Essay 2: Research Project

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Part I: Limitations

A) Over-reliance on Market Access as a Sufficient Statistic

Donaldson and Hornbeck (2016) anchor their empirical strategy on a core insight from quantitative trade theory: that market access, derived from a structural gravity model, serves as a sufficient statistic for the equilibrium price index and thus productivity or welfare in each location. While this approach is elegant and tractable, it inherits several weaknesses.

In "Market Access in Global and Regional Trade" (2005), Mayer and Zignago underline the theoretical limitations of market access measures derived from trade flows, arguing that market access can be highly collinear with other geographic and institutional variables. Indeed, market access is an aggregate spatial index that may conflate multiple channels (e.g., labor mobility, firm relocation, technology spillovers), and fail to isolate the causal effect of railroads from other co-evolving forces such as urbanization, land policy, or institutional development. Thus, their critique suggests that Donaldson and Hornbeck's empirical estimates may conflate multiple channels and obscure other important mechanisms, questioning the empirical sufficiency of market access as a metric for productivity or welfare.

B) Static Design and Lack of Dynamic Adjustment

The paper estimates a static treatment effect of railroad-induced changes in market access on land values using cross-sectional data. However, in reality, land prices may reflect expectations of future rents, not just current ones. If agents expect that railroads will spur longer-term industrialization, migration, or urban growth, this could inflate land values beyond the contemporaneous productivity gains. Indeed, land markets are forward-looking, and land prices may incorporate expectations of future growth, which could be driven by non-transportation factors like industrialization, education, or political changes. Jedwab and Moradi (2016) show, using evidence from Ghana, that railroads can have persistent effects due to agglomeration externalities and local public good provision, pointing to dynamics missing from Donaldson and Hornbeck

(2016).

C) Historical Transportation Routes Are Not Always Optimal

Contrary to what is implied in the paper, real economies may not use the lowest-cost routes due to frictions or political economy. In "Persistence and Path Dependence in the Spatial Economy" (2020), Allen and Donaldson develop a dynamic spatial model to examine how historical shocks can have persistent effects on the spatial distribution of economic activity. They emphasize that the placement of infrastructure is often influenced by historical contingencies and political factors, leading to path-dependent outcomes that may not align with the most efficient configurations. This challenges the assumption that trade flows naturally follow minimum-cost paths, and potentially disconnect modelled trade flows from actual economic behavior. As a result, if modeled trade routes overstate the efficiency of the historical network, then the estimated gains in land value or productivity from railroad access may be biased; this concern applies to counterfactuals. Also note that the reliance on "iceberg" trade costs might obscure fixed handling costs, scale effects, and terrain irregularities captured by real freight costs.

D) Land Value as a Proxy for Welfare and No Explicit Land Use Model

While agricultural land prices are a clever proxy to capture (agricultural) productivity gains under general equilibrium, this choice has limits.

First, the assumption that land values internalize all welfare changes is debated. As Fajgelbaum and Schaal (2020) point out, welfare impacts differ across agents, and measuring only capitalized land values omits potential redistributional effects or sectoral transitions (e.g., from agriculture to manufacturing). Indeed, trade infrastructure also affects inequality, which challenges use of land value as a stand-in for broader economic welfare and critiques the neglect of distributional channels in Donaldson and Hornbeck's (2016) analysis.

Second, urban economics models typically emphasize multiple land uses (residential, commercial, public), which the paper abstracts away from. The rural context may justify this, but it limits the generality of conclusions regarding spatial equilibrium. Thus, Donaldson and Hornbeck do not model land use behavior explicitly. Their framework assumes land values capture all spatial economic activity, but does not distinguish between residential, industrial, or mixed-use land, nor does it accommodate urban expansion dynamics. Finally, by omitting features such as commuting or agglomeration externalities in their model, the paper may bias estimates in regions transitioning toward urbanization.

Part II: Proposed Extensions to Address Key Limitations

This section outlines several extensions designed to address the main limitations identified in Donaldson and Hornbeck (2016). The proposed approaches aim to disentangle the mechanisms underlying market access effects, introduce dynamic adjustment, account for political economy constraints in infrastructure placement, and incorporate explicit land use decisions into the spatial equilibrium framework.

A) Combining Market Access Estimates with a Structural Multi-Sector Spatial General Equilibrium Model

Market access may aggregate effects from multiple spatial mechanisms (trade frictions, labor mobility, institutional variation) and thus fail to isolate the causal impact of infrastructure improvements. We suggest combining market access estimates with a structural multi-sector spatial general equilibrium model (as in Caliendo, Dvorkin, and Parro, 2019) to disentangle the mechanisms by which infrastructure affects economic outcomes.

First, we would need to construct a model in which trade, migration, and sectoral reallocation respond jointly to infrastructure shocks. Next, the model should be calibrated using county-level data on land values, population, wages, and sectoral output. Finally, we could use the model to simulate counterfactuals that separate pure gains from improved goods-market access, labor market adjustments, endogenous firm location decisions, and policy or institutional complements.

This approach directly addresses the concern that market access conflates multiple forces. It allows us to compute the share of land value changes attributable to trade cost reductions versus other mechanisms such as labor inflow or sectoral specialization.

B) Developing a Dynamic Spatial Equilibrium Model of Land and Labor Markets

The paper's model fails to account for expectations, anticipation, and the longer-run dynamics of reallocation or agglomeration triggered by the railroad shock. That is why we propose developing a dynamic spatial equilibrium model of land and labor markets that captures both forward-looking behavior and temporal adjustment.

To implement it, we would need to embed dynamic forward-looking agents (e.g., landowners, firms, workers) in a spatial model where investment and migration respond to expected future market access. Then, using digitized historical data over multiple decades (e.g., 1850–1910), we could estimate a dynamic event-study of railroad exposure on land values, population, and sectoral transformation. This would allow for the introduction of anticipation effects by exploiting timing differences in railroad construction across counties.

This extension allows for an explicit comparison between short-run capitalization of expected rents and long-run realized productivity gains. It also enables the study of persistence, lag, and convergence dynamics, addressing the key limitation that land values may reflect future—not current—economic fundamentals.

C) Instrumenting Route Placement Using Historical and Political Determinants

The assumption that trade flows followed lowest-cost routes neglects political economy and frictions in infrastructure provision. This concern could be addressed by instrumenting route placement using historical and political determinants, and assessing the divergence between optimal and actual routes.

For example, one could use 19th-century military maps, land survey plans, and congressional records to identify political and strategic factors (e.g., federal land grants, lobbying intensity) that influenced routing. Then, one could compare a "frictionless optimal network" (based terrain and cost data) to the historical network, and estimate the economic loss from deviation between optimal and actual placement using spatial equilibrium simulations.

This design would allow us to identify inefficiencies in infrastructure allocation and would provide a basis for computing the welfare cost of political distortions in historical infrastructure investment and trade routes.

D) Augmenting the Model with a Land Use Equilibrium Structure

Land value reflects only part of the welfare effects of infrastructure, and the framework lacks a theory of land use allocation (residential, agricultural, industrial). To address this issue, we propose augmenting the model with a land use equilibrium structure (following the Alonso-Muth-Mills urban framework) to separate the impacts on land types and agents.

To implement this design, we would need to use census and tax data to distinguish between land ownership, land use (e.g., cropland vs. residential), and land tenure (owners vs. renters). Then, we could model households and firms as optimizing agents choosing land and location jointly based on wages, rents, and amenities, in order to estimate how railroad access changed land use composition and the distribution of welfare across agent types.

This approach recovers more nuanced measures of spatial welfare, identifies winners and losers, and distinguishes between gains to capital owners (land) and gains to workers (through wages or amenities), addressing the concern that land values are a narrow welfare proxy.

Part III: Additional Extensions and Variants

A) Railroads and the Urban Fringe—Land Rents, Competition, and City Expansion

The expansion of the railroad network increased access to urban markets for distant rural producers, intensifying competition for farmers located near cities. This eroded the agricultural land rent advantage at the urban fringe, potentially reducing agricultural land rent or encouraging conversion of farmland to urban uses. Simultaneously, improved transport access made commuting and logistics easier, allowing cities to expand outward and shift the location of the urban fringe.

In this extension, we wish to test two hypotheses. First, agricultural land values at the urban fringe grew more slowly (or declined) relative to rural counties further away, due to increased market competition enabled by railroads. Second, urban expansion (e.g., population growth, land conversion to residential/commercial use) occurred disproportionately in fringe counties with improved rail access, consistent with a bid-rent driven urban boundary shift and lower farmers' rent.

Our conceptual framework builds on the monocentric model, adding the effect of increased competition in agriculture on farmers' land rent. Thus, land prices decline with distance from the city center, and when transport costs fall (as with rail expansion), the urban boundary expands and land at the fringe becomes more valuable for urban use, and less valuable for agriculture. At the same time, the fall in good transport costs causes agricultural land near cities to face more competition from distant farms, reducing its profitability. This leads to two opposing forces on fringe land: a decline in agricultural land rent and an increase in land value as urban uses expand outward.

To implement this design, we would use Donaldson and Hornbeck's (2016) GIS railroad network in 1870 and 1890. In addition, we would daw on digitized county-level data on agricultural land values, population and housing, from the U.S. Censuses of Agriculture and Population (Haines, 2005). Finally, we would need data on land use (e.g. urban, cultivated, vacant) that could be available from tax rolls, or from Sanborn maps for the urban fringe.

Then, we would define "urban fringe counties" as those within 10 miles of major cities, determined using a population threshold (e.g., cities >25,000 inhabitants). Each county would be attributed a type based on concentric distance bands, from urban core to urban fringe to rural. We adapt the main specification to our design:

$$\Delta Y_o = \beta_1(\Delta MA_{ot} \times Fringe_o) + \beta_2(\Delta MA_{ot} \times Rural_o) + \gamma X_o' + \delta_{st} + \varepsilon_{ot}$$

Where Y_o is our outcome, that is: land value, share of cultivated land, population density, shift in labor force from farming to other occupations. ΔMA_{ot} represents the change in market access from 1870 to 1890. $Fringe_o$ and $Rural_o$ indicate the location type. X_o' is a vector of county-specific controls for initial land use, soil quality, proximity to existing trade routes (e.g. canal, waterway), and economic development. Finally, δ_{st} corresponds to a state-year fixed effects.

This extension would contribute to the literature in three ways.

First, it would test classic bid-rent predictions from urban economics under historical infrastructure shocks, and show how urban expansion interacts with rural land values and agriculture. Then it would bridge the rural-focused analysis from Donaldson and Hornbeck (2016) with urban transition, offering a richer picture of how infrastructure shaped both agricultural decline and urban growth. Finally, it would offer insights on how infrastructure affects land use transitions, which is critical for modern debates in development economics.

B) Railroads and French Economic Growth: a "Market Access" Approach

We aim to test whether the economic impact of railway expansion in 19th-century France mirrors the effects estimated by Donaldson and Hornbeck (2016) in the U.S., particularly the capitalization of market access improvements into agricultural land values. Thus, our research question is: Does improved market access due to France's 19th-century railroad expansion increase agricultural land values, consistent with structural trade theory predictions?

France experienced a major wave of railway construction from 1840 to 1870, similarly transformative as the U.S. case. However, unlike the US, France had denser pre-existing transport infrastructures (roads, canals, rivers), a smaller spatial scale and fewer (or no) "frontier" regions, and a fixed cadastral system for land tenure, strong state intervention, less internal migration and higher population density. By testing the same framework in France, we aim to evaluate whether market access effects generalize across geographies with different frictions, settlement patterns, and state roles in infrastructure.

Our conceptual framework would be based on the same theoretical framework as Donaldson and Hornbeck (2016). We would mobilize data from several historical sources. First, we would need to digitize historical railway maps of France between 1840 and 1870, or rely on geocoded data of all French railway stations in 1852 and 1870 from Chambru, Henry, and Marx (2024). For agricultural land value and use, we could use data from the Enquêtes Agricoles of 1852 and 1866–70 from the Statistique de la France. Population data are available in the Cassini database at the municipality level (censuses). Finally, we could gather data on topographic and geographic controls, such as terrain ruggedness or soil quality (from the GAEZ database), as well as canal and road network overlays.

Following the same logic as Donaldson and Hornbeck (2016), we would compute minimum-cost freight distances between each pair of administrative units, and then assign costs to different transport modes to construct municipalities or cantons market access. We would then compare market access in 1850 (early years) to 1870 (post-expansion). The reason we do not focus on 1840 as a start date is the lack of consistent data on agriculture. Our empirical specification would then be similar to the original paper:

$$Y_o = \beta \ln MA_{ot} + \delta_o + \delta_{st} + f(x_o, y_o)\delta_t + \varepsilon_{ot}$$

The only difference is that we allow Y_o to represent land value, share of agricultural land, or population density. Note we could also use 1842 planned rail lines (Loi de 1842) as an instrument for the realized network in 1870. This plan laid out a theoretical grid before private firms modified it and therefore could serve as a quasi-exogenous variation.

This variant would test whether Donaldson and Hornbeck (2016) results are robust to institutional, geographic, and demographic variation. Then, it would then offer insight into France's centrally planned rail system, compared to U.S. private networks. Finally, this would help deepen our understanding of how market integration affects land markets and regional development under different path dependencies.

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