Warehouse location choice: A case study in Los Angeles, CA

Sanggyun Kang [1]

[1]University of Southern California, Sol Price School of Public Policy, Los Angeles, CA, USA

Abstract. During the last decade, the logistics industry has reprioritized from storage to throughput in order to move large volumes of goods more frequently and reliably. Concurrently, the warehousing industry has built large and automated facilities on the periphery of metropolitan areas. This spatial shift is attributed to inventory and transport cost trade-offs, in which the gains of low land prices and lower per-unit inventory costs from economies of scale outweigh the increase in transport costs that result from locating further from urban markets. I use the framework of firm location choice and hypothesize that (a) the logic of location choice varies with respect to the facility size and (b) the logic has changed over time. I evaluate the location choice of 5,364 warehousing facilities built between 1951 and 2016 in the Greater Los Angeles area. Results suggest significant differences in the effect of location choice factors over facility size and over time. For warehouses built before 1980, the most influential factors affecting location choice are local market, labour, seaport/intermodal terminal proximity. In contrast, for warehouses built after 2000, lower land price and airport/intermodal terminal proximity have the greatest effects.

1 Introduction

The purpose of this research is to understand how and why warehouses have decentralized over time from central urban areas to the periphery by examining the location choice of warehouse owners/developers. The location of a warehouse, as part of a supply chain, is strategically chosen based on "productivity enhancing location attributes" [1] (pp. 1262). A change in warehouse location suggests that profit maximizing location attributes have changed. For instance, as a new facility is relocated farther from the urban centre, the gains of lower land prices and lower per-unit inventory costs from economies of scale and automation offset the increase in transport costs. In this way, logistics operators may internalize the cost savings of facility relocation, but any increased negative impacts from more truck travel will be incurred by the society.

This paper evaluates trends in the location choice of existing warehousing facilities that were built between 1951 and 2016 in the Greater Los Angeles region. I use the conceptual framework of firm location choice and estimate a discrete choice model with facility and location attributes as independent variables. Results suggest significant differences in warehouse location and location choice factors over time. Warehouses built after 2000 have prioritized lower land price and proximity to airport and intermodal terminal over local market access. It is a significant shift from location choice factors for warehouses built before 1980 (proximity to local markets and seaport).

2 Research Approach

The literature on warehouse location and decentralization suggests that the processes of logistics restructuring have led to the establishment of large distribution centres in the periphery of urban areas. To empirically evaluate this transition in facility size and location, I adopt the conceptual framework of firm location choice. The characteristics of a warehousing facility that a logistics firm or developer demands, in conjunction with those of a chosen location, constitute an unobservable structure of business costs, which, in turn, influence the probability that the firm establishes a warehousing facility on the location [2-6]. Likewise, if the characteristics of a facility are different, the facility's location choice will also differ. In the case of W&D decentralization, we observed both the change in facility characteristics (larger facility size) and the change in location decision (urban outskirts). These shifts have occurred as cost trade-offs, in which the cost benefits of lower land prices, scale economies, and facility centralization outweigh the increase in transport costs [7-10]. Thus, I hypothesize that (1) the characteristics of a firm's demand for a facility (*size*) and the characteristics of a location (*land price, proximity to the nearest local market, proximity to the nearest trade node, and labour force access*) jointly influence the cost structure and ultimately the probability that a given location is chosen and that (2) this logic of location choice has changed over time.

I estimate the location choice in multiple time periods separately and formally compare estimated parameters across the periods [11]. I expect that estimated parameters of the location attributes differ significantly over facility size and over time.

3 Data and Model Design

This paper is a case study of the recent warehousing location choice in the Los Angeles combined statistical area, CA, USA. The warehousing location data are from CoStar, a real estate database which includes commercial and industrial real estate listings. The database provides rentable building area, year of construction, and each facility's address, by which the exact location and the location's characteristics can be identified.

I use 5,364 listings of logistics facilities, which are classified as warehouses, truck terminals, distribution centres, or cold storage facilities. Similar facilities coded under manufacturing or retail trade sectors are not included. The minimum rentable building area is set as 30,000 ft^2. The built year ranges from 1951 to 2016.

The CoStar database has an important limitation. The primary purpose of the database is to provide real estate agents with up-to-date property listings. Hence, the dataset used in this paper includes only those facilities active at the time of data retrieval in early 2016. CoStar does not keep records of facilities that are currently unavailable. Because of this limitation, I conduct a cross-sectional evaluation of the location choices of existing warehousing facilities (early 2016) and use the location attributes of 2016.

As an independent variable, I use an interaction dummy of facility size. The size, as rentable building area, ranges from 30,000 to 1,800,000 square feet; I divide into three categories: small (30-100k), medium (100-300k), and large (over 300k). The division is arbitrarily made based on the sample distribution. Using the sample methodology, I also divide the sample into three time periods using the facility built year: stage 1 (1951-1980), stage 2 (1981-2000), and stage 3 (2001-2016). Figure 1 presents the spatial distribution of warehousing facilities.

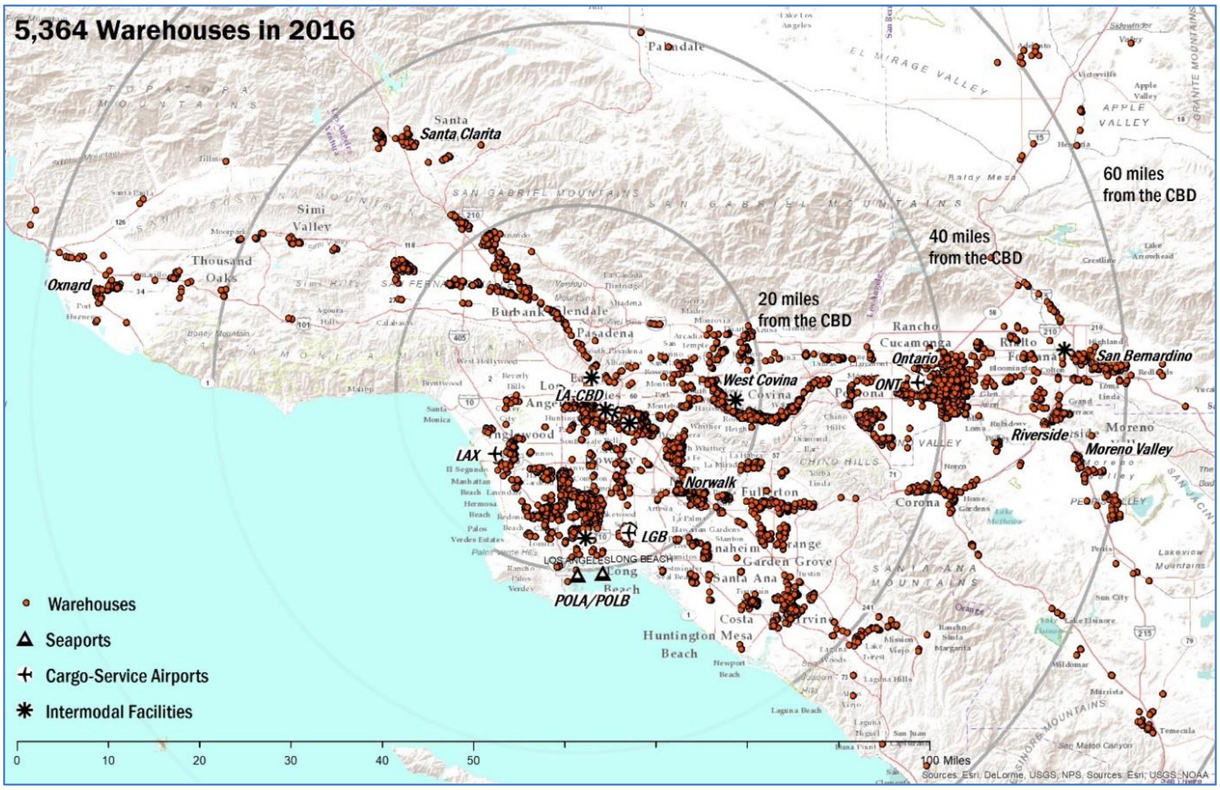

Figure 1. Spatial distribution of 5,364 warehouses and trade nodes

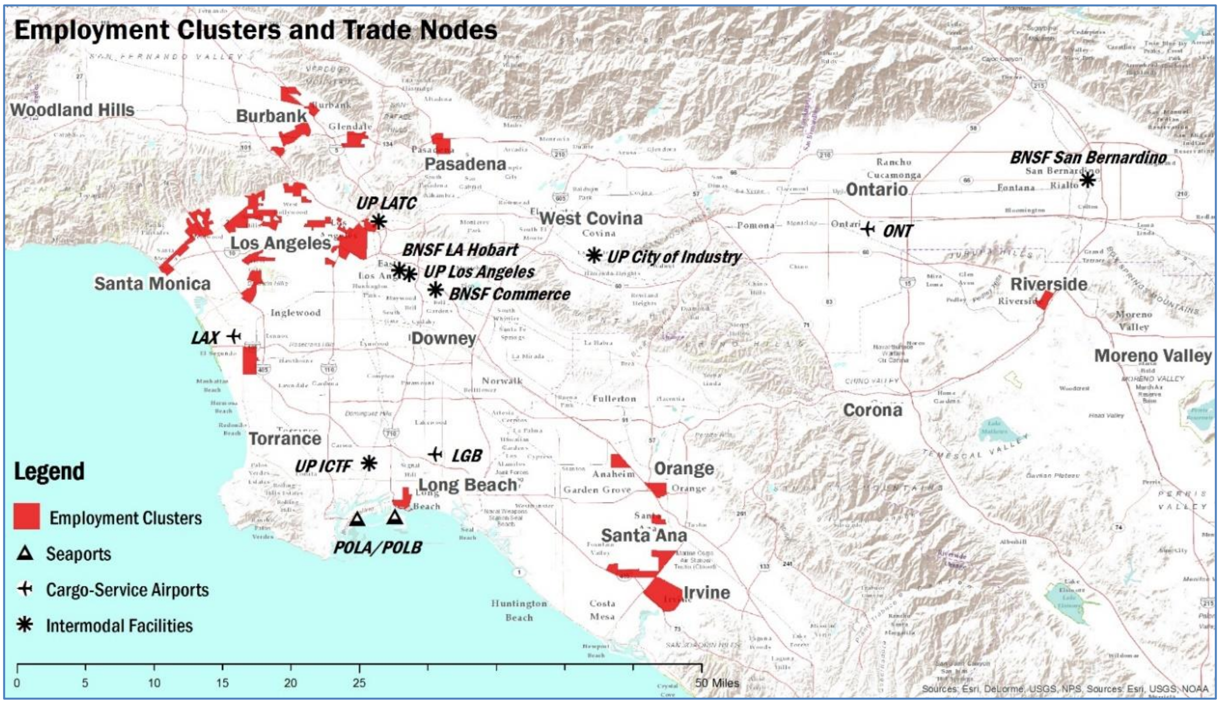

Figure 2. Distribution of employment subcenters and trade nodes (close-up of the region)

There are 3,920 census tracts in the Los Angeles CSA, but only 660 have at least one warehousing facility. From this universal choice set (G) of 660 census tracts, I draw nine random choice alternatives per chosen alternative to form a choice set of ten (5,364 x 10 alternatives = 53,640 observations). I use 10 choice set alternatives (a typical number), because the size of a choice set does not influence estimation results [12, 13]. The location attributes used in this analysis are: land prices (population and employment densities), proximity (PM travel time) to the nearest local market (as an employment subcenter [14]), proximity to the nearest trade node (airport, seaport, intermodal terminal, and highway exit), and labour force access. Figure 2 presents the distribution of employment subcenters and all trade nodes.

4 Results

I estimate models of warehouse location choice for three time periods (1951-1980; 1981-2000; 2001-2016). The first set of models excludes interaction terms for facility size (Model 1-1, 1-2, and 1-3), whereas the second set of models includes interaction terms for facility size (Model 2-1, 2-2, and 2-3). The interaction term identifies the varying preferences of warehouse location by facility size (small, medium, and large warehouses). Also included are tests of whether the difference in estimated parameters across time periods is significant. If the chi-square statistic (χ^2) is greater than 3.841, the difference is significant at $P < 0.05$. Model structure is presented in Table 1.

Table 1. Model Structure

Period	Warehouses built in…		
	1951-1980	1981-2000	2001-2016
Without interaction terms	Model 1-1	Model 1-2	Model 1-3
With interaction terms	Model 2-1	Model 2-2	Model 2-3

Estimated parameters of multinomial models excluding or including interaction dummies are very consistent. Land price measures work in two directions: as a push factor, the effect of population density has become more intensified, especially for large warehouses, whereas, as a pull factor, the effect of employment density has diminished substantially over time. Labour force access has been an important and stable location factor over time. Local market proximity and seaport proximity are two significant deterrents for warehouses built in 1981-2000 and 2001-2016. On the contrary, airport proximity and intermodal terminal proximity are two important location determinants particularly for large warehouses built in 1981-2000 and 2001-2016. It is notable that the difference in location choice attributes between 1951-1980 and 1981-2000 is far greater than that between 1981-2000 and 2001-2016. Overall, the transition in the effect of location attributes on warehouse location choice is as expected that large warehouses in 2001-2016 have been established in locations with lower land prices, lower access to local markets, yet better access to airport and intermodal terminals.

This finding suggests a potential decrease in facility and inventory costs from the lower land prices, economies of scale, and inventory consolidation. Savings in transport costs are unclear, because warehouses moved away from local markets to trade nodes. The increase or decrease in transport costs depends on the function of a facility within goods supply chains, which is unknown.

5 Discussion

These results raise two important research questions for future research: 1) what is the potential impact of the concentration of large-scale warehousing facilities in an inland area of the region; 2) will present or future logistics restructuring result in different location patterns?

First, over the last decade, there has been a substantial increase in the number of large-scale distribution centres in the San Bernardino-Riverside area (approximately 100 km from Los Angeles). For example, 333 facilities (6.2% share of total) in SB-Riverside have supplied a total of 97 million ft^2 of warehouse floor area (14.5% share of total), and 85% of the floor area (209 facilities, 83 million ft^2) have been constructed since 2001. The average size is approximately 400,000 ft^2, more than three times the average size of all warehouses (125,000 ft^2) of the region. Given that warehouses are major truck travel attractors, it is important that potential negative externalities on the community are carefully examined.

Recent developments in warehouse management systems and the rise in e-commerce and online shopping may change the location determinants of future warehousing facilities. So far, the development of the state-of-the-art distribution facilities has sought the location determinants documented in this study. In January, 2017, Amazon, a leading online shopping company, promised an expansion of their supply chain capacity with an air cargo hub in Kentucky for fast, reliable delivery speeds [15]. Also, in the Greater Los Angeles region, the company has built multiple fulfilment centres, which have apparently unique facility and location characteristics: very large-scale, high-tech facility with direct access to the local market and an air cargo hub. The expansion of facilities and changes in logistics practices might have entirely changed the geography of urban freight movement. Therefore, an evaluation of whether these changes are a problem worthy of planning/policy intervention is necessary.

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