Transport infrastructure and the economics of cities

Diego Puga

IMDEA Social Sciences

Urban economics and urban transport

- This presentation will discuss key implications for urban transport infrastructure projects from
  - the mono-centric city model and estimations of its implications for transport improvements,
  - systems of cities,
  - and studies of micro-foundations of agglomeration economies.

The mono-centric city model

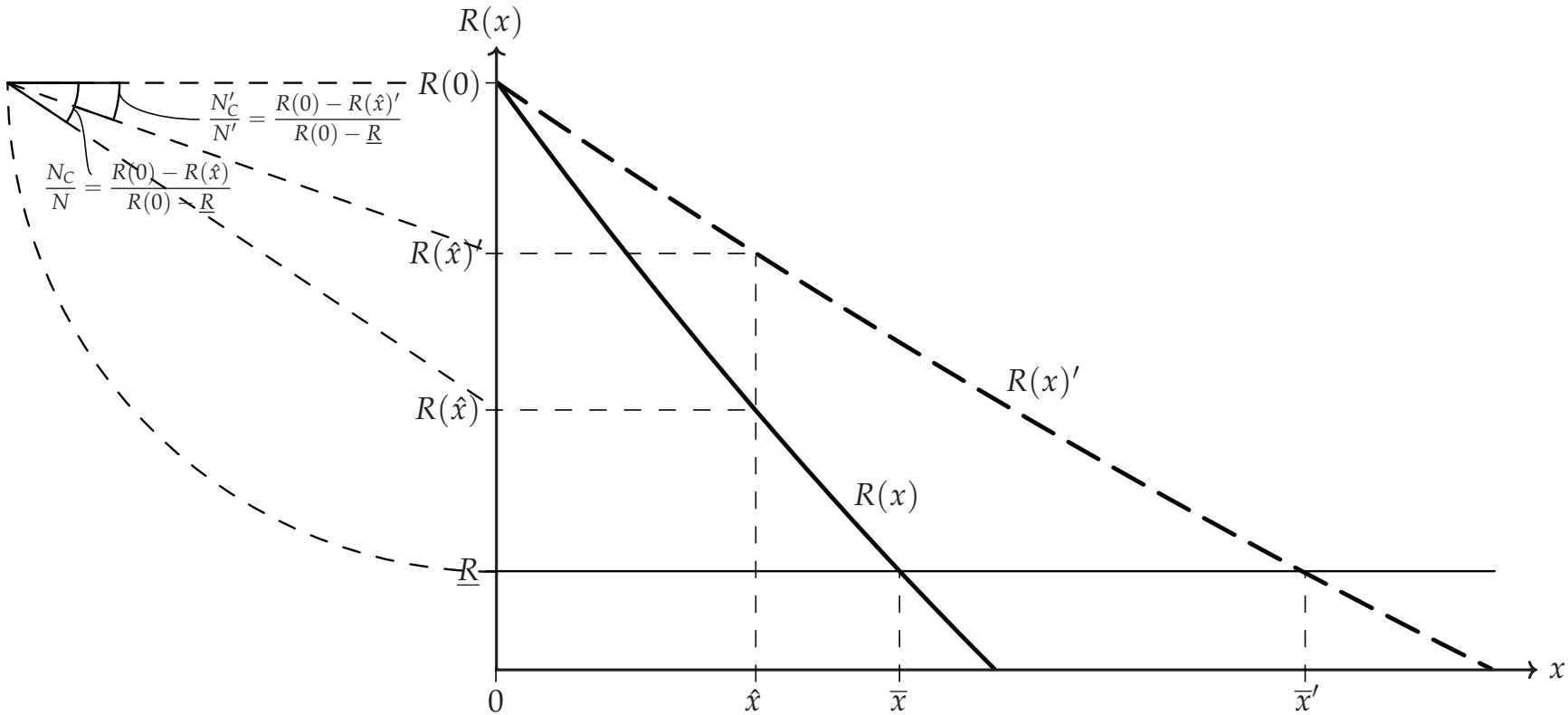
- Simplified model of a city, where everyone commutes to the Central Business District to work (Alonso, 1964, Mills, 1967, Muth, 1969, Thünen, 1826).
- Focus is on the individual trade-off in *within-city* location choice: better access for more central locations vs. cheaper land and housing further out.
- Also (open-city version) migration across cities tends to equalize utility.
- The advantages of cities (agglomeration economies) or the process of city formation are not considered.
- A huge simplification of reality, but still very useful basis for empirical work on the broad patterns.

Equilibrium regularities in the mono-centric city model

- In equilibrium, as we move closer to the city centre,
  - house prices increase because of better accesibility;
  - people, in response to higher prices, inhabit smaller dwellings;
  - land prices increase, reflecting the higher house prices;
  - developers, in response to higher land prices, build taller buildings;
  - population density increases through the combination of taller buildings and smaller individual dwellings.

Comparative statics for transport in the monocentric model

- Improvements in local commuting infrastructure (reductions in commuting costs) make the city more attractive relative to others and attract population.
- Land and house prices increase.
- To accommodate the larger population, cities physically expand outwards and experience rising densities.
- Of these two channels, the first is more important, so the fraction of suburban population rises.



Source: Duranton and Puga (2012)

Estimating the effect of transport on population growth

- Duranton and Turner (2010) estimate using US data the relationship between transport cost improvements in a city (measured by kilometers of highways crossing through the metropolitan area) and population and employment growth.
- If adjustment is slow, theory suggests regressing changes (in population) on levels (of transport costs or infrastructure).
- Two key identification concerns:
  - Reverse causation (new roads may be assigned based on expected growth).
  - Possible missing variables driving urban growth and correlated with roads.
- To tackle these estimation issues, Duranton and Turner (2010) use instrumental variables (IV).
- They find an elasticity of city employment in 2003 with respect to 1983 lane kilometres of interstate highway of 0.04 with OLS and 0.11 with IV (higher!).
- This indicates that road building is endogenous to urban growth, but because more roads are built in cities with slow, not fast, growth.
- More roads lead to higher population and employment growth, but not so much when they are just trying to help declining cities.

Estimating the effect of transport on suburbanization

- Baum-Snow (2007) estimates using US data the relationship between transport cost improvements in a city (measured by highway rays crossing through the metropolitan area) and the suburbanization of population.
- He uses IV to address endogeneity.
- As predicted by the monocentric city model, suburban population rises relative to population in the historical centre when transportation improves.
- An extra ray of interstate highways leads to a decline in central city population of about 9 percent.
- This IV estimate is again larger than its OLS counterpart.

Systems of cities models

- Build on the mono-centric city model, but incorporate not just disadvantages of larger and denser cities (congestion) but also advantages (agglomeration economies).
- Thus, they address the 'fundamental trade-off of spatial economics' (Fujita and Thisse, 2002).
- Not clear whether this trade-off can be improved through intervention.
- Hard to make a case for tinkering with agglomeration economies.
  - Several careful recent studies on spatially targeted firm subsidies (Einiö and Overman, 2011, Mayer, Mayneris, and Py, 2011) reach the same conclusion: effects on employment and business location are moderate at best, and are basically a displacement from nearby areas not subject to the policy.
- However, working on the urban cost side of things in probably safer, more transparent and more effective.

Quantifying wider economic impacts: Agglomeration

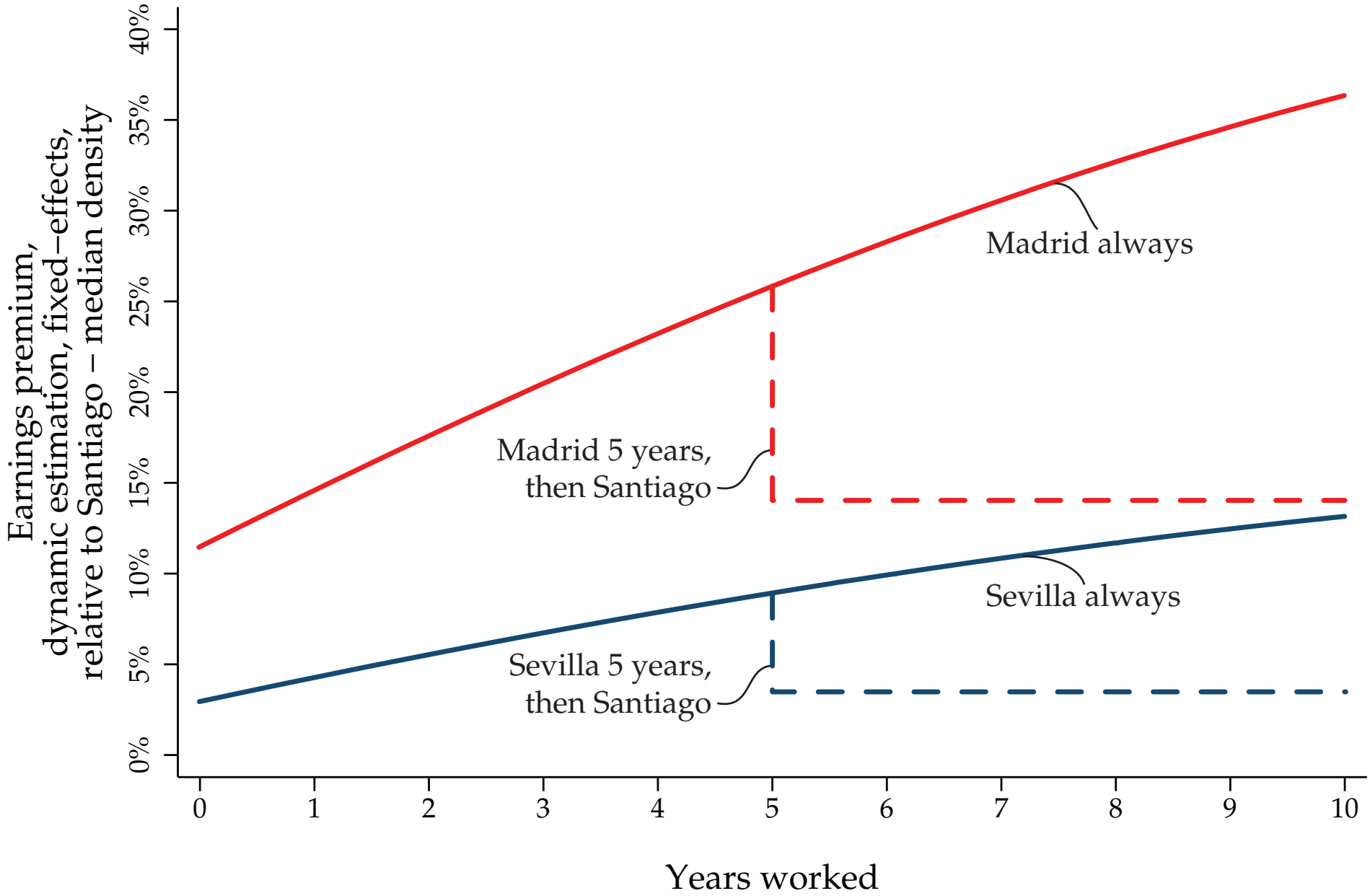
- A possible approach is to calibrate a computable general equilibrium model (e.g. based on 'new economic geography model'), as in Venables and Gasiorek, 1997, Bröcker, 2004.
  - More relevant for inter-city transportation than for intra-city transportation.
- Another approach is to calculate increase in density resulting from a transport project and apply an estimate of the elasticity of productivity with respect to density (Venables, 2007, Graham, 2007).
  - Good starting point for intra-city transportation, but subject to important concerns.

Concerns about using standard elasticity estimates

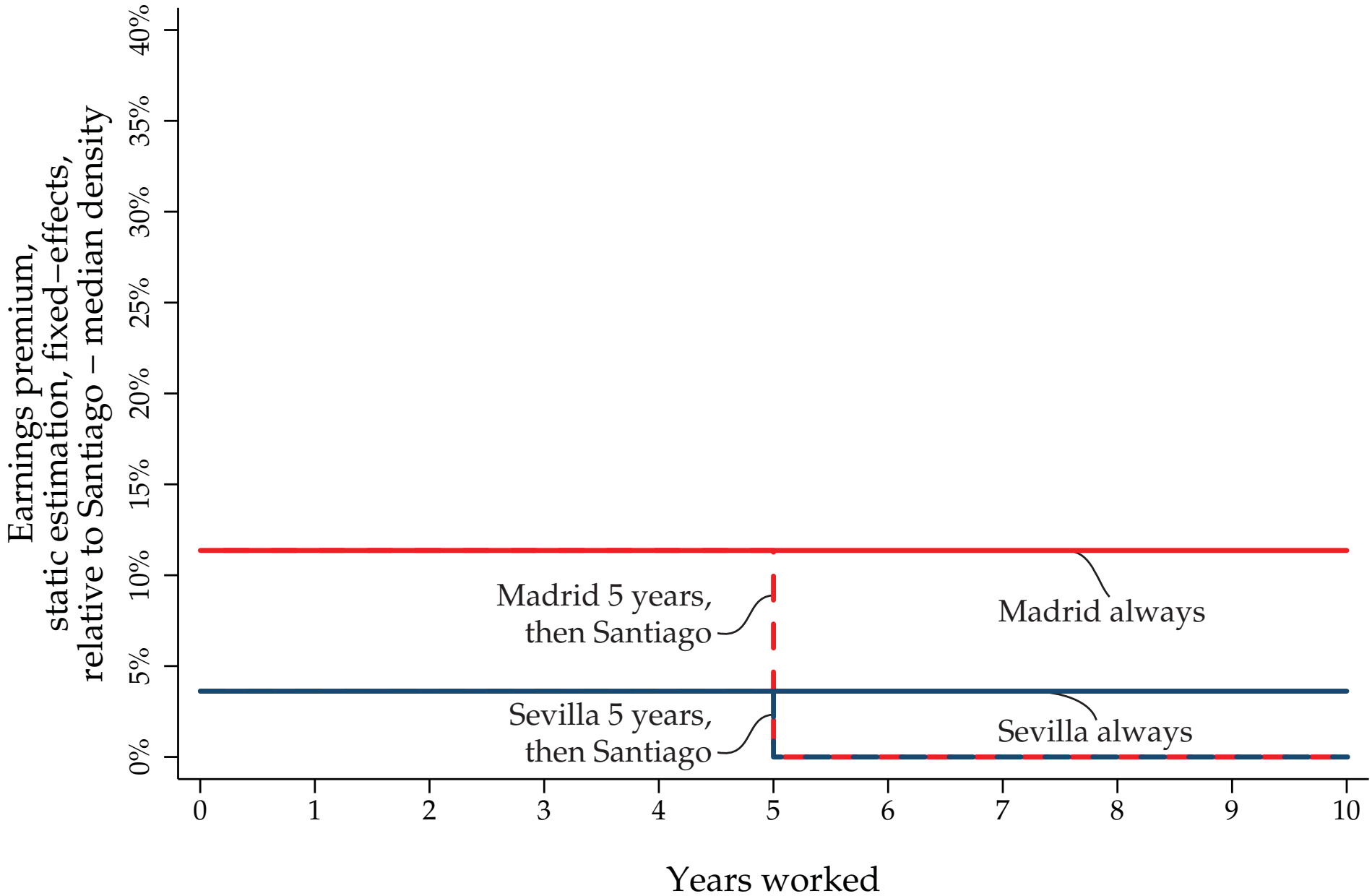
- A simple OLS regression of individual earnings on observable characteristics and urban density for France yields an elasticity of 0.05.
- Applying this elasticity to the increase in effective density resulting from a large local transport improvement is subject to 3 problems:
  1. This OLS estimate includes not just benefits of producing in a given location, also sorting and urban experience effects.
  2. This number, like most available, is estimated on the basis of cross-section variation and may not apply to time series variation.
  3. But getting a more precise estimate of the elasticity is not enough, one needs to think about micro-foundations, since not all sources will be strengthened by better transport.

Sources of the urban density premium

- Workers earn more in denser cities. This reflects:
  - Economies of agglomeration — advantages tied to the current work location.
  - The sorting of more educated and skilled workers into denser cities — innate advantages that become spatially concentrated.
  - The accumulation of more valuable experience — advantages that build over time and potentially move with the workers.



Source: De la Roca and Puga (2011)



Source: De la Roca and Puga (2011)

Learning by working in denser cities

- Faster learning in denser labour markets is a large component of the benefits of denser cities.
- For the average worker, the value of the more valuable accumulated experience in denser cities is about half of the total benefit (De la Roca and Puga, 2011).
- The value of this experience is largely portable.
- Sorting is also important, but most of it is on observables (education, occupational skills).

What components are affected by transport projects?

- A major public transport project in a large city will not increase the sorting component of the urban density premium.
  - If anything, in places where public transport is more heavily used by lower income workers, it will reduce it.
- It is also unclear how it will affect the value of portable experience acquired in a larger and denser city (plus financing issues associated with this component).
- It seems reasonable to concentrate on the advantages tied to being located in a denser location.

Cross-section vs. time series variation

- Existing estimates of the elasticity of earnings or productivity with respect to density are generally based on cross-sectional variation (i.e., they compare different cities with each other, and not a city with itself over time).
- Such estimates are meant to capture what are the advantages of locating in Paris vs. locating in Lyon (10% higher average productivity) vs. locating in Nantes (another 5%), using density or population as a simple statistic to summarize the characteristics of each city.
- They do not measure how productivity in a given city may change if people can commute more easily.
- To estimate an elasticity appropriate for project evaluation, we can
  - exploit the time dimension — but we need instances of large changes, since generally there is strong persistence in density over time,
  - or compare locations within a city affected differently by transport project — but we need to deal with endogeneity of station/route location, using IV or diff-in-diff.

Looking at mechanisms

- Aggregate elasticity of productivity with respect to density captures all agglomeration mechanisms combine.
- Not all of them will be affected by a major transport project.
- Input-output linkages are unlikely to be affected by passenger commuting infrastructure.
  - Not used to transport goods.
  - Production of intermediate inputs is increasingly located outside major urban centres (Duranton and Puga, 2005).
- Mechanisms related to labour markets more likely, but need to think of details.
  - Labour pooling, allowing labour to be more easily shifted from less to more productive firms.
  - Labour matching (e.g., public transport could alleviate spatial mismatch).
  - Will it affect face-to-face interactions and/or the value of experience (perhaps strong spatial decay makes these operate at small scales).