Spatial frictions

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A B S T R A C T

The world is replete with spatial frictions. Shipping goods across cities entails trade frictions. Commuting within cities causes urban frictions. How important are these frictions in shaping the spatial economy? We develop and quantify a multi-city general equilibrium model to address this question at three different levels: Do spatial frictions matter for the city-size distribution? Do they affect individual city sizes? Do they contribute to the productivity advantage of large cities and the toughness of competition in cities? The short answers are: no; yes; and it depends.

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1. Introduction

According to the classic work by Marshall (1920), agglomeration of economic activity is beneficial in three different dimensions, as it reduces transportation costs for accessing a wide range of goods, people, and ideas [Ellison et al., 2010]. The new economic geography (NEG), due to the pioneering work by Krugman (1991), focuses on the first mechanism: trade frictions for shipping goods across cities induce consumers and firms to spatially concentrate in order to take advantage of large local markets. Yet, a long literature in urban economics, dating back to Alonso (1964), Mills (1967), Muth (1969), emphasizes that such a concentration generates urban frictions within cities – people spend a lot of time on commuting and pay high land rents.

This fundamental trade-off between agglomeration and dispersion forces has been studied for decades. Among others, Fujita et al. (1999) and Fujita and Thisse (2002) analyze how firms and workers choose their locations depending on the magnitudes of – and changes in – spatial frictions. However, little is known about the quantitative importance of urban and trade frictions in shaping the spatial economy. To what extent do spatial frictions matter for the city-size distribution? By how much do they affect individual city sizes? To what degree do they contribute to the productivity advantage of large cities and the toughness of competition in cities?

Answering these questions is difficult for at least two reasons. First, one needs a spatial model with costly trade and commuting, featuring endogenous location decisions. To investigate the productivity advantage of large cities and the toughness of competition in cities, productivity and markups also need to be endogenous and responsive to changes in spatial frictions. Second, to perform counterfactual analysis aimed at quantifying the importance of those frictions, one must keep track of all general equilibrium interactions when taking the model structurally to the data. To the best of our knowledge, there exist no spatial models dealing jointly with these difficulties.

We develop a multi-city general equilibrium model to fill this gap. Our tractable model features endogenous productivity and
marks up, in line with recent approaches to monopolistic competition for a single economy or a multi-region economy without labor mobility (Zhelobodko et al., 2012; Behrens et al., 2014b; Dhingra and Morrow, 2014). Unlike these studies, however, we develop a spatial framework where workers are mobile so that city sizes respond to changes in urban and trade frictions. More specifically, holding the population distribution across cities fixed, falling trade costs or urban costs affect productivity and markups, as well as wages, in all locations. These changes, in turn, generate utility differences across cities, thus affecting individual location decisions and hence city sizes. Shocks to spatial frictions thus induce tougher competition and firm selection, as emphasized in the recent trade literature, and trigger population movements, as highlighted in urban economics and the NCG.

To build intuition we first consider an example with two cities, as is standard in the NCG literature. We find that, other things equal, the larger city has a higher average productivity and a lower average markup than the smaller city. Starting from such an initial spatial equilibrium, we then conduct two comparative static exercises which correspond to the counterfactual experiments in the quantitative analysis: “no urban frictions”, i.e., a hypothetical scenario where commuting within cities is costless and land rents therefore play no role; and “no trade frictions”, i.e., when shipping goods is not more costly across than within cities. In the former case, we find that the large city tends to become even larger, because the main congestion force disappears. This, in turn, magnifies the productivity advantage and the tougher competition there. By contrast, in the latter case, we find that the large city tends to become smaller, because local market access no longer matters, and that the small city catches up in terms of productivity and competition.

We quantify our framework with data for 356 US metropolitan statistical areas (MSAs) in 2007 and then conduct two counterfactual experiments. First, we consider a scenario with no commuting costs and land rents. Second, we analyze a scenario where consumers face the same trade costs for local and non-local products. In both cases, we compare the actual and the counterfactual equilibria to assess the quantitative importance of spatial frictions for the city-size distribution, individual city sizes, as well as productivity and markups in cities. Those counterfactuals are meaningful as they provide bounds that suggest to what extent the US economic geography is affected by urban and trade costs.

What are our main quantitative findings? First, neither type of frictions significantly affects the US city-size distribution. Even in a world where urban or trade frictions are eliminated for all cities, that distribution would still follow the rank-size rule also known as Zipf’s law. Second, eliminating spatial frictions would change individual city sizes within the stable distribution. Without urban frictions, large congested cities would gain, while small isolated cities would lose population – a pattern in line with the intuition of the two-city example. For instance, the size of New York would increase by 8.5%, i.e., its size is limited by 8.5% by the presence of urban frictions. By contrast, in a world without trade frictions, large cities would shrink compared to small cities as local market access no longer matters. For example, the size of New York would decrease by 10.8%, i.e., its size is boosted by 10.8% by the presence of trade frictions. Turning to productivity and competition, eliminating trade frictions would lead to aggregate productivity gains of 68% and markup reductions of 40%, both of which are highly unevenly distributed across MSAs. Eliminating urban frictions generates smaller productivity gains up to 1.4%. Still it leads to a notable markup reduction of about 10% in the aggregate, but again with a lot of variation across MSAs. Summing up, our counterfactual analysis suggests that spatial frictions do not matter for the city-size distribution, they do matter for individual city sizes, and they matter differently for productivity and competition across cities.

To check the robustness of our results, we first extend – following Combes et al. (2012b) – the model to encompass external agglomeration economies that affect the productivity advantage of large cities in addition to firm selection.1 We then deal with potential biases when estimating how individuals’ location decisions are affected by changes in spatial frictions. In both cases, the key qualitative and quantitative results remain unchanged: the city-size distribution is fairly stable when spatial frictions are eliminated, and productivity and markup changes are very similar to those in our benchmark.

Our analysis contributes to the empirical urban economics and NCG literatures and provides a structural estimation of an urban system model with costly trade across cities and costly commuting within cities. The quantified model allows us to assess the general equilibrium impacts of spatial frictions on city sizes, productivity, and markups. We therefore add to the recent works by Desmit and Rossi-Hansberg (2013), Ahlfeldt et al. (2015), and Brinkman et al. (2015), who also adopt a structural approach.2 The latter two papers focus on the internal structure of a single city, however, whereas the former paper assumes that trade between cities is costless. Our framework is also related to recent quantitative trade and geography models following the seminal contribution by Eaton and Kortum (2002), That literature, which includes Combes and Lafourcade (2011), Corcos et al. (2012), Allen and Arakolakis (2014), Behrens et al. (2014a), Holmes and Stevens (2014), and Monte et al. (2015), among others, has abstracted either from population movements across locations or from endogenous markups due to constant elasticity of substitution (CES) preferences.

The rest of the paper is organized as follows. In Section 2 we set up the basic model, and then analyze the equilibrium in Section 3. Section 4 describes our quantification procedure and discusses the model fit. We turn to our counterfactual experiments and examine the robustness of our main results in Section 5. Section 6 concludes. Several proofs and details about our model and quantification procedure are relegated to the appendix.

2. The model

We consider an economy that consists of K cities, with L_i individual workers/consumers in city r = 1, 2, …, K. Labor is the only factor of production. In this section, we consider consumers’ utility maximization and firms’ expected profit maximization, given city sizes L_i. In Section 3, we turn to the market equilibrium holding city sizes constant, and then analyze the spatial equilibrium in which city sizes are endogenously determined.

2.1. Preferences and demands

There is a final consumption good, provided as a continuum of horizontally differentiated varieties. Consumers have identical preferences that display ‘love of variety’ and give rise to demands with variable elasticity. Let p_i(t) and q_i(t) denote the price and the per capita consumption of variety i when it is produced in city s and consumed in city r. Following Behrens and Murata

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1 The empirical findings by Combes et al. (2012b) suggest that the productivity advantage of large cities is mainly due to such agglomeration externalities. Their results, however, rely on two identifying assumptions: a common productivity distribution for entrants in all cities; and no income effects, which allow for the separability of agglomeration and selection effects. In our model, there are both income effects and different productivity distributions for entrants across cities. Thus, our predictions are not comparable to theirs. In particular, it is a priori unclear whether agglomeration economies are more important than selection effects once income effects and city-specific productivity distributions are taken into account.

2 See Holmes and Sieg (2015) for a recent survey on structural estimation in urban economics.
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