EXTERNAL INTEGRATION, STRUCTURAL TRANSFORMATION AND ECONOMIC DEVELOPMENT:
EVIDENCE FROM ARGENTINA 1870-1914

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ABSTRACT

This paper uses the natural experiment of Argentina's integration into world markets in the late-nineteenth century to provide evidence on the role of internal geography in shaping the effects of external integration. We develop a quantitative model of the distribution of economic activity across regions and sectors. The model predicts a spatial Balassa-Samuelson effect, in which locations with better access to world markets have higher population densities, higher shares of employment in the non-traded sector, higher relative prices of non-traded goods, and higher land prices relative to wages. We use the model and data on population density and sectoral employment shares to recover sufficient statistics that isolate the economic mechanisms through which external and internal integration affect economic development. Our analysis highlights the role of complementary investments in internal infrastructure and technology adoption in mediating the economy's response to external integration.

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1 Introduction

External economic integration is often argued to be an important driver of economic development, as it raises income through specialization in comparative-advantage sectors, provides low-cost access to imported goods, and shapes the pattern of structural transformation from agricultural into non-agricultural activities. These relationships are typically examined at the aggregate level, implicitly treating each country as a point in space. In reality, however, countries differ substantially in terms of their internal geography, and internal trade costs hamper the ability of interior regions to participate in world markets. How important is geographic heterogeneity within countries for the aggregate impact of external integration?

In policy circles, the role of domestic infrastructure in enabling countries to participate in world markets has received renewed attention, and a growing body of evidence suggests that internal trade costs can be large.\(^1\) Yet there is little quantitative evidence on the role of internal trade costs in shaping the effects of external integration on the pattern of economic development and welfare within countries. This scarcity of evidence reflects in part both empirical and theoretical challenges. Empirically, it is difficult to find large-scale changes in both external and internal integration. Theoretically, to explore the relationship between them, we require a general-equilibrium model that can incorporate trade within and between countries, structural change across sectors as a key part of the development process, and factor mobility across space. At the same time, we require this model to remain sufficiently tractable as to be amenable to quantitative analysis.

In this paper, we address both of these challenges. Empirically, we make use of the natural experiment provided by Argentina’s integration into world markets in the late-nineteenth century. This large-scale increase in external integration was driven by a cluster of related technological innovations that reduced international transport costs. Increases in the size of ships and the spread of steam navigation made it profitable to ship wheat, corn, and other cereals from Argentina to European markets. New technologies such as meat refrigeration, first invented in Australia in the 1860s to serve British colonial markets, made it possible for the first time to trade frozen and chilled meat from Argentina to Europe. These reductions in external transport costs propelled an export boom and an “agricultural revolution on the pampas,” as Argentina’s traditional production of animal hides, salted meat and wool was progressively replaced by specialization in the new comparative-advantage products of cereals and frozen and chilled beef. This increase in external trading opportunities stimulated an expansion of the railroad network to connect the agricultural hinterland with ports such as Buenos Aires, mass immigration that enlarged the labor force, and increased imports of manufacturing goods.\(^2\)

\(^1\)See, for example, Inter-American Development Bank (2013), United Nations Economic and Social Council and United Nations Economic Commission for Africa (2009), World Bank (2009, 2011), and World Trade Organization (2004). Limao and Venables (2001) find that improving a country’s infrastructure from the median to top 25 percent of countries would reduce its transport costs by the equivalent of 481 kilometers of overland travel and 3,989 kilometres of travel by sea. Atkin and Donaldson (2012) provide further evidence on the importance of domestic trade costs within several developing countries.

Theoretically, we develop a tractable quantitative general equilibrium model that determines the distribution of economic activity across both regions and sectors. Both of these distributions are central to understanding the process of economic development, as this process is typically characterized by growing urbanization and spatial inequalities as well as structural transformation from agriculture to non-agriculture. We model an economy with many locations (districts in our data), some of which are interior, and others of which are coastal. Some coastal or riverine locations are directly connected to world markets (through ports) while interior locations are connected to world markets through an internal transportation network that can change over time, as for example railroads are constructed. The model includes two tradable sectors (Agriculture and Manufacturing) and a single non-tradable sector (Services or Manufacturing that is only supplied to the local market). Each of these sectors uses land and labor as factors of production with different intensities. To make contact with disaggregated data on trade and land use across goods within sectors, each sector may in turn comprise several goods. Labor and land in each location is endogenously allocated across Agriculture (produced in rural areas) and Manufacturing and Services (produced in urban areas). Workers are mobile across regions and choose their location to arbitrage away real wage differences.

We first characterize the key analytic properties of the framework. We identify a simple general-equilibrium channel for the impact of internal geography on the pattern of development that we term the spatial Balassa-Samuelson effect. At the country level, the Balassa-Samuelson effect refers to the fact that nontraded factors of production are more expensive in more productive countries. In our model of internal geography within countries, the spatial Balassa-Samuelson effect implies that locations with low trade costs to international markets, such as regions close to ports or railway lines, feature a high relative price in the nontraded sector and high land rents relative to wages. These differences in relative prices govern the pattern of economic development. As long as traded and nontraded goods are complements in final consumption, the high relative price of nontraded activities in well-connected locations drives large shares of employment in the non-traded sector. In turn, because labor is cheap relative to land and sectorial specialization is biased toward the labor-intensive nontraded activities, output in well-connected locations is produced with labor-intensive techniques, leading to high labor density. Thus, the model offers a unifying rationale for patterns of spatial development within countries observed in the historical Argentinean data and today in developing countries: Proximity to trade hubs is associated with high employment density, high land rents relative to wages, and structural transformation away from agriculture.

We next provide empirical evidence on these predictions of the model. An advantage of our empirical setting is the availability of rich spatially-disaggregated data for a long historical time period characterized by large-scale changes in external integration. We combine historical censuses, official trade statistics, and railway records, among other sources, to assemble a new dataset on rural and urban employment, specialization patterns across agricultural goods, and railway shipments of these goods for 386 Argentinian districts from 1869-1914. Over this period, real exports and imports increased by more than 500 and 200 percent respectively, with agricultural and livestock products
accounting for more than 95 percent of the total value of exports in each year. Total population increased from 1.8 to 7.9 million, and real income per capita grew so rapidly that Argentina became the eighth richest country in the world by 1914.

We find strong empirical confirmation of the spatial Balassa-Samuelson effect in both the cross-section and time-series. At the beginning of our sample period, population density and the urban population share are both sharply decreasing in measures of geographical remoteness from world markets. Over time, despite the fall in internal trade costs from the construction of the railroad network, there is a steepening of the gradients of both population density and the urban population share with respect to remoteness. We show how the structure of the model can be used together with observed data on population density and the urban population share to recover two sufficient statistics for the distribution of economic activity for each location: (a) productivity in the export sector (agriculture) adjusted by the tradables consumption price index (including imported manufactures) and (b) productivity in non-tradables. Together with the population of the economy as a whole and geographical land area for each location, these sufficient statistics determine all of the model’s endogenous variables, including the relative price of tradables and the relative wage-rental ratio for each location, as well as population density and sectoral specialization for each location.

We use the structure of the model to undertake counterfactuals for changes in each of these sufficient statistics and quantify their role in explaining changes in aggregate welfare and the distribution of economic activity. Reducing Argentina’s frontiers from 1914 to 1869 boundaries, while holding the economy’s total population and productivity in all other locations constant, reduces real wages to 93 percent of 1914 values, as less of the immobile factor land is available per person. In contrast, reducing both Argentina’s frontiers and its total population from 1914 to 1869 values, while holding productivity in all other locations constant, increases real wages to 103 percent of 1914 values, as the reduction in population dominates the reduction in land area.

In comparison, changing adjusted agricultural productivity and non-agricultural productivity for each location has effects that are large relative to those for total land area and population. Adjusting frontiers, total population and all productivities to 1869 values reduces real wages to 62 percent of 1914 values. Adjusting frontiers, total population and only adjusted productivities in agriculture to 1869 values reduces real wages to 92 percent of 1914 values, an effect that is around the same magnitude as for total population.

We use these counterfactuals to show the role of adjusted agricultural and non-agricultural productivities in understanding changes in the internal distribution of economic activity across regions and sectors. The combination of an agricultural export boom and increased urbanization is explained in the model by faster growth in adjusted agricultural productivity than in non-agricultural productivity, which with inelastic demand between sectors reallocates employment away from agriculture (produced in rural areas) towards non-tradables (produced in urban areas). The steepening of the gradients of population density and the urban population share with respect to remoteness is rationalized in the model by a steepening of the productivity gradients, which is particularly marked for adjusted agricultural productivities.
Finally, we provide evidence on the economic mechanisms underlying the changes in adjusted agricultural productivities. In the model, the gradient of adjusted agricultural productivity depends on the rate at which the prices of exported agricultural goods decline with remoteness, the rate at which the prices of imported agricultural goods rise with remoteness, and the spatial distribution of the technologies for producing agricultural goods. Other things equal, the expansion of the railroad network might be expected to flatten the gradient of adjusted agricultural productivity, both by reducing internal trade costs and facilitating the diffusion of technology. However, both the expansion of the railroad network and the adoption of agricultural machinery are themselves geographically uneven. We find that a substantial component of the steepening of the gradient of adjusted agricultural productivity can be explained statistically by these internal investments.

To address the non-random assignment of railroads and agricultural machinery, we use an instrument based on the idea that locations can be treated with transport infrastructure, not because of their own unobserved characteristics, but because they happen to lie along the route between other locations (see Chandra and Thompson 2000 and Michaels 2008). After controlling for initial levels of development and geographical remoteness, we show that locations along the shortest route from the centroids of districts to 16th-century cities are more likely to obtain railroad connections, which in turn stimulates the adoption of agricultural machinery. We find that this source of quasi-experimental variation leads to large changes in both these internal investments and adjusted agricultural productivity.

Our paper is related to a number of literatures. Our use of the natural experiment of Argentina’s integration into world markets in the late-nineteenth century relates to a small number of other studies that have used natural experiments in trade. Bernhofen and Brown (2004, 2005) examine Japan’s opening in the nineteenth century but are not primarily concerned with the internal distribution of economic activity within Japan; Davis and Weinstein (2002, 2005) exploit the large-scale bombing of Japanese cities during the Second World War; Hanson (1996a,b) considers the implications of Mexican trade liberalization for the spatial distribution of employment and wages; Redding and Sturm (2008) investigate the impact of Germany’s division in the aftermath of the Second World War on the distribution of population across West German cities. None of these papers examines the relationship between external integration, structural transformation and economic development.

Our paper also connects with the theoretical literature on new economic geography, as synthesized in Fujita, Krugman and Venables (1999). The complexity of these models typically restricts attention to stylized examples assuming symmetry and/or a handful of regions. Nevertheless, a small number of papers have recently begun to develop quantitative models of trade with endogenous internal distributions of economic activity, including Allen and Arkolakis (2013), Caliendo et al. (2013), Coşar and Fajgelbaum (2012), Ramondo et al. (2012) and Redding (2012). Theoretically, a key distinguishing feature of our model is the relationship between internal trade costs and structural transformation across sectors through the spatial Balassa-Samuelson effect. Empirically, in contrast to these papers, our analysis is geared toward the quantitative analysis of a
natural experiment involving large-scale changes in external and internal trade costs and geographic reallocation of labor.

Our research is also related to the literature on transport infrastructure investments, including Banerjee et al. (2012), Baum Snow (2007), Berlinski et al. (2011), Chandra and Thompson (2000), Coşar and Demir (2014), Donaldson (2013), Donaldson and Hornbeck (2013), Duranton and Turner (2011, 2012), Duranton et al. (2013), Faber (2013), Martincus et al. (2012), Michaels (2008), and Sotelo (2014). The main concern of this literature has been finding exogenous sources of variation in transport infrastructure to estimate its causal impact on relative outcomes in treated versus untreated locations. In contrast, we develop a quantitative general equilibrium model of the internal distribution of economic activity across regions and sectors. Distinctive features of our quantitative analysis are the emphasis on the role of transport infrastructure in enabling interior regions to participate in world markets and in driving structural transformation.\(^3\)

Our analysis also connects with the macroeconomics and development literatures on structural transformation from agriculture into non-agriculture, including Bustos et al. (2012), Caselli and Coleman (2001), Foster and Rosenzweig (2007), Gollin et al. (2012, 2013), Karádi and Koren (2013), Lagakos and Waugh (2013), Matsuyama (1992), Michaels et al. (2012), Ngai and Pissarides (2007), Herrendorf et al. (2013), Swiecki (2013), and Uy, Yi, and Zhang (2012).\(^4\) In the macroeconomics literature the Balassa-Samuelson effect is driven by differences in productivity between the traded and non-traded sector for the aggregate economy as a whole.\(^5\) In contrast, in our model, these effects emerge endogenously from geographical location alone: more remote locations have higher relative prices of tradables, higher wage-rental ratios, higher agricultural employment shares and lower population densities. This role for internal geography in turn influences the aggregate magnitude of structural transformation from agriculture towards non-agriculture.

The remainder of the paper is structured as follows. Section 2 discusses the historical background. Section 3 develops the theoretical model that we use to guide our empirical analysis. Section 4 discusses the data sources and definitions. Section 5 undertakes a quantitative analysis of the model and reports counterfactuals. Section 6 provides further evidence on the economic mechanisms in the model. Section 7 concludes. Technical derivations and supplementary material are collected together in the web appendix.

\(^3\)Reduced-form studies of the impact of trade liberalization on local labor markets include Kovak (2013), Topalova (2010), and McCaig and Pavcnik (2012).

\(^4\)Much of this literature excludes geographic variation within countries. A small number of studies do consider transport costs as a potential determinant of agricultural employment shares, including Adamopoulos (2012), Gollin and Rogerson (2012) and Herrendorf et al. (2012). But these studies consider stylized settings of for example two regions that do not trade internationally and are less well suited to taking to our spatially disaggregated data.

\(^5\)See Balassa (1964) and Samuelson (1964) for the conventional explanation of this relationship.
2 Historical Background and Aggregate Trends

2.1 Pre-Export Boom Era

The earliest Spanish explorations of present-day Argentina date back to the first half of the Sixteenth Century.\(^6\) Initially, economic activity was orientated towards the silver mines at Potosí in Bolivia rather than the Atlantic coast.\(^7\) Official trade routes with Spain ran towards the Northwest, through Potosí and Lima, to Panama. In contrast, international trade was officially forbidden from Buenos Aires, so that the River Plate region (Río de la Plata) lay on the periphery of the Spanish Empire as an outpost for illegal trade with Brazil, Portugal and Britain.

Eventually, the growth of this illegal trade and threats from Portuguese settlement along the Río de la Plata spurred the opening of Buenos Aires to official trade and the establishment in 1776 of the Viceroyalty of the Río de la Plata. Throughout the colonial era, Spanish merchants retained a monopoly of all official trade. However, population growth and economic development led to growing demands for political autonomy from Spain. When the Napoleonic Wars undermined Spanish imperial power, these growing pressures brought about a transfer of political power to a local junta in 1810 and the opening of official direct trade with the merchants of other countries (in particular Britain and Portugal).

Despite initial attempts to restore Spanish imperial power, Argentinian independence was ultimately achieved in 1816. The decades immediately following independence were taken up with internal power struggles between Buenos Aires and the interior regions of Argentina. However, there was a move towards political stability from 1850 onwards. The first national constitution was agreed in 1853, the first constitutional government of all provinces met in 1862, and Buenos Aires was absorbed into the federal structure of Argentina in 1880. Further consolidation came with a series of campaigns against native populations in the hinterland of Buenos Aires that culminated with the “Conquest of the Desert” in 1879-80.\(^8\) The election of Julio Roca to the Presidency in 1880 ushered in a sequence of liberal regimes open to foreign trade, capital and migration.

2.2 External and Internal Trade Costs Reductions in the Late-19th Century

From the mid-nineteenth century onwards, a series of technological innovations led to substantial reductions in maritime transport costs. According to the freight indices of North (1958) and Harley (1988), freight rates across the North Atlantic fell by around 1.5 percent per annum from around 1840 onwards, with a cumulative decline of around 70 percent points from 1840-1914.\(^9\)

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\(^6\)This section draws in particular on the discussions in Adelman (1994) and Scobie (1971).

\(^7\)Early settlement patterns were heavily influenced by the availability of passive native Indian populations that were used as a source of forced labor under the feudal encomienda system. Interior towns were established at Asunción (1537), Santiago del Estero (1553), Mendoza (1561), San Juan (1562) and San Miguel de Tucumán (1565). In contrast, the establishment of coastal towns lagged by several decades, including Santa Fe (1573), Buenos Aires (1580), Concepción del Bermejo (1585), and Corrientes (1588).

\(^8\)Until 1880, the development of large areas of the land subsequently used for agricultural production was limited by incursions from hostile native populations (see for example Droller 2013).

\(^9\)These declines in freight rates were associated with a convergence in commodity prices: the gap between wheat prices in Liverpool and Chicago fell from 57.6 percent in 1870 to 17.8 percent in 1895 and 15.6 percent in 1913 (Harley