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Geographic determinants of China's urbanization ☆

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ABSTRACT

This study exploits a unique set of satellite and other spatially explicit data to examine the role of three exogenous geographic factors in shaping and constraining urbanization: biophysical land suitability for agriculture, distance to major ports and terrain slope. The setting is China in the 1990's, the most expansive process of urban growth in history. Our empirical results suggest that these geographical factors explain nearly half of the variation in urbanization levels. However, controlling for long-run levels, we find a weakly negative relationship between agricultural land suitability and urban expansion from 1990–2000, which is consistent with the theoretical expectations that rising opportunity costs affect the development of fertile lands. We examine heterogeneity in the effects of geography using interactions with province fixed effects and, even more flexibly, with a localized regression technique (geographically weighted regression). Our results indicate that agricultural land suitability has opposing effects in different regions, for example leading to increased urban expansion in the Pearl River Delta and restricting urban expansion along the northern coast. These results should caution scholars against assuming homogeneous effects of physical geography across regions when doing empirical analysis of urban dynamics.

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1. Introduction

Many now refer to the 21st century as the urban century. The global urban population is expected to grow from 2.8 billion in 2000 to 6.25 billion by 2050 before stabilizing at the end of the century (United Nations Population Division, 2012). It is clear that much of this growth will occur in emerging Asia and Africa, however far less is known about the distribution and types of settlements that are developing in those regions. Rapid urbanization around the developing world and the trade-offs over land use have generated interest in the study of how geographic features influence the spatial distribution of urban growth. There is evidence that locational fundamentals are first-order determinants of city size rank (Davis and Weinstein, 2002). Recent research has examined the effect of geography on the timing of urban development (Motamed et al., 2014), urban activity as a function of access to primate cities (Storeygard, 2014), housing market responses to land constraints (Saiz, 2010), and how physical geography conditions urban sprawl in the U.S. (Burchfield et al., 2006). This paper employs a unique set of satellite and spatially explicit data on land quality, ports, rivers, groundwater and topography to study the impact of market access and land suitability for agriculture in determining urban location and expansion during the most rapid build-out in history: China in the 1990's. We employ a variety of econometric specifications to identify the total effect of these exogenous geographic characteristics, providing new estimates on how the biophysical landscape conditions human society.

Our work builds upon models that relate agglomeration and urban dynamics to underlying geography. Given that modern societies locate most of the labor, production, and high-productivity activity in cities, economics has long been concerned with the geographic constraints that determine the location and growth of urban areas. One feature that is extensively discussed in the literature is access to markets. The "new economic geography" tradition implicitly linked geography to the virtuous cycles of agglomeration, postulating that declining transport costs can stimulate industrial production by increasing the purchasing power of rural consumers and the market for manufactured goods (Fujita et al., 1999; Fujita and Thisse, 1996; Krugman, 1991). Importantly, the growth of the industrial sector and further reduction in transport costs ultimately

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Table 1
Urban Land Cover, by province.

Province	# 0.5-Degree grid cells	Urbanization in 1990	Urbanization in 2000	
		%	%	km sq.
Tianjin	6	14.36%	15.52%	2070
Shanghai	5	13.12%	17.88%	1877
Jiangsu	41	11.80%	13.99%	14,186
Shandong	69	11.58%	12.39%	20,057
Henan	64	9.66%	10.40%	17,039
Beijing	8	9.04%	13.50%	2563
Anhui	52	7.23%	8.02%	10,865
Hebei	77	5.94%	7.12%	12,718
Liaoning	71	5.51%	5.73%	8716
Guangdong	69	3.53%	4.24%	7303
Jilin	93	3.10%	3.18%	6533
Zhejiang	40	2.51%	3.08%	2866
Shanxi	65	2.36%	2.59%	4145
Hubei	73	2.32%	2.52%	4892
Heilongjiang	236	1.81%	1.85%	9139
Ningxia Hui	21	1.68%	1.92%	986
Hainan	3	1.68%	1.91%	656
Fujian	48	1.60%	1.73%	1874
Guangxi	89	1.58%	1.70%	4199
Jiangxi	63	1.40%	1.50%	2581
Shaanxi	82	1.28%	1.47%	3054
Hunan	72	1.09%	1.22%	2394
Nei Mongol	561	0.91%	0.93%	11,777
Gansu	166	0.68%	0.74%	3044
Chongqing	31	0.48%	0.78%	644
Yunnan	153	0.45%	0.52%	2172
Sichuan	186	0.45%	0.58%	2880
Guizhou	65	0.29%	0.34%	602
Xinjiang Uygur	735	0.25%	0.29%	4792
Qinghai	285	0.12%	0.13%	930
Xizang	463	0.01%	0.01%	128
China	**3992**	**1.57%**	**1.74%**	**168,370**

fuels a spatial re-organization as industrial firms respond to returns associated with agglomeration. A growing urban center is the product of this emerging production hub and the simultaneous migration of workers (Murata, 2008; Ottaviano et al., 2002). A somewhat distinct and long-standing body of theory emerged to explain the spatial patterns of growth within and across urban regions (Alonso, 1964; Mills, 1967; Muth, 1969), as well as the timing of agricultural land conversion (Capozza and Helsley, 1989). As with the new economic geography models, the growth of urban areas will depend on access to global and regional markets — trade will increase both the incomes of urban producers as well as potential in-migrants.

A second geographical feature relevant for urban dynamics is agricultural production potential. One strand of the literature that addresses agriculture and urban growth focuses on the transition from agricultural to industrial production, explaining the agglomeration of firms and population as a part of a multifaceted structural change described by Kuznets (1973) and Lucas (2000). When agricultural productivity rises beyond subsistence, labor is freed up for the manufacturing and service sectors, both of which achieve higher productivity in urban areas, particularly in those with access to local and global markets to competitively buy inputs and produce exports. The effect of geography in affecting the timing of structural change and urbanization was proposed by Gollin et al. (2002) and empirically tested by Motamed et al. (2014), who find that areas with higher agricultural productivity and navigable river access were more likely to urbanize sooner. On the other hand, the Alonso–Mills–Muth models and Capozza and Helsley (1989) predict that highly productive agricultural areas present a high opportunity cost to urbanization. Cities grow away from a Central Business District (CBD) and trade off benefits of urban activity (urban wages net of rent and commuting costs to the CBD) with the agricultural land rents forgone by expanding the urban area. Empirical work has measured a negative relationship agricultural land rents and urbanization, including in China (Deng et al., 2008).

The question of how geographical features constrain urbanization is particularly relevant for China, where contemporary economic reforms have catalyzed urbanization at an unparalleled rate. China added more that 150 million inhabitants to its cities between 1990–2000 and another 452 million are expected between 2000 and 2030 (United Nations Population Division, 2012). As Table 1 shows, by 2000 six provinces had urbanized over 10% of their land area (Shanghai, Tianjin, Beijing, Jiangsu, Shandong, Henan). The first three have smaller land areas but competing interests for land use has already led to social tension. The latter three are much larger provinces and their high percentage of urban land cover implies larger impacts of land use change on agriculture and ecosystems. At the national level, China's urban areas covered 1.74% of land by 2000, as compared to 1.92% in 1992 in the United States (Burchfield et al., 2006). Given China's ongoing structural transformation and the fact that its population is four times that of the U.S., urban land cover is likely to expand significantly in the coming decades.

Among policymakers, attention has been paid to determining the optimal location for urban growth within the country as well as preserving farmland around rapidly growing urban centers. A growing literature has examined China's urbanization processes and the policies that regulate them (Ding and Lichtenberg, 2011; Lichtenberg and Ding, 2008). Deng et al. (2008) test and confirm classic predictions from urban economic theory about what drives the spatial structure of urban growth, including the role of agricultural land value. Our paper extends this line of inquiry by studying the role of exogenous physical characteristics affecting agricultural potential, providing an alternative to some of the measures used in the literature that are likely endogenous to urban processes. Au and Henderson (2006a) examine the relationship between worker output and the spatial size of cities, finding that China's cities appear to be undersized relative to the optimum. Other studies have looked at the impacts of political incentives (Lichtenberg and Ding, 2009) and institutional constraints such as the Hukou system (migration restrictions) on China's process of urbanization (Au and Henderson, 2006b; Bosker et al., 2012). Ongoing work focuses on the effects of transportation infrastructure on city population decentralization (Baum-Snow et al., 2015) and on incomes (Banerjee et al., 2012; Faber, 2014).

This study contributes to the literature by exploiting a unique set of satellite and other spatially explicit data to examine the role of three exogenous geographic factors in shaping and constraining the location of China's new urban lands: biophysical land suitability for agriculture, distance to major ports and terrain slope. Our empirical results suggest that these three factors explain around half of the variation in urbanization levels in China. However, controlling for urban levels in 1990, we find a weakly negative relationship between agricultural land suitability and urban expansion from 1990–2000, which suggests that the opportunity cost of developing fertile land is not negligible. Our parsimonious model of geographic constraints does not account for many possible omitted variables. We address the possible impact of confounding variables through a variety of additional specifications: controlling for other geographical variables emphasized in related empirical work, controlling for long-run levels in a growth specification, controlling for major policy changes, adding province fixed effects, and examining heterogeneity at the province level and with a localized regression technique (geographically weighted regression, discussed in the online appendix). Our results suggest that agricultural land suitability has opposing effects in different regions, leading to increased urban expansion in the Pearl River Delta and restricting urban expansion along the northern coast. These results should caution scholars against assuming homogenous effects of physical geography across regions when doing empirical analysis of urban dynamics.

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