "Notes on CEPII's Distances Measures: The GeoDist Database." *CEPII Working Paper no. 2011–25*.

GDP: Maddison, Angus. 2009. *Historical Statistics of the World Economy: 1–2008 AD*. Updates drawn from Bolt, J. and J. L. van Zanden. 2014. "The Maddison Project: Collaborative Research on Historical National Accounts." *Economic History Review* 67(3): 627–651.

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