# APPROXIMATING THE RELATIONSHIP OF URBAN FORM AND OUTCOMES USING PHYSICAL DEVELOPMENT AND SMALL BUSINESS SECTOR DATA

by

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# Abstract

The paper explores the relationship between urban characteristics and urban outcomes by introducing new instruments to the literature. A theory supporting the relationship between the physical development patterns of agglomeration economies and the size of the small business sectors that operate within them is introduced, and it presents an empirical investigation of the relationship. The paper finds that the results do not contradict the theories found in the literature, however these results also suffer from the same simultaneous causality issues that have affected earlier instrumentation in the literature.

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# Contents

# 1 Introduction

It is quickly becoming apparent that cities are the building blocks of success for 21st Century economies. In order to have a successful national economy, modern countries must contain successful local economies. In pursuit of fostering successful local economies, it is essential to identify the drivers of local economies which can be influenced by government. This paper concerns itself with the policy decisions influencing the market for urban space. Its goal is to contribute to the understanding of policy levers available within the market for space in urban environments, particularly choices of development intensity and scale, as well as their effects on the local economy.

The research presented herein is primarily concerned with the effects of choices regarding urban built form. Its contribution is to introduce to the economic literature a theory of how local land development decisions can affect the economy. This objective is accomplished by investigating the relationship between the breadth and depth of physical development and the size of the local Small and Medium Enterprise (SME) sector. The empirical work here does not bare fruit[1]; however, it serves to identify data sources and expose their limitations. It is a recurring theme in agglomeration economics that research explores and exhausts possible methodologies of demonstrating the relationship between local characteristics and economic outcomes.

In fact, there exists a large body of literature on urban economics. Many economists have spent time investigating the productivity of cities. Much of the early economic research is focused on a "chicken or the egg" hunt to explain whether clustering individuals or firms are responsible for the productivity increase that is observed in urban environments. Largely, it appears to be the case that an endogeneity problem prohibits direct identification of an answer to the question. There is no dominant strategic choice between prioritizing firms or individuals in policy.

[1]Tangentially, in this context both "bare" and "bear" are applicable verbs as the investigation neither uncovers nor yields "fruit", a metaphor for results. My thanks to Shelly Kaushik for this discussion.

In the agglomeration economics literature, problems of endogeneity, particularly simultaneity, appear to occupy a large portion of research efforts. To date, the search for instruments that explain the relationship between agglomeration characteristics and the local economy has yielded limited results. The literature has demonstrated the application of measures of local economic productivity, employment, and innovation. All of these avenues of exploration have raised concerns of accuracy, appropriateness, and endogeneity – economists struggle to find instruments that do not scale directly with city size. It cannot be stressed enough that economists continue to collaborate in a search for improved instrumentation in the field of agglomeration economics.

Specifically, papers have studied variations in labour markets, knowledge dissemination, transport systems and firm location and there does not seem to be a consistently dominant factor in determining the outcomes of cities. It is apparent from the literature that there exists a trade-off between the benefits of proximity and the drawbacks of congestion. The literature, for all its inconclusiveness, does not leave room for uncertainty with regards to one important issue: all cities are not designed equally. It is made apparent by the efforts to explain variation in productivity that there exists characteristic variation between urban centres, the challenge lies in describing their relationship.

It is the contention of this paper that the variation is driven, in part, by structural frictions which can be influenced by urban design choices. The literature has not performed much exploration of the economic consequences of decisions about urban form. This paper presents an empirical investigation into how urban geography, using new data from the National Land Cover Database, may influence the health of the local SME sector.

It is, to my knowledge, novel in agglomeration economics to leverage SME data as an instrument for urban economic health. It is introduced here due to demonstrated desirable characteristics for instruments in agglomeration economics. First,

it is positively correlated with macroeconomic health in developed economies. Second, it addresses issues of assignment identified in knowledge instruments while still being positively correlated with them; SME statistics are, by definition, localized, and therefore they cannot be wrongly assigned to distant locations of parent companies. Finally, there is reason to believe that agglomerations provide SME sectors with the opportunity to expand in response to market forces relatively unconstrained. For these reasons, this paper presents an exploration of SMEs an instrument for the health of agglomeration economies.

This work introduces new data for the instrumentation of both urban form and urban outcomes. The paper provides an investigation into the characteristics of these instruments and a discussion of their limitations. As is the case with existing research, problems of simultaneous causality raise questions of endogeneity within the empirical exercise; however, it endeavours to move the discipline forward nonetheless by introducing new ideas. This research emphasizes the need for further investigation into agglomeration economies in order to inform place-making policies that aim to maximize the net benefits between proximity and congestion in urban developments.

This paper is divided into seven sections. The proceeding section endeavours to review the existing literature to provide motivation for the subsequent study. Afterwards, the third section presents arguments for key factors in both scoring and determining the outcomes of urban environments. It is followed by the fourth section, which describes the new data which will be relied upon for demonstrating the established relationships. Subsequently, the fifth section presents the results of the data fitting exercise. A discussion of the policy implications that arise from the results is presented in the sixth section. Finally, the seventh section concludes the exercise with a discussion of the work that is demonstrated in the paper.

# 2 Literature Review

The review of the literature is subdivided into four sections. The first subsection presents an overview of the search for drivers of agglomeration highlighting the issues of geographic advantage, firm selection and scale effects. Afterwards, the second subsection provides an overview of the methods of qualifying urban economic performance that have been used previously in academic research including productivity, and measures of knowledge creation, and the known problems of relying upon these methods. Subsequently, the third subsection presents the evidence which supports the use of the status of SMEs as a potential instrument for local economic prosperity in developed economies. Finally, the fourth subsection discusses the research on the determinants of urban economic health, identifying a space for geographic composition in the investigation.

## 2.1 The Drivers of Agglomeration

Cities have been a feature in societies for thousands of years, and measures of their prosperity are of perennial interest. However, the economic rationale for the co-location of individuals is not as self-evident nor is the debate settled as to the determinants of their prosperity. In fact, there are two major competing economic theories for human agglomeration behaviours (Strange 2009). One theory is that human agglomeration occurs around particular geographically advantageous locations. The alternative theory is that human agglomeration itself leads to increased prosperity for the participants, there exist economies of agglomeration. A second more lively debate in the economic literature focuses on whether these benefits arising from agglomeration are a function of increasing competition between firms who co-locate in these agglomerations or whether the benefits are a function of the geographic proximity of the inhabitants. It is unapparent that a single distinct winner can be identified.

There is no definitive argument for a single driver of human agglomeration behaviour; however, results from the research demonstrate that geographical traits cannot completely explain agglomeration behaviour. In the literature, it is evident that although there likely exist some inherent advantages in geographies, the existence of agglomeration economies is virtually undeniable (Glaeser and Gottlieb 2009). Further, the article dismisses the absolute importance of geographic attributes, noting that with decreased inland marine transport there would be no purpose in developing agglomerations located along tributaries. The phenomena of continued development is observed globally, as the major urban areas in France and Japan, originally selected for their access to waterways, have retained their size relative to other metropolitan areas as they grow over time (Eaton and Eckstein 1997). These findings empower the assumption that, although geographic advantage may determine the original selection of a settlement, human agglomeration is related to economies of agglomeration.

In order to support economies of agglomeration with the objective of maximizing local economic prosperity, it is important to determine the source of the gains from agglomeration. One theory of the gains from agglomeration is that they arise from firm selection. This theory suggests that the co-location of firms drives competition which strengthens firm quality in these urban centres (Winter 1971). However, it has been demonstrated through nesting the model of a firm within a model of the urban economy, inference can be drawn about the relative affects of selection and agglomeration (Combes et al. 2012). In this article, Combes et al. demonstrate through empirical application that firm selection cannot explain the varying productivity levels between regions. The rejection of firm-selection as the sole determinant of economies of agglomeration does not mean that it cannot play a part, merely that the theory does not provide a complete explanation.

For further explanation of economies of agglomeration, the research turns to evaluation of the alternative benefits to co-location. The introduction of the concept of a

"new economic geography" represents a watershed moment in the study of urban economics (Krugman 1991). The paper identifies the motivation for co-location of firms as a variety of factors including access to demand and supply, increased scale economies and decreased costs of delivering goods to market. Some have echoed this sentiment by demonstrating the increased quality of labour matching in urban economies (Wheeler 2001). Even still, other works have identified the role of human agglomerations as decreasing the barriers to knowledge transfer in the economy (Sedgley and Elmslie 2011). The latter explanation gains additional clout as urban agglomerations continue to grow while the costs of transporting goods decreases (Glaeser 1998). All of these results suggest that human agglomeration leads to economies of agglomeration which coexist with the gains from firm-selection.

Overall, several items about agglomeration effects seem apparent from the literature. Firstly, it seems evident that agglomeration yields economic benefits beyond those created by local geographical features. Secondly, there exist some degree of firm selection effects that contribute to these agglomeration economies, but that these effects do not sufficiently explain the gains. Thirdly, some of the effects beyond firm selection are intrinsic to the clustering of humans within these agglomerations. There is economic value associated with human agglomeration that extends beyond the individual; the existence of this agglomeration externality is important, as it suggests there may be a need for policy which drives human clustering to efficient levels.

## 2.2 Quantifying Urban Economic Performance

In order to measure the capacity of governments to push the market towards an efficient equilibrium, it is important to determine a relative measure of agglomeration performance. In the literature, there have been two measures explored extensively, in a number of variants, with the goal of measuring the relative agglomeration economies of different human agglomerations. The first metric that is often considered is pro-

ductivity; it is fairly intuitive that a productive human agglomeration is a prosperous one. The second measure that is commonly employed is knowledge creation; again, it is fairly intuitive that a human agglomeration which is actively creating human capital is likely to be economically successful. However, both of these metrics have advantages and disadvantages that must be better understood to appreciate the difficulty of analyzing human agglomerations.

There is a good case for productivity as a measure of the relative agglomeration gains. If human agglomeration increases economic prosperity through firm selection, scale economies or decreased exchange frictions, it follows that these markets should be more productive. Research suggests that these cost reductions may exist in the markets for goods, people or ideas, but, regardless of the area of impact, it must be the case that an endogeneity problem is created by this relationship (Glaeser 1998). If researchers wish to investigate the relationship of population and productivity, the authors conclude that it cannot be done through direct analysis. The use of instruments for productivity is complicated as most urban factors scale proportionally as urban centres grow. Therefore, it is difficult to study the levels of urban performance in response to other policy variables through observation of productivity.

A category of alternative instruments to productivity that has garnered a lot of research interest is knowledge creation, or innovation. As a dependent variable, measures of innovation in the economy are studied in a variety of forms. A review of the literature identifies multiple instruments for measuring innovation: research and development investment, patent creation, and new product creation (Carlino and Kerr 2014). In their review of the literature, Carlino and Kerr demonstrate that choosing an instrument raises issues associated with each type of data: research and development data does not capture the efficiency of knowledge creation; patents are not sorted by their merit nor do they capture innovation, only invention; finally, new product creation is flawed due to a bias of data recording and an omission of non-

product innovation fields. A review of the literature indicates knowledge creation metrics are an imperfect measure of agglomeration economies.

Overall, it is unrealistic to conclude that there is a perfect measure of the success of agglomeration economies. The literature demonstrates the limitations of productivity as a meaningful statistic to quantify the effects of potential determinants on prosperity pertaining to issues of endogeneity and size effects. Further, there are well documented issues with regards to leveraging data on knowledge creation that relate to the absence of a statistic with complete balanced coverage of knowledge creation across fields. It has been a characteristic in the literature of agglomeration economies that research proposes and evaluates the viability of new instruments, frequently with limited success. As such, there is motivation to explore and critique new measures of the relative prosperity of urban regions.

## 2.3 Research on Small and Medium Enterprises (SMEs)

There is a case to be made that a suitable metric for the health of an economy is the strength of its smallest components. Small and Medium Enterprises (SMEs), firms with labour forces that are below a specific threshold, have often been viewed in the literature as such an indicator of the health of the economy. In advanced economies, the departure of manufacturing from urban areas creates a void that could be replaced by SMEs. The case can be made that these SMEs, with access to a large pool of workers and a low cost of market delivery, are exactly the types of firms that generate innovations in the agglomeration economy. There is evidence to support all of these phenomena.

Research has made a sizable effort to document the relationship between SME sector health and the health of the larger macro economy. A general study of the relationship suggests that there exists a positive relationship between SME sector size and economic growth, but no strong evidence of a relationship between SME sec-

tor size and poverty alleviation (Beck, Demirguc-Kunt, and Levine 2005). However, when the nations studied are subdivided into developed and developing economies the results change (Cravo, Gourlay, and Becker 2012). The relationship between SME sector performance and the health of the economy at large in developing nations is generally concluded to be negative or insignificant (Van Stel, Carree, and Thurik 2005; Wennekers et al. 2005). In contrast, investigation into the ties between SME sector health and economic prosperity within developed nations show a positive correlation (Audretsch and Keilbach 2004; Mueller 2007). In limiting the research to industrialized economies, there is evidence that strong SME performance can be closely tied to the health of the larger economy.

With respect to the determinants of SME health, empirical evidence supports the existence of relationships between the attributes of agglomeration and the economic performance of SMEs. The role of knowledge in the size of the SME sector at a national level has a demonstrated positive relationship (Petrakis and Kostis 2015). Petrakis and Kostis further demonstrate that growth of the SME sector has a positive endogenous relationship with the level of trust in the economy. It has also been observed in many national studies that SMEs play an important role in the level of job creation in the economy (Schreyer 1996). It stands to reason, if SMEs benefit from access to locations with high concentrations of knowledge, their presence should also be a good indicator of the level of knowledge in the economy. Similarly, if SMEs strongly impact the level of job creation in the economy, it would be rational behaviour for these firms to locate in areas with proven positive matching externalities. Given these arguments, it follows logically that SME location should be positively correlated with both advanced knowledge creation and productivity potential within agglomeration economies.

Theory also suggests that there is potential for SMEs to integrate relatively easily within urban agglomerations; in industrialized economies, a depleted manufacturing

core in urban agglomerations has created a space for SME sectors to thrive. The theory purports that modern cities are characterized by economic specialization, containing a high concentration of particular sectors (Sassen 2009). Sassen contends that urban economies now house specialized services and urban manufacturing centres which function as complements to the advanced national sectors, supporting the economic activities of firms which serve customers both inside and outside of the urban environment. The theory ultimately boils down to the notion that cities are the locations for specialized shared services and nascent firms who benefit from leveraging the new economic geography. For the former group, their customers are businesses that require these specialized services but for whom the activities are outside of their own core production specialization; for the latter, their choice of location is a function of access to markets for labour, knowledge and demand that are bolstered by agglomeration.

Regarding business-specific firm location choices, the literature makes another important contribution. The literature finds evidence that the locational choice of extremely small SMEs is relatively non-permanent as these firms are often established by local entrepreneurs and are frequently subject to relocation when these firms outgrow their locale (Van Noort and Reijmer 1999). This finding is important as it suggests that firms of the smallest size may not be a good indication of an agglomeration's relative appeal. It is important to consider the size of the SMEs within the empirical investigation.

From the literature, there is a strong argument SME location choices being a response to positive agglomeration traits. It has been demonstrated that SMEs are a strong indicator of overall economic health in developed countries. There are also demonstrated relationships between the health of the SME sector and common alternative metrics of urban economic performance which suggest it may be an appropriate instrument for urban economic success, particularly as a substitute for levels of knowl-

edge creation and productivity advantages. Perhaps most importantly, theory suggests that there should be ample room for SMEs to locate within agglomerations, and a sizable customer base to sustain their business activities while cautioning against the treatment of all sizes of SMEs as equals. As such, SME locational choices may be a strong indicator of the attractiveness of an urban agglomeration relative to its peers when treated carefully.

## 2.4 Determinants of Economic Health for Urban Regions and SMEs

It is important to consider what factors can logically be associated with the relative attractiveness of a particular urban agglomeration, and in designing human agglomeration, the research does highlight key elements for prosperity. Principally, research suggests that the relative success of a human agglomeration is determined by the gap between the benefits of agglomeration and the costs of congestion (Gill and Goh 2010). Much has been said in this literature review about indicators of the benefits of agglomeration and their linkages; the level of human capital, the size of the labour force, and the number of firms all correlate with the level of prosperity. However, attention is due to the factors that contribute to the local levels of agglomeration and congestion effects.

Perhaps one of the most literal forms of congestion within urban agglomerations is traffic congestion. Principal externalities of traffic congestion identified in one study include air pollution and increases the real intra-city distance (Timilsina and Dulal 2011). The authors identify fiscal, regulatory and investment policy tools that correct these externalities; specifying regulatory policy as the effective corrective measure for pollution (and pushing the issue beyond the scope of agglomeration-level governance). This implies that agglomeration-level efforts, and therefore policy differences, would be found in the measure of real intra-agglomeration distance. One can think of traffic

congestion as something decreasing the effective proximity of the group, which is where theory suggests the gains from agglomeration arise.

In the literature, it has been demonstrated that proximity has a direct relationship with location choices of firms. In a study of sub-centres of Chicago, it was shown that firms and people are more likely to cluster around transportation hubs (McMillen and McDonald 1998). The authors demonstrate this co-location behaviour is distinct from clustering behaviour that is driven by industry specific agglomeration effects. Coupling this result with what has been discussed previously, there is reasonable ground to posit that intra-agglomeration distance affects prosperity. Intra-agglomeration real distance is a measure of the gap between the physical proximity and congestion effects, or effective proximity.

Closely related to effective proximity, is the concept of agglomeration space management. The effects of space allocation within an agglomeration are not limited to determination of relative internal distance; space allocation can also have effects on property values and determine the quantity of public goods within the agglomeration (Bolitzer and Netusil 2000). Bolitzer and Netusil demonstrate that the proximity to open-space has a positive relationship with property values, concluding that open-space access benefits outweigh the additional costs of congestion created by commuters accessing the area at the micro-level. There does not appear to be any conclusive evidence, to date, that this relationship extends to the agglomeration level. The existence of a structured relationship between space-management and agglomeration outcomes would have interesting implications for agglomeration-level policy priorities.

It stands to reason, that if there is a relationship between agglomeration-level policy on open-space and agglomeration outcomes, consideration must also be given to agglomeration-level and super-agglomeration-level policy. Case studies on the effects of policy in a particular jurisdiction do exist in the literature. In a long-run study of the place-making policy initiatives of the Tennessee Valley Authority, it is found

that public infrastructure investments in the area had positive long-run effects on the growth of manufacturing in the region (Kline and Moretti 2013). The authors estimate that, contrary to previously held beliefs about agglomeration policy having a zero-sum effect on the macro-economy, the infrastructure investments yielded a long-run growth increase in the national economy that exceeded the costs of implementation. The positive macroeconomic effects of infrastructure investments contrast the ambiguous or negative effects of discretionary policy that has been found in the literature (Neumark and Simpson 2014). The authors review multiple studies that find local policies which favour particular members of the economy often create both positive and negative externalities, and that the net effect is often ambiguous. It follows as a logical supposition that place-making policies which strive to improve the agglomeration as a whole are more likely to have wholly positive effects than those which strive to pick winners.

In conclusion, it appears that there are qualities to prioritize in investigating the determinants of agglomeration prosperity. From the literature, it is well established that there is a relationship between agglomeration returns and the local levels of firms, people and knowledge. Extending beyond these well established linkages, the literature sows the seeds for investigation into the relationship between real distance, space management, and legislative decisions and agglomeration outcomes. The literature does not appear to relate these policy effects on agglomeration-level outcomes. Note that all of these factors share a common linkage - each relates to the built geography of an urban agglomeration. A study of geographic factors as they relate to urban outcomes is not readily found in the literature to date.

# 3 Theoretical Model

I propose a model for the market for firm location where the designers of metropolitan areas compete to attract businesses to their agglomeration. Assume that the supply of businesses grows over time as more viable economic opportunities are created, and that new businesses must make a location decision before they can begin production. It is designers' objective to increase the attractiveness of their city in order to attract these new businesses. Simply, metropolitan areas work to maximize the benefits of their city and new businesses then choose the location which maximizes their profitability.

In this model, the success of a business is a function of the quality of the workforce and the benefits of agglomeration in their location. The quality of the workforce is assumed to be exogenous to the designers of the metropolitan area (which is demonstrated in the literature by findings suggesting these attributes are a function of higher levels of government). In contrast, the benefits of agglomeration are directly influenced by the physical development decisions of the designers.

Suppose that physical development decisions can be simplified to a two-dimensional choice for designers. Physical development within an agglomeration can expand in range and intensity. Expanding the range of development leads to an increase in the total built area, $A$, of a community, while increasing intensity, $I$, correlates to an increased level of developmental activity within the existing built area. From the literature, it is expected that this decision is made with the objective of maximizing the benefits of agglomeration, optimizing effective proximity.

The real proximity is a function of the levels of physical proximity and congestion in the economy. An increase in the level of proximity in the local economy increases the benefits of agglomeration by making it easier for members of the economy to exchange inputs and outputs. In contrast, increasing the level of congestion decreases the benefits of agglomeration by increasing the difficulty of exchange within the local economy. The effective proximity is a function of the difference between these two

forces.

There is no clear methodology for directly measuring the real effective proximity within an economy. However, the relationship between the net benefits of agglomeration, $B$, and the physical development decisions of designers can be modelled rather simply. A model of this relationship takes the form displayed below:

$$B = f(I,\, A) \tag{1}$$

where $f(\cdot)$ is continuous and differentiable. From the theory, it is expected that increasing developmental intensity initially has a positive effect on agglomeration benefits (through increasing proximity) which would decrease in intensity as congestion is created through increased development utilizing the infrastructure; this relationship is expressed mathematically by the following relationships: $f_I(\cdot) > 0$ and $f_I^2(\cdot) < 0$. In contrast, the theory is less predictive with regards to the effects of increasing the total area. An increasing amount of travel would be correlated with an increase in congestion; however, an increase in the total area also allows for additional members to join the agglomeration which would increase aggregate proximity. From the theory, the effect on agglomeration benefits of increasing total area is ambiguous.

Now suppose that new businesses can observe these agglomeration benefits as well as a set of characteristics describing the workforce quality, $W$, in each city that competes in the market. Assume that the businesses act as, what are effectively, price-takers, selecting the city which offers the highest benefit to their firm. Using this relationship, the number of firms that establish in a particular city, $N$, can now be modelled. Again, a simple mathematical representation would be as follows:

$$N = g(W, I, A) \tag{2}$$

where $g(\cdot)$ is continuous and differentiable. Assume that businesses benefit from

accessing agglomeration economies. The theory suggests that $B$ and $N$ should be positively correlated, and as such the behaviour of the function with respect to intensity and total area is identical to the above. Further, research suggests that a higher quality workforce should attract more firms relative to a competing city, which can be modelled mathematically as $g_W(\cdot) > 0$.

# 4 Data

The data discussion of the literature is subdivided into two sections. The first subsection includes a description of the data and its sources. The second subsection provides an illustration of the limitations associated with the data.

## 4.1 Data Description

In order to study the determinants of local economy size, a number of sources are used to aggregate a cross-sectional data set at the metropolitan statistical area (MSA) level. The variables used in the study describe the number of small and medium enterprises (SMEs), the demographic characteristics, and the physical built form of 359 MSAs. These variables are derived from the Community Business Patterns (CBP) Survey, the American Community Survey (ACS), and the National Land Cover Database (NLCD). The period of sample is 2011 for SME and NLCD data while the CBP uses a three year average from 2010 to 2012. Summary statistics for all of the data used in the analysis are presented below in Table 1.

This study relies on data for small and medium enterprises as the focus is on locational choice of firms, and firms with more than 500 employees are assumed to be relatively immobile. This study uses SME data that is derived from the 2011 CBP. The CBP is published annually by the U.S. Census Bureau, combining data from the Business Register with supplemental data collected through surveys to provide

Table 1: Summary Statistics of MSA-level Data from NLCD, ACS, and CBP

| | Min | Max | Median | Mean | Variance |
|---|---|---|---|---|---|
| $N_{SMEs}$ | 880 | 532,800 | 5,678 | 17,150 | $1.758 * 10^9$ |
| $N_{mSMEs}$ | 217 | 105,000 | 1,425 | 4,208 | $84.68 * 10^6$ |
| Population | 43,330 | $14.75 * 10^6$ | 187,000 | 550,900 | $1.523 * 10^{12}$ |
| BA+ Edu Share | 0.077 | 0.441 | 0.189 | 0.195 | 0.004 |
| Area Estimate | 407.3 | 70,990 | 4,587 | 6,838 | $50.53 * 10^6$ |
| **Area Shares** | | | | | |
| Total Density | 0.004 | 0.360 | 0.097 | 0.109 | 0.004 |
| High Density | 0.009 | 0.154 | 0.043 | 0.048 | 0.001 |
| Ready, Undeveloped | 0.266 | 48.010 | 6.214 | 7.516 | 35.790 |

economic statistics at the sub-national level (United States Census Bureau 2016).

For the purpose of this analysis,two measures of the SME sector are created using data from the CBP. The first measure is the traditional SME definition of any establishment with fewer than 500 employees, $N_{SMEs}$; the second measure is a count of mobile SME firms, $N_{mSMEs}$, defined as employing between 20 and 99 employees. Both of these measurements is created by summing the total number of establishments with the appropriate employee counts at the MSA level as presented in the CBP. The mSME definition is designed to eliminate transitory firms as well as focus on firms for whom relocation is an intuitive possibility – these firms are unlikely to be locally invested to the same extent as larger ones.

In order to control for community characteristics, the study uses demographic data derived from the ACS for the three-year sampling period of 2010 to 2012. The ACS is an ongoing survey conducted by the U.S. Census Bureau, which replaced the long form census upon completion of the 2000 Census (United States Census Bureau 2013). For this analysis, ACS statistics on working age population and education at the MSA level are used. The working age population is available from the raw data, and the education statistic used in the paper is the share of the working age population with at least one post-secondary degree at or above the the level of a bachelor's degree. This statistic is calculated using a sum of the estimates for post-secondary graduates

divided by the population estimate.

Finally, for data on built form, the study leverages the NLCD 2011. The NLCD is a land cover mapping of the United States of America created using 30-meter segments of satellite imagery and a classification system to categorize the type of land cover (Homer et al. 2015). This classification is done by segment on a 5-year cycle using a single, defined algorithm. This data is made available in ArcGIS Raster file for the 48 contiguous states, data for Alaska, Hawaii and Puerto Rico are available in separate files. For the purposes of this analysis, the data for the 48 contiguous states are used as they are the most relevant [2].

The process to amass the land cover data was significantly more involved than the other variables. In order to determine the proportion of each MSA that has been developed, and to isolate the high intensity development, the shapefile from the U.S. Census Bureau's Geography Division is used to isolate the NLCD data relevant to the particular MSA and the total area of each MSA. Once the data is extracted from the NLCD raster file, a summary table calculating the proportion of each of the NLCD's 15 land cover classifications exist within the MSA. This process was repeated for each of the 359 MSAs for which CBP and ACS data was available.

Using the raw summaries of land cover classification proportions in the MSA, different levels of development can be captured. For this analysis, three statistics are captured. The first statistic is the proportion of the MSA that is classified as developed; development is categorized into four categories within the NLCD, these range from "Developed, Open Space" to "Developed, High Intensity". The second statistic captured for the analysis is the ratio of developed area within the MSA that is considered to be of the highest intensity; this statistic is calculated by dividing the "Developed, High Intensity" estimate by the total developed proportion. The final statistic is the share of land that can be classified as undeveloped and reasonably ready

[2]The cost of relocation within the conterminous states is lower than migration to Hawaii and Alaska.

for development; this area is a sum of the proportions of categories that could reasonably be developed by designers and include "Planted/Cultivated", "Herbaceous", and "Forest" land cover designations [3].

There are multiple factors that led to the ultimate creation of a data set of 356 MSA which includes variables capturing SMEs, population, the share of working age individuals with post-secondary degrees, high-intensity development as a proportion of total development, and the proportion of undeveloped land. First among them are limitations of geography: there are a total of only 382 MSAs within the Union's 50 states; of those MSAs, only 379 are located within the 48 contiguous states. Beyond these geographical limitations, the sample size is reduced by a further 23 MSAs due to a lack of data availability within the ACS and CBP sources. Ultimately, there are 356 MSAs for which complete cross sectional data is available.

## 4.2 Data Limitations

There is a small list of items that must be observed regarding the data set, and their implications to the analysis. First, MSAs as a unit of observation are not a direct reflection of the organization structure of municipalities. Second, the calculation of the MSA areas is limited in accuracy due to its methodology. Although it is important to be aware of these issues, their impact on the analysis is limited and corrective steps are taken during the empirical exercise where required.

The issues of MSA definition deserve further discussion. The major issues arising from the use of the MSA unit pertain to their inaccurate reflection of political boundaries. The Office of Management and Budget (OMB) defines MSAs by scoring regional economic integration which can span municipal and state boundaries (Management and Budget Office 2010). As such, the practical issues of implementing an urban design plan in these areas may increase; however, that is an issue that affects

[3] "Barren lands", "wetlands", and "water" NLCD categories are considered unsuitable for easy development.

policy and should not affect the relationship between development choices and the local economy. Further, it is important to note that using this criteria of economic integration can also lead to a wide variation in the size of MSAs.

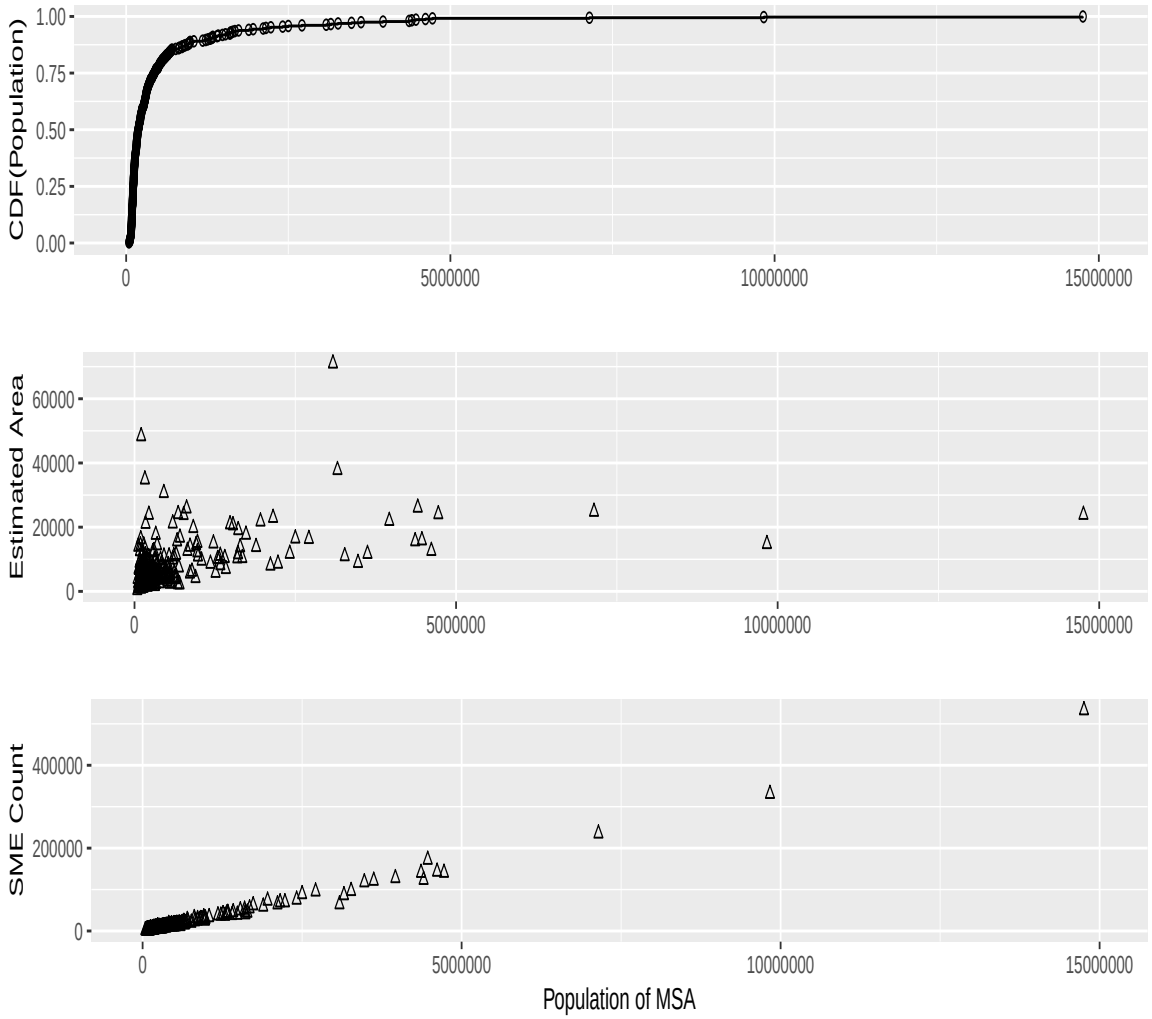
The large variation in MSA size as a result of the definition focusing on regional economies has two easily observed effects on the data (as illustrated in Figure 1). The classification weakens a potential correlation between built area and population that could arise from other delineation techniques. However, the definition of MSAs does lead to the creation of outliers, as demonstrated by the estimated cumulative density function of population. There is also a correlation between the SME count and the population within an MSA, which will be elaborated upon in the analysis section.

Additionally, it is important to note the impact that discrepancies in the estimation of MSA area may have on the analysis. The estimation of MSA area is done by calculating the space within the MSA polygons in the shapefile that represent latitudinal and longitudinal boundaries. The algorithm that is used to estimate the area has a bias that returns larger estimates for MSAs located closer to the equator. As the United States spans a large portion of the Northern Hemisphere, two MSAs of equal physical size located at opposite borders of the nation will not have identical area estimates. As such, relative measures of area are emphasized in the analysis stage including the portion of area that is developed, and the portion of viable area that is left undeveloped. These measures have their own caveats as they are functions of the MSA boundaries as defined by the OMB and may not accurately reflect the scale of the area available to designers.

# 5 Analysis

For the empirical analysis of the effects of urban design decisions on economic activity in a region, a specific model of the theory presented in Equation 2 must be developed.

Figure 1: Population, Area and SME Counts Comparison, and Density by Population by MSA



The model describes an economy where the stock of SMEs is continuously evolving, and each of these firms must pick a location in which to conduct its business based on the available information about the amenities of feasible locations. These firms are considered to be too small to directly impact the shape of the local economy individually. The suitability of the local economy for firms is determined by the development choices of local designers and a set of exogenous criteria that are outside of the control of all parties. All of this can be approximated through a relatively simple empirical model.

The number of SMEs that are located within a city is a function of the designers' development choices and the quality of the local workforce. In order to implement the theoretical model, a workforce quality statistic must be defined. For the purpose of this analysis, workforce quality is comprised of the proportion of the working age population that has attained a post-secondary degree at or above the bachelor's level. The relationship can then be modelled as follows:

$$N_i = \beta_1 D_i + \beta_2 I_i + \beta_3 I_i^2 + \beta_4 A_i + \epsilon_i \tag{3}$$

where, similar to the theoretical model, $N$, $D$, $I$, and $A$ represent the number of SMEs, the share of the workforce with higher education, the intensity of development and the area of development respectively, and the subscript $i$ is an index of MSAs. No intercept term is included as an area with no developed area logically contains no businesses. This equation can be estimated using OLS regression techniques using the data.

Applying the OLS regression technique to this model is unwise as the residuals can not be assumed to have normal behaviour. The residuals of fitting the model in Equation 3 on the total SME count have high third and fourth moments, 6.37 and 75.10 respectively. An alternative model that justifies transformation of the data is

considered:

$$N(W, I, A; \beta, \sigma, \eta, \gamma) = e^{(\beta_2 D + \beta_3 I + \beta_4 I^2 + \beta_5 A)} \tag{4}$$

where the equation is now non-linear. When a log-transformation is applied to this model it yields an equation that can once again be estimated through OLS regression techniques:

$$log(N_i) = \beta_1 D_i + \beta_2 I_i + \beta_3 I_i^2 + \beta_4 A_i + \epsilon_i \tag{5}$$

where the variables are the same as in Equation 3.

The results of estimating the model in Equation 5 with SME and mSME counts as the dependent variables are displayed in the Appendix Tables (Table 2 and Table 3 respectively). The residuals of this OLS estimation are closer to normal with a kurtosis of 0.26 and a skewness of 0.64 for the SME count. This behaviour of the error terms represents a result that is more appropriate in OLS applications.

The results from the empirical exercises are relatively simple. In each exercise, every regressor is statistically significant. The signs of the results are all reasonable: as posited by the theory, density has a positive linear relationship with the SME sector, which appears to diminish with growth; further, limiting development of viable land and increasing the knowledge level of the population correlate with increased SME sector size. All of these results are predicted by the literature.

However, the result has a high $R^2$ value, which warrants further discussion. For comparison purposes, in addition to modelling Equation 5, logarithmic relationships between SMEs (and mSMEs) and high density shares of development, both in a linear and quadratic form, as well as logarithmic population were investigated empirically. These results are also included in Table 2 (and Table 3). For each of these empirical exercises, the results were statistically significant and adhered to their theoretical relationships to enterprise counts.

# 6 Discussion

The results of the model fit, although simple and statistically significant, do not provide much support for inference. The purpose of this exercise is to identify a new instrument to enable investigation into the determinants of urban agglomeration health. The instruments which have already been explored in the literature are faced with simultaneity issues which makes their relevance to discussions of policy dubious. The work presented here suffers from similar simultaneous correlation issues which raise identical concerns. Although this research has identified and introduced new data sources to the literature, the search for new instruments and research techniques to inform the topic of agglomeration economics must continue.

The poor performance of existing instruments is exemplified by the regression of the logarithmic population on logarithmic enterprise counts demonstrated in the first results columns of Tables 2 and 3. It is interesting to note that the mobile SME is less strongly correlated with population than the total SME count – visible as a small difference in the $R^2$ values, while it is more closely correlated with the development intensity measures. The distinction is small but aligned with the prior as perceived mobile firms are more strongly correlated with urban characteristics than pure size. The extremely high $R^2$ is an issue of greater importance, as it is characteristic of the simultaneous causality problem which has hindered previous attempts to instrument both dependent and independent variables in the relationship between urban characteristics and success.

The introduction of the development intensity measure was designed to provide an alternate measure of urban characteristics in order to reduce the simultaneity issue. However, it can be seen in the results that an extremely high $R^2$ value persists; the simultaneous correlation issue is lessened through the substitution of development decisions for population, but only to a limited extent. It is my contention that this change does not represent a large enough improvement to justify the use of this

instrument to inform policy discussions.

Perhaps the most noteworthy finding is that the empirical results presented herein align with the assertion of the literature regarding proximity and congestion effects. The results do not contradict that physical growth of cities could lead to extreme congestion offsetting gains from proximity but there is little evidence that the incident is imminent. It is often a conclusion in the literature of agglomeration economics that cities will continue to grow for the foreseeable future, as has been discussed at length in this paper; this finding is supported by the research in this paper.

In addition to highlighting the continued potential for growth of agglomeration economies, this paper emphasizes the degree of difficulty associated with the search for a proper instrument for urban form. As cities continue to serve as economic hubs in a global economy, it is vital that the search for a better understanding of their behaviour continues as well. Investigating this problem at a more granular level, such as zoning registers, may prove fruitful as it would abstract away from issues regarding MSA definitions while continuing to distance the research from urban scale. However, perhaps it is time to move on from the hunt for instruments.

Should the opportunity present itself, a novel means of investigating the affects of urban characteristics on the relative strength of a local economy would be to study the establishment behaviour of new firms during an economic boom. The motivation for such an investigation is rather simple: new firm starts are able to make their locational choice with limited friction, and the decisions of these firms would be visible in the data using a difference-in-difference technique. During the period for which data is available, there has not been an instance of extreme economic growth that would provide such an opportunity. Due to this limitation, the investigation technique remains a subject for future research.

A similar future investigation technique could rely upon the difference in policy between municipalities. Researchers could identify two or more similar agglomerations

which have distinct development policies to study the differences in SME growth. The challenge with this approach lies in the differences between agglomerations beyond development policies. It is very difficult to construct an empirical investigation where all non-policy factors can be controlled as equal. Economists must watch for the appearance of such natural experiments which may be suitable for future study.

There is no evidence that agglomeration economies will have a lessened role in the immediate future. As such, it is important that economists continue to turn their attention toward this subject and aid in the search for an improved understanding of the determinants of success for agglomerations. The discipline is rife with opportunity for new research, and the demand exists from policy makers for answers and advice in shaping the form of urban economies. Understanding how decisions relating to geography, information and development can influence proximity and congestion is vital to optimizing cities.

# 7 Conclusion

The research of agglomeration economies is characterized by the difficulties of empirical investigation. This paper demonstrates the issues of empirical instrumentation of urban characteristics and outcomes as found in the existing literature, and subsequently introduces new data to instrument this relationship in the literature before ultimately determining that the issues of simultaneous correlation persisted. It is vital that a solution to this problem be discovered if the empirical literature is to inform policy of the effects of proximity and congestion on agglomeration economies.

The paper illustrates the issues that have hindered previous empirical exercises in the subject. When research has attempted to instrument urban form through productivity and workforce measures, issues of endogeneity arise rendering the findings uninformative. In contrast, research relying on measures of knowledge as issues

of variable definition have distorted the relationship between the instrument and the underlying factors of interest. The research repeatedly attempts to introduce new empirical demonstrations of the relationship between urban form and outcomes; however, no result currently found in the literature has been wholly satisfactory to economists.

In this paper, a new set of variables is introduced to instrument for both urban form and urban economic health. A case is made for the viability of Small and Medium Enterprises as an instrument for urban economic health, and a similar case is made for the importance of urban physical development in characterizing an agglomeration. Upon empirical application of this theory, it is apparent that these instruments are still subject to the same endogeneity concerns associated with earlier instruments. Although these results should not be used for inference, the findings in the paper do not contradict the prevailing theories about proximity and congestion that exist in the literature.

In order for empirical economic research to contribute to policy discussions surrounding decisions of urban form, progress must be made. It is important that new research work to establish a solution to the endogeneity problem that existing instruments. Should policy makers present economists with the opportunity to investigate natural experiments, it would be wise to exercise the option – currently, data for these types of policies is scarce. The ability to inform place-making policies will assist in minimizing the frictions congestion create in the market while increasing proximity. Due to the noted issues surrounding policies that favour particular parties, it is important that empirically-informed agglomeration-level policies can be implemented to support urban economies.

# 8 Appendix – Tables

Table 2: OLS Estimations of Equation 3

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Logarithmic Small and Medium Enterprise Counts | | | |
| | (1) | (2) | (3) | (4) |
| Logarithmic Population | 0.718*** | | | |
| | (0.002) | | | |
| High Density Share of Developed Area | | 155.345*** | 275.433*** | 161.016*** |
| | | (3.378) | (4.618) | (7.468) |
| (High Density Share of Developed Area)$^2$ | | | −1,662.787*** | −913.121*** |
| | | | (58.485) | (61.318) |
| Undeveloped, Development-Ready Share of MSA | | | | 0.064*** |
| | | | | (0.012) |
| Share of Pop with Post Secondary Degrees | | | | 15.687*** |
| | | | | (1.099) |
| Observations | 356 | 356 | 356 | 356 |
| $R^2$ | 0.998 | 0.856 | 0.956 | 0.976 |
| Adjusted $R^2$ | 0.998 | 0.856 | 0.956 | 0.976 |
| Residual Std. Error | 0.366 (df: 355) | 3.403 (df: 355) | 1.881 (df: 354) | 1.387 (df: 352) |
| F Statistic | 213,332.100*** (1; 355) | 2,114.882*** (1; 355) | 3,866.371*** (2; 354) | 3,627.644*** (4; 352) |

*Note:* *p<0.1; **p<0.05; ***p<0.01

Table 3: OLS Estimations of Equation 3

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Logarithmic Mobile Enterprise Counts | | | |
| | (1) | (2) | (3) | (4) |
| Logarithmic Population | 0.610*** | | | |
| | (0.002) | | | |
| High Density Share of Developed Area | | 132.436*** | 231.718*** | 135.224*** |
| | | (2.812) | (3.904) | (6.345) |
| (High Density Share of Devloped Area)$^2$ | | | −1,374.704*** | −750.432*** |
| | | | (49.444) | (52.101) |
| Undeveloped, Development-Ready Share of MSA | | | | 0.042*** |
| | | | | (0.010) |
| Share of Pop with Post Secondary Degrees | | | | 13.781*** |
| | | | | (0.934) |
| Observations | 356 | 356 | 356 | 356 |
| $R^2$ | 0.996 | 0.862 | 0.957 | 0.976 |
| Adjusted $R^2$ | 0.996 | 0.862 | 0.957 | 0.976 |
| Residual Std. Error | 0.461 (df: 355) | 2.833 (df: 355) | 1.590 (df: 354) | 1.179 (df: 352) |
| F Statistic | 96,993.210*** (1; 355) | 2,218.008*** (1; 355) | 3,907.269*** (2; 354) | 3,627.656*** (4; 352) |

*p<0.1; **p<0.05; ***p<0.01

*Note: Mobile enterprises have between 20 and 99 individuals, inclusive.*

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