ECON 33550: Spatial Economics, Problem Set 1

This problem set is due Friday February 7th at 11.59pm CT. You can work individually or with a group of at most three students. Please submit one final document per group on Canvas.

Overview

The first half of the class gives an overview of quantitative spatial economics and an introduction to some of its workhorse static models. In this problem set, you will get your hands dirty and develop a quantitative model of US counties that incorporates trade, migration, and commuting.

One common definition of local labor markets used in labor economics is commuting zones—aggregations of counties chosen to minimize commuting flows. Researchers often use commuting zones to estimate the effect of some local, exogenous shocks on labor market outcomes. Yet, as Monte et al. (2018) point out, there exists no choice of boundaries for local labor markets that completely eliminates commuting. If the effects of policies depend on the ability of labor to move in response, it might be advantageous to explicitly model the spatial interactions between locations in goods and commuting markets.

This problem set has two goals. The first goal is substantive. It will help you better understand how commuting linkages moderate the economy's response to a shock or policy change. The second goal is practical. As you navigate through the problem set, you will learn how to develop and solve quantitative spatial models, how to take the model to the data, and how to perform counterfactual analyses.

The instructions below do not make prescriptions. Instead, they will guide you through choices. You are free to tailor your work to your particular interests and resources. While you are encouraged to be creative and ambitious, please be realistic about how much you can accomplish, given your time constraints.

Instructions

1. **Topic.** What is the question or policy you want to examine? Although we encourage creativity, our main goal is to make you more familiar with quantitative spatial models and give you some practice. If you have hard time coming up with an implementable idea, you can choose from the following list of topics:

   (a) Allen and Arkolakis (2014) find that the construction of the interstate highway system increased welfare by 1.1 to 1.4 percent. Their model allows for inter-county trade and migration, but does not allow for inter-county commuting. Yet, the construction of US highway system had a large effect on commuting patterns. How would the welfare estimates change if commuting were taken into account?

(b) Many European and Asian countries developed high-speed rail systems, but the US has lagged behind. Recently, there has been multiple incentives to build high-speed rail in the US. Two examples of high-speed rail projects are California High-Speed Rail and Northeast Maglev.[1] How would the construction of one of those project affect the distribution of economic activity in the US?

(c) Baum-Snow (2007) examines the effect of interstate highway system on suburbanization in the US. Using back-of-the-envelope calculation, he finds that the aggregate city population would have grown by about 8 percent had the interstate highway system not been built. Instead of back-of-the-envelope calculation, use a quantitative spatial model to estimate the effect of the interstate highway system on the population of central cities. How does the resulting estimate differ from that of Baum-Snow (2007)? What are the underlying mechanisms?

2. **Background and Diagnostic.** Why is the question or policy you want to examine important? Why is a quantitative spatial model the right tool to answer the question? Are there any particular features of the policy/economic environment that are important for the analysis? Feel free to focus on one or a few aspects that you want to study in depth and identify the underlying mechanisms, which will inform you about the key elements to be included in your model.

3. **Model.** Write down the model that directly speaks to the mechanisms you identified in the previous step. You need to specify all the building blocks and solve for the equilibrium (equilibria). Please be clear and concise, and feel free to leave tedious derivations in the appendix or cite any relevant derivations you want to lift from existing papers.

   You are encouraged to tweak or simplify an existing model, like the one in Monte et al. (2018). If you want to be more creative, feel free to select components from the "menu of quantitative spatial models" in Section 2 of Redding and Rossi-Hansberg (2017). When tweaking an existing model or building a model of your own, make sure you include only the *necessary* elements related to your proposed mechanisms. Importantly, please be aware of the time and feasibility constraints when specifying your model.

4. **Data and Estimation.** Describe the data you use to estimate the model. What variables do you need? How do you access them? How do you plan to estimate the model? For parameters that you will calibrate, justify your choices. For parameters that you will estimate, explain your strategy.

5. **Counterfactual Exercise/Policy Evaluation.** Carefully describe the counterfactual exercise (i.e., a policy that you want to evaluate) you want to examine. What is

[1] Northeast Maglev aims to connect Washington DC and New York City and reduce travel time to 1 hour.

your plan for implementing it? Are you going to fully invert the model to back out fundamentals? Are you going to use exact hat algebra to solve the model in changes?

For the purpose of this problem set, you can restrict your attention to policies that are *local* in nature (i.e., policies that target a specific county or a set of counties independently of others). If you are interested in a *non-local* policy (i.e. a policy like a construction of interstate highways that affect many counties similtaneously), you do not need to compute changes in fundamentals with high level of precision (e.g., changes in commuting costs in each county), a rough approximation will suffice.

6. **Implementation.** The preceding instructions should have helped you make all the necessary decisions before going to the computer. Now it is time to implement your plan. Estimate your model with the data you have. Perform your counterfactual exercise: solve for the responses to your proposed policy. Rationalize your findings using the mechanisms in your model.

   You are allowed to leverage resources (public data, code, etc.) from existing replication packages, but you should not share them between groups. Make sure to leave ample time for this step as there are always unforeseen hurdles that must be surmounted.

7. **Write-up.** The final document should look like an academic paper. At the minimum, it should include the following parts as separate sections:

   (a) Abstract and introduction

   (b) Background and diagnostic

   (c) Model

   (d) Data and estimation

   (e) Counterfactual exercise/policy evaluation (including quantification strategies and results)

   Please be concise.

Useful Sources

1. Replication files for Allen and Arkolakis (2014). If you look carefully, you can find (a) raster files of roads together with the code for fast marching algorithm, and (b) their estimates of trade costs with/without interstate highway system.

2. Replication files for Monte et al. (2018).

3. To estimate commuting times between counties, you can use Google Maps API and related R or Python packages. It has an option to calculate travel times while avoiding highways. We do not recommend using Google Maps to find commuting between many

pairs of counties as it can be expensive. Instead, you can use it to get a few examples and then use them to calibrate your model.

References

Allen, Treb and Costas Arkolakis, "Trade and the Topography of the Spatial Economy," *The Quarterly Journal of Economics*, 2014, *129* (3), 1085–1140.

Baum-Snow, Nathaniel, "Did highways cause suburbanization?," *The Quarterly Journal of Economics*, 2007, *122* (2), 775–805.

Monte, Ferdinando, Stephen J Redding, and Esteban Rossi-Hansberg, "Commuting, migration, and local employment elasticities," *American Economic Review*, 2018, *108* (12), 3855–3890.

Redding, Stephen J and Esteban Rossi-Hansberg, "Quantitative Spatial Economics," *Annual Review of Economics*, 2017, *9*, 21–58.