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A comparative study of urban occupational structures: Brazil and United States

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Resumo:

This paper compares the occupational structure of cities in Brazil and United States aiming at the evaluation of the extension to which the economic structure of these urban agglomerations is associated with the different stages of development, specifically when comparing a rich and a developing country. Using a harmonized occupational database and microdata from the Brazilian 2010 Demographic Census and the U.S. American Community Survey (2008-2012), results show that Brazilian cities have a stronger connection between population size both with occupational structure and human capital distribution than the one found for cities in the United States. These findings suggest a stronger primacy of large cities in Brazil's urban network and a more unequal distribution of economic activity across cities when compared to USA, indicating a strong correlation between development and occupational structure.

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Abstract

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Introduction

Cities are the engines of growth for national economies. The agglomeration advantages that they generate, and that constitute their main reason for existence, make these spaces attractive to both the most talented workers and most productive firms, creating an environment favorable to growth and development. Through high density, cities facilitate better sharing, matching and learning of people and companies in a process that boosts economic progress (Duranton and Puga, 2004). In addition, the sheer concentration of people leads to potential new outcomes because, as Marshall (1890) said, ideas are "in the air."

The functional role played by each city in an urban-system is related with its capacity to offer more specialized goods and services to their surrounding areas (Lösch, 1964; Christaller 1966). Since population growth increases the capacity to generate economies of agglomeration and market potential, population size is also related to the centrality level of the cities, potentially affecting their role in the urban network. Moreover, given utility's preference for diversity, enhanced access to a broader range of goods and services leads to higher welfare levels and development.

However, growth in size is not followed only by the benefits associated with specialization (Marshall, 1898) and/or diversification (Jacobs, 1969). Unplanned urban expansion can create dynamics that stifle the agglomeration benefits of cities, since it precipitates problems related with pollution, congestion, segregation, sprawl and other unintended consequences. These inefficiencies tend to increase with city size, especially if urbanization is not properly managed and cities do not offer essential public infrastructure. In other words, “cities can become victims of their own success and the transformative force of urbanization can be attenuated” (United Nations, 2016: 32).

Understanding the role of cities has become more urgent as migration to urban locations increases around the world. In OECD countries, for example, two out of three people live in cities with a population of 50,000 and above (OECD, 2014). A United Nations Report (2016) projects that the world’s urban population in 2050 will be approximately 66 percent, with the most accelerated rates of urbanization happening in under or developing countries, i.e., places that have a different development pattern than the USA and Western Europe. As pointed by Chauvin et al. (2017), the rapid growth of these localities creates a knowledge mismatch for urban economists and urban theory predominantly focused on cities of the “wealthy west.”

These facts point out the necessity to create cross-country comparisons to investigate and understand the differences and similarities between cities from rich and poor countries[1]. Simply importing successful urban or economic strategies into developing country cities ignores the context of both the importing and exporting locations. Comparative research constitutes a framework to achieve policies that focus the paths of cities on those external policies that best match their context.

Therefore, the main objective of this paper is to compare the urban agglomerations of Brazil and the United States of America (USA) using occupational composition and relate that with city size to identify similarities and differences in the urban structure of both countries. Even with the growing importance of this topic on urban economics, there remains a scarcity of empirical work attempting to understand cross-national variation between cities and their place in the urban hierarchy beyond simple city-size approaches[2].

The remainder of this paper is structured as follows: Section 2 shows how it is possible to establish a comparative base for occupational job structure and cities between Brazil and USA; Section 3 presents the main results and discussion in a comparative framework between these two countries, stressing the occupational structure and its similarities and differences related to human capital and city size; and Section 4 offers some concluding remarks and identifies potential avenues of investigation for further research.

[1] Or as some researchers prefer, between the Global South and Global North. See Roy (2009).

[2] For details, see Gabaix and Ioannides (2004). Some examples of empirical works considering Brazil and/or the United States are Ruiz (2005), Matlaba et al. (2013) and Chauvin et al. (2017).

Occupational structure in Brazil and the United States

In this paper's context, the choice to compare the occupational structure of Brazil and United States is based on the objective of comparing two countries at different development stages. In terms of developed nations, there are scarce examples of other countries with similar geographic and population size as Brazil. In fact, these two nations occupy the fourth (USA) and fifth (Brazil) positions of largest land area in the world[3] and have a fairly comparable population size[4], making this pairing appropriate for comparison of city structure between a developing and developed nation.

Any attempt to create an international comparison using different data sources brings challenges and important decisions that need to be made. Therefore, given the aim of this paper, it is important to clarify how it is possible to generate a harmonized framework that allows the comparison of the occupational structure of United States and Brazil.

Census Data

The Brazilian data used in this study comes from publicly available microdata from the *Censo Demográfico 2010*, the official national census conducted every ten years. Each observation in this representative sample has a weight, which allows individuals to be summed to construct socioeconomic profiles of cities. Individual observations can be easily aggregated to provide the average characteristics of each *município* – an administrative entity with relative autonomy that are subordinated to States.

By their turn, in 2005 the United States switched from a decennial census model to an annual data collection model (Spielman et al, 2014). While the decennial census is still in place for building a complete enumeration of the population and collecting a few basic demographic characteristics[5], the *American Community Survey* (ACS) is now the source for detailed socioeconomic information on households. This uninterrupted inquiry produces estimated characteristics[6] for the entire country. Data are currently published in a 1-year base (for geographic areas above 65,000 people) and 5-year base (for all geographies). The corresponding microdata is available via *Public Use Microdata Sample* (PUMS), where the most detailed unit of geography is the *Public Use Microdata Area* (PUMA). PUMAs are special non-overlapping areas that partition states into contiguous geographic units containing no fewer than 100,000 people each. These are statistical areas that do not map exactly onto USA counties, the geographic unit most similar to Brazilian *municípios*.

In this analysis, cities are understood as agglomerations defined by their commuting, where flows characterize a place as a single unit. For the USA this characterization is obtained

[3] In overall land territory, the USA is bigger than Brazil, but here were considered just the continental USA – represented by 48 States as showed in Map 2 – which makes Brazil a little bigger then USA
[4] According to census data for each country, in 2010 USA had 308 million people and Brazil 190 million.
[5] Starting in 2010, the census focuses on age, sex, race, Hispanic origin, family status and homeownership.
[6] That is a crucial aspect in ACS. Since there is continuously inquiry on *fractions* of households around the nation, it can produce reliable *distributional* characteristics but not *counts* of USA

via *Core Base Statistical Areas* (CBSA), which group counties based on contiguity, density of people and intensity of flows to work. Since the use of microdata necessitates using PUMAs instead of counties, this study employed a classification provided by the Missouri Census Data Center that approximates CBSA geographies using PUMAs.

In Brazil's case, the agglomeration definitions come from the IBGE's study *Arranjos Populacionais e Concentrações Urbanas no Brasil* published in 2015, which was based on 2010 Census results and that can be easily aggregated by municípios. It is important to stress that such a study constitutes an important mark for Brazil[7], because contrary to the generally used Metropolitan Areas in which members are institutionalized by law, the definition of urban agglomeration employed in IBGE's work emerges from data on density of people and flow to work and/or study, a less arbitrary rule and closer to that used in the USA.

Bringing all these pieces together and aiming to match the Brazilian data as closely as possible, this study uses 5-year base ACS data centered at 2010. More specifically, ACS 2008-2012 was used, which is a multiyear combination of the 1-year PUMS files with appropriate adjustments to the weights and inflation factors. Also, the minimum agglomeration size considered for both countries is 100,000 inhabitants.

Occupational Crosswalk

With the agglomerations and data sources established, the final concern is about occupational structure of workers. Brazil's census classifies occupational positions of working people (variable V6461) according to the *Classificação de Ocupações para Pesquisas Domiciliares 2010* (COD). In the United States, the ACS occupational position (variables OCCP02, OCCP10, OCCP12) is classified using the *Standard Occupation Classification 2010* (SOC). Since there is no direct crosswalk between these two, a classification system from the International Labor Organization, *International Standard Classification of Occupations 2008* (ISCO) was used for linkage.

The Brazilian COD and the ISCO already maintain high compatibility[8] so these two databases were easily harmonized.[9] The U.S. Bureau of Labor Statistics provides a conversion table between SOC and ISCO that permit a direct conversion of 94% of all USA occupations when grouped into a two digits ISCO base. Therefore, it was possible to create comparative classes of occupations between those two countries employing a crosswalk strategy that used ISCO as the bridge between the two.

Finally, it is important to note that this study only included employed people between 24 and 65 years old that received money from their work and for whom it was possible to identify the occupational category of their job. Whenever necessary, Brazilian salaries were

[7] Prior to this, Brazil had the *Região de Influência das Cidades* (REGIC) that tried to establish centrality of cities.
[8] All groups are consistent at 2-digit level in which eight of ten groups are compatible at four digits scale.
[9] The final results converting the four-digits Brazilian's occupations to a two digits SOC base can be seen in the Appendix of this work.

adjusted using dollar currency of July of 2010. In the USA case, personal wages were converted in a monthly base and adjusted to 2010.

Results and Discussion

Urban Hierarchy

As shown in Table 1, in 2010 Brazil had 185 urban agglomerations above 100,000 in population, which together concentrated 60 percent of the country's overall inhabitants. As highlighted in Map 1, São Paulo and Rio de Janeiro, which together are home to more than 31 million residents, occupy the top positions. Considering the fact that Brazil does not have any agglomerations between 5 and 10 million people increases the relevance of these two cities in Brazil's city-network.

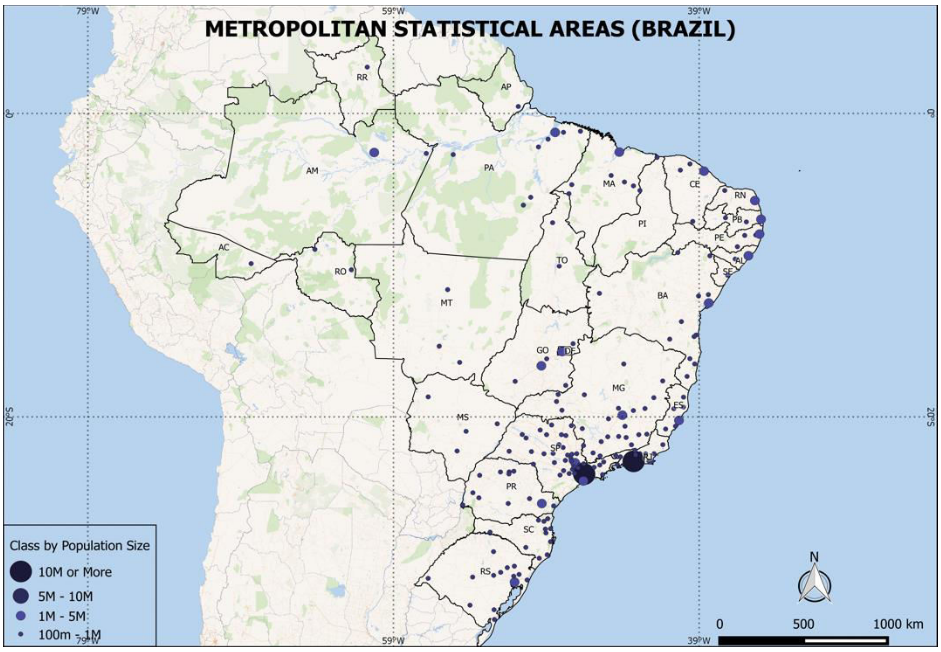
Table 1. Distribution of population by size (Brazil and USA)

Populational Size	Brazil		USA	
	Total of Cities	*Population (%)*	*Total of Cities*	*Population (%)*
10 Million or More	2	27.56%	2	12.55%
5 Million to 10 Million	0	-	7	17.14%
1 Million to 5 Million	17	35.08%	42	35.58%
100 Thousand to 1 Million	166	37.36%	295	34.72%

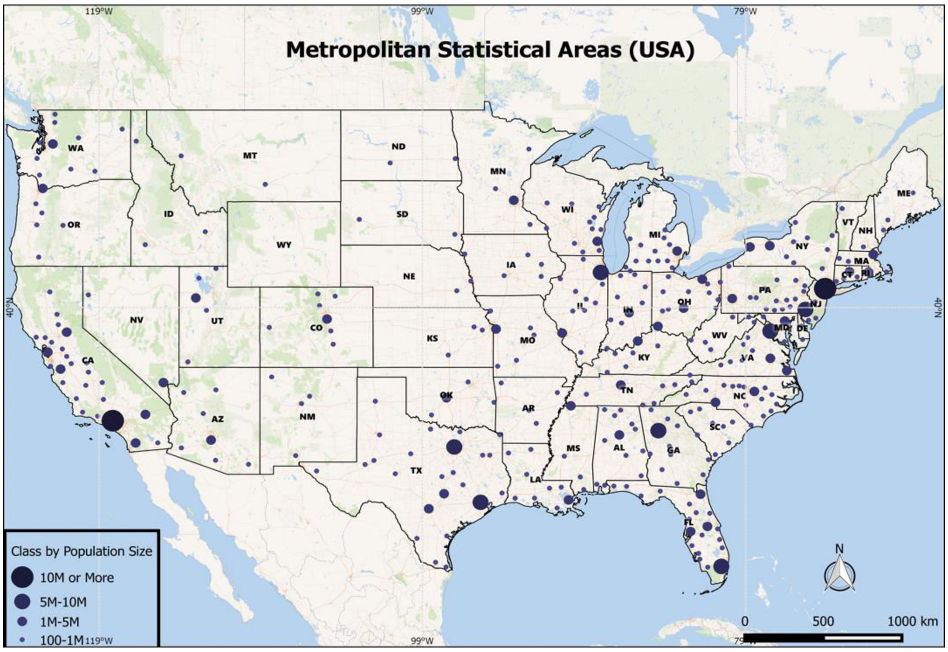
The next category (1 - 5 million) highlights the importance of state capitals in the city-network structure of Brazil. All 20, except Campinas and Baixada Santista, both closely related with São Paulo dynamics, are capitals, including the national capital Brasilia. The last category shows sparse points representing the small agglomerations that have relevance in a regional context for the Brazilian economy.

As Map 1 points out, it is not difficult to recognize a regional pattern in Brazil: a high density of cities of all categories located in the Southeast; while at same time the North and Northeast reflect a pattern of dispersed and disconnected places, where almost all larger points are state capitals. This regionally imbalanced composition reflects a long-term trend in the Brazilian economy. Among the many factors helping to explain it is the regional path followed by the industrialization process which concentrated in an "industrial polygon" as pointed out by Diniz (2003), sprawling in areas that cover a significant fraction of the agglomerations in the map below.

In 2010, the USA had 347 agglomerations that together represented approximately 84 percent of overall population; a result that when compared with Brazil reveals simultaneously a more concentrated, but as can be seen in Map 2, a more sprawling country. As important, emerges the fact that USA cities can be considered relatively well distributed throughout the country. The top of the hierarchy is held by New York and Los Angeles that together have 32 million residents, a number similar to the top two cities in Brazil. In contrast to Brazil, the USA has seven cities, Chicago, Boston, Washington, Atlanta, Miami, Houston and Dallas, in the 5 to 10 million inhabitant category.



Map 1. Brazilian city-network structure by size and distribution



Map 2. North American city-network structure by size and distribution

As observed by Ruiz (2005), even when adjusted to the North American population, Brazil has a more unbalanced city-network without a smooth transition between large and small places. From a regional perspective, Map 2 also highlights the agglomeration of points in the Northeast, which represents a long established and economically important part of the nation. At the same time, the center of the country, the Great Plains and Mountain West for example, represent a more sparsely populated space.

For both countries, it is visually clear that coastal areas play a strong role in city dispersion, an argument previously noted by Rappaport and Sacks (2003) when analyzing long trends in economic growth. Also, for both countries, the spatial distribution presented in the maps is closely related with their migration patterns. For example, the USA railroad system development that started around 1850 helped to connect the already established East to a rapidly growing Midwest and West (Atack et al., 2009; Donaldson and Hornbeck, 2016).

Brazil's also had a latter occupation of its West lands, but it was much more recently than USA – specially in 1960s and 1970s – and drove mainly by farming activities. That movement enable the emergence of a corridor of occupation and development on Midwest in the country borders (Cunha, 2002) and helped to improve Brazil's city-network composition.

By other hand, these results highlight an institutional difference that goes back the colonial times of these two countries and that affect their spatial economic development in uneven ways (Galiani and Kim, 2008; Kim and Law, 2012). While in Brazil from top 25 metros 22 are State capitals in USA just 7 figures in those group. Even that in both cases the national capitals were purpose built cities and do not occupy the top spot in the urban hierarchy, the primacy exerted by Sao Paulo and Rio de Janeiro – as the distance in populational size from them to the next group of cities – along with the prominent position of state capitals in Brazil's city-network points out a difference between them.

Human Capital

While institutional paths have a strong link to the current shape of the city-network, the focus here is on the employment structure and human capital across the respective city-networks. Human capital stocks, using educational attainment as a proxy, are displayed in Figure 1. In 2010 nearly 50% of Brazil's employed population had finished at most middle school, while in the USA more than 94% of workers completed at least high school. If understood as an overall productivity measure of nations, this helps to explain the huge gap in median monthly wages received in each country after sort by educational attainment.

In both countries, wages rise with education, which indicates an increase in productivity as workers improve their knowledge. Moreover, the ratio between Brazilian and USA. wages shows a converging trend: starting at 3.93 for high school going down to 1.60 for people with doctorate degrees. This converging pattern does not hold if the two lowest skill groups are included, which is likely explained by the large pool of workers in Brazil in these groups, making replacement easy and thus keeping the salary for both groups closer.

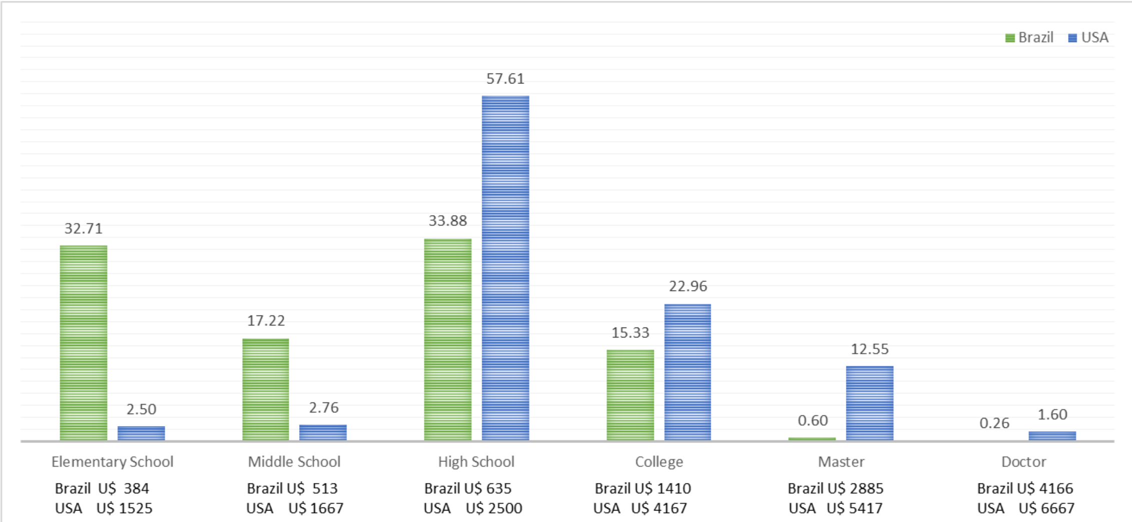


Figure 1. Educational composition by share and median salaries (2010)

At the within country ratios, the countries are quite different. In the US, the jump from middle school to high school education represents a half again increase in wages; and then a slightly more than half again increase (62.5%) for the next jump to bachelor's degree. However, in Brazil the high school diploma only buys a 23% increase in wages over middle school, but the bachelor's degree results in more than a doubling of wages (122%) over a high school diploma. We hypothesize that these different patterns represent signaling to employers.

The meaning of a high school diploma in the USA is relatively similar across the country and as such is a clear signal of a minimum level of competency. More important, a high school diploma is so common in the USA that not having the degree is a strong negative signal in the job market. In contrast, the Brazilian high school diploma does not carry that same consistent signal in terms of skills attained. With so many workers not having the designation in Brazil, employers have likely developed other screening techniques when selecting among candidates for low to medium skill jobs. The bachelor's degree in the USA is another clear signal of skills attained, and brings with it a similar proportional increase in wages. In Brazil, the share of the population with a bachelor's degree is substantial but still relatively small and people with higher degrees (masters and doctorate) represent a tiny share of the labor pool. The bachelor's degree becomes the dominant distinguishing signal a worker can make on the job market and thus has twice the effect as in the USA.

Occupational Distribution

The previous analyses showed that although having some similarities in land area and population size, there is a large gap between the countries in socioeconomic characteristics and city-network composition. Given the established links between educational attainment, wages and productivity, disproportionality in regional distribution of types of workers represents an important indicator for larger regional imbalances. Therefore, this section considers the regional variation in occupations and its connection to city size and education.

The approach proposed here complements that from the Urban Wage Premium (UWP) literature. UWP research has as a core objective identify the extent to which the density of economic activity in cities influences workers' productivity and to disentangle this effect from a sorting effect, unobserved individual characteristics and spatial heterogeneity (Heuermann et al., 2010). Basically, if higher urban prices do not fully account for the higher nominal wages, i.e., if a real wage difference exists, then it must be true that workers in larger cities are more productive (Glaeser and Mare, 2001).

In contrast to those studies that focus on determining the fraction of wages that could be associated with individual and agglomerative effects, here the emphasis is on cities as a unit and more precisely on their occupational composition and human capital structure. In addition, this paper investigates how this structure can be related to different development stages of cities, using population size as a proxy, independently of whether the city is in a developed or developing country.

Considering that, Table 2 presents economic structure based on occupation for both Brazil and the USA. From a national perspective, the distribution of workers across employment categories shows strong similarity, with a correlation coefficient of 0.75. There are however some noticeable differences in select occupations. The largest gaps are related with occupations typically associated with low skill service jobs in Brazil, compensated by high skill occupations in the USA Together, Building and Grounds Cleaning and Maintenance; Installation Maintenance and Repairs; and Transportation and Material Moving occupations account for 70% of the occupational composition that are larger in Brazil. While in the USA, Healthcare Practitioners and Technical; Management; Business and Financial Operations; and Office and Administrative Support represent 50% of the positive differences.

In both cases, the highest associations between occupational composition and city size (first pair of columns in Table 1) were found for Business and Financial Operations; Legal; and Computer and Mathematical jobs. This supports Florida's (2014) finding that these jobs are linked with those that tend to grow with city size. Since these jobs are filled by some of the highest educated workers (second pair of columns in Table 1), and thus some of the highest paid workers (all are in the top five), it is not surprising that they correspond to the typically more expensive and amenity rich larger cities.

On the other hand, four of the occupational groups had correlations with different signs between the countries: Healthcare Support; Healthcare Practitioners and Technical; Food Preparation and Serving Related; and Building and Ground Cleaning and Maintenance. In all cases they are positively associated with city size in Brazil and negatively in the USA Besides that, Management and Education, Training and Library are the only groups that can be considered randomly associated with size in Brazil, while in the USA six occupations are randomly correlated.

Table 2. Brazil vs USA classification by composition and economic shares (2010)

Group of Occupations (SOC)	Correlation with MSA Size		High/Low Skilled		Share of Total (%)	
	Brazil	*USA*	*Brazil*	*USA*	*Brazil*	*USA*
Management	0.0219	0.2876	0.43	1.24	8.56	10.79
Business and Financial Operations	0.3206	0.4176	1.28	1.97	2.80	4.66
Computer and Mathematical	0.4950	0.3153	1.07	2.10	1.15	2.97
Architecture and Engineering	0.1657	0.1202	0.78	2.16	2.37	2.03
Life, Physical, and Social Science	0.1526	0.0604	3.76	5.37	0.66	0.98
Community and Social Service	-0.1085	-0.1811	0.49	2.82	0.69	1.73
Legal	0.2531	0.4496	5.20	8.31	1.25	1.03
Education, Training, and Library	-0.0062	-0.1014	2.13	3.95	4.71	6.25
Arts, Design, Entertainment, Sports, and Media	0.2332	0.4057	0.45	1.72	1.37	2.07
Healthcare Practitioners and Technical	0.1567	-0.1300	1.31	1.31	3.54	6.09
Healthcare Support	0.1178	-0.1292	0.22	0.14	0.65	2.25
Protective Service	0.1320	0.0287	0.15	0.42	3.46	2.67
Food Preparation and Serving Related	0.1136	-0.0074	0.02	0.12	3.36	4.02
Building and Grounds Cleaning and Maintenance	0.1146	-0.0344	0.01	0.06	11.01	4.36
Personal Care and Service	0.1411	0.0500	0.09	0.21	4.51	3.45
Sales and Sales Management	0.1070	0.1832	0.11	0.51	8.90	10.38
Office and Administrative Support	0.2243	0.0098	0.26	0.26	9.80	13.55
Farming, Fishing, and Forestry	-0.2079	-0.1213	0.02	0.06	2.23	0.56
Construction and Extraction	-0.1438	-0.1621	0.02	0.07	4.06	5.26
Installation, Maintenance, and Repair	-0.1945	-0.2774	0.02	0.09	6.85	3.16
Production	-0.0891	-0.2134	0.02	0.08	10.35	7.43
Transportation and Material Moving	-0.0479	-0.1579	0.02	0.10	7.72	4.30

Note: tests for correlation with size were based on the share of each occupation in the city structure composition; the High/Low Skilled is the proportion for each class of occupations between the total number of workers with college and above by those with at most high school; share of total represents the total fraction in the country.

Although Table 2 shows an overall similarity for occupational composition of Brazil and the USA, those results are tempered by different patterns at the regional scale. Even though jobs associated with high skilled workers tend to be more concentrated in big cities for both countries, in Brazil low skilled jobs also appear to follow this pattern. Together, these facts raise two hypotheses: (i) employment structure of cities has a divergent pattern between nations and (ii) size plays a different role in each of them.

Based on the previous hypotheses, an important question to investigate is how the employment composition variation among cities can be related with their size and human capital distribution, both within and between countries. Understanding how each city-network responds to increases in city size is a valuable tool to help in the design of policies. *Krugman's Dissimilarity Index*[10] (Krugman, 1991) is used to investigate this issue; the measure can be traced back to Duncan and Duncan (1955), which used this framework to understand racial segregation, i.e., racial dissimilarity. The measure is used here to capture the dissimilarity in occupational structure between pairs of cities. The index ranges from 0 to 2, with low values indicating city pairs that have similar employment distributions and high values for those pairs that are not alike.

Figure 2 shows results for three different inquiries using the index to compare each city to: a) the "average city", b) the largest city, c) the city with the highest concentration of high-skilled workers – chosen based on the location quotient[11] for concentration of workers with college education and above – and d) the city with the lowest concentration of high-skilled workers. In all cases the results are plotted against the log of population.

In Brazil's case, the negative association between occupational structure and city size is clear: as city size increases, dissimilarity decreases, implying convergence toward the national average. The USA also shows a negative trend, but far less pronounced. In addition, the average Brazilian city has and index of 0.25 and 18 cities are above 0.4; in contrast, these values are 0.20 and 3 in the USA indicating that occupational composition is far less variable in the USA relative to the national average.

The next pair of graphs shows the dissimilarity between the largest city and the others, which again highlights the strong association with size in the Brazilian economy. The similarity between the first and second pairs of plots highlights the disproportional weight that the largest cities have on the overall national employment distributions. Put together these two results indicate that large cities tend to be more similar, but also tend to be much more different than other places in the Brazilian city-network.

Occupational dissimilarity relative to the most educated city in the USA presents a far different story. San Jose, California is the 34th largest city in the USA and is the anchor of Silicon Valley's high-tech complex. The most noticeable trends are a reduction in variance as city size

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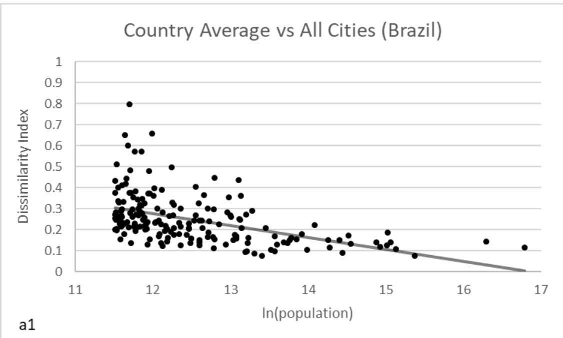
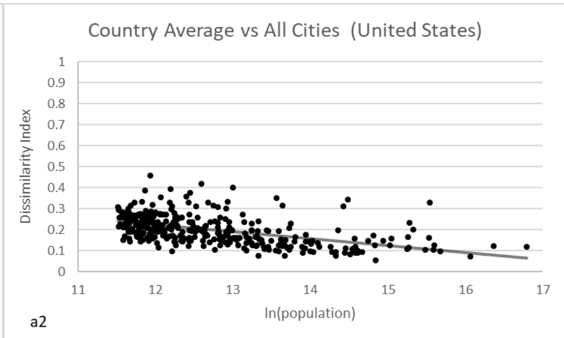
[10] $SI_{ij} = \sum_k \left|\frac{E_{ki}}{E_i} - \frac{E_{kj}}{E_j}\right|$ where i and j are cities and k represent the sectors of the economy.

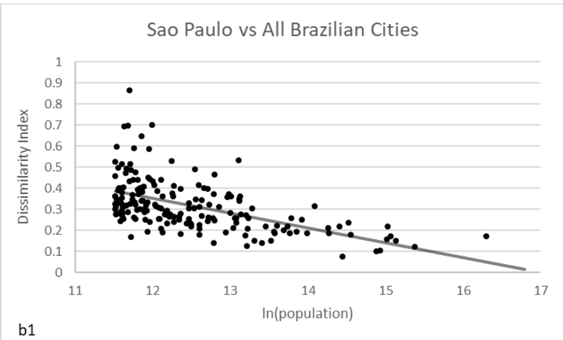
[11] $QL_{ki} = \frac{E_{ki}}{E_i} \Big/ \frac{E_k}{E}$ where k indexes education level, i indexes cities and E is the employment count; no subscript implies summation over all members of the category.

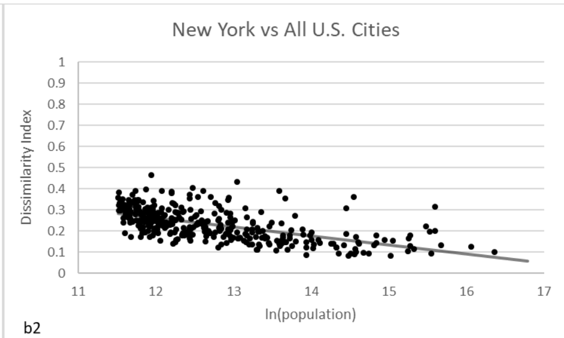
increases and that dissimilarity is converging to a level considerably above zero. To Brazil, the dissimilarity pattern generally matches that of the average and largest city, indicating convergence to low dissimilarity as city size increases. The city of Florianopolis is the 23th largest in Brazil and was ranked by ONU as having the third highest Human Development Index in Brazil[12]. It should be noted that there are quite a few cities with indices below 0.1 at all city sizes.

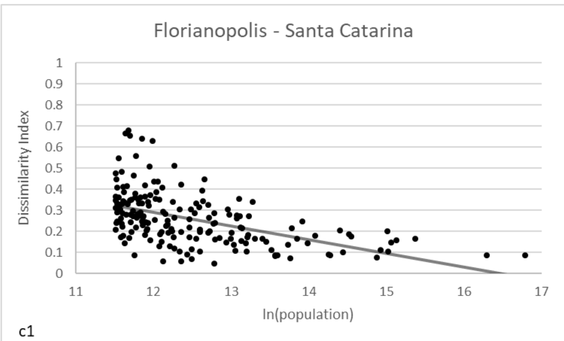
The hypothesis of polarization in high-skilled workers in Brazil cities is reinforced when we analyze the lowest levels of human capital qualification, since the dissimilarity raise with size. By their turn, in USA even the worst city in this scenario still showing a flat relation with others presenting a sprawl scheme of human capital.

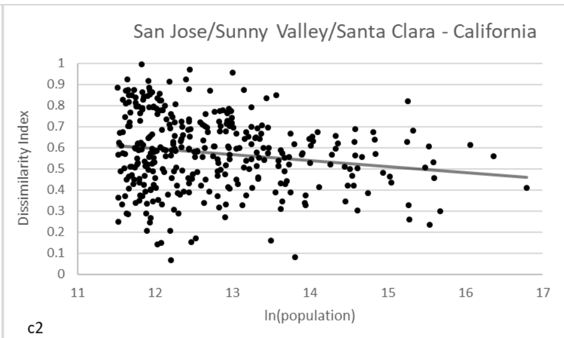












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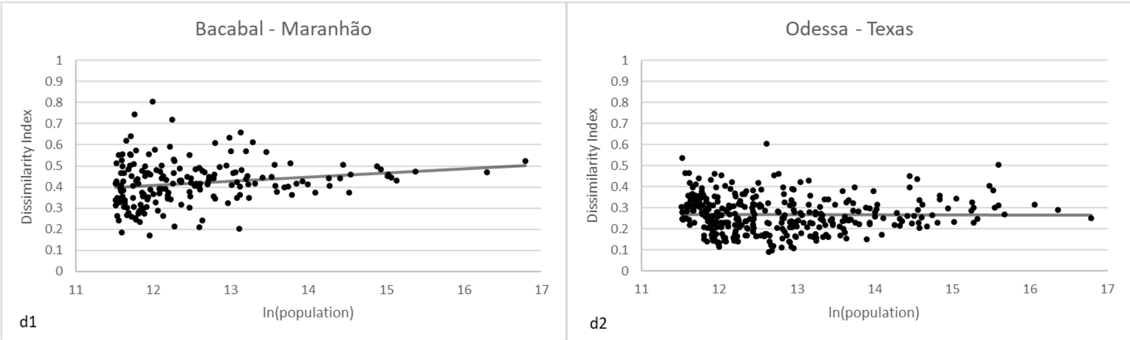

Figure 2. Krugman Index vs City Size (Selected Units)

At first glance, a reader could think that this variations with biggest gap running around 50% (since de Index goes from 0 to 2) is not so expressive. But reader should note that a city is an organism that demands some fundamental functions – as schools, food service, grocery stores, hospitals. Taking the fact that its structures could not be 100% different each other, a 50% differentiation between two places is an expressive distinction.

Figure 3 shows all pairwise dissimilarity values for cities both within and between countries, again the results were ordered from the smallest to the biggest agglomerations. The story for the USA is that cities tend to be similar (average of 0.12) and that there are few outliers (standard deviation of 0.14). In Brazil, the largest cities (top of triangle) appear to be consistently similar. But dissimilarity increase when moving to medium and smaller cities, the bulk of the triangle. Also, it is possible to see some cities that are highly dissimilar from most other cities (represented by purple streaks), these are both small and specialized places, generally in agriculture, such as Cameta/PA and Braganca/PA, or industry, such as Taquara-Igrejinha/RS, Brusque/SC and Jaragua/SC. The average index value in Brazil is 0.16, with a standard deviation of 0.19.

When comparing between countries (the rectangle in the figure), the highest similarity is found between the largest cities in Brazil and smaller and medium size cities in the USA (tendency for lighter orange colors toward the top and left of the plot). The most divergent associations (blue horizontal lines) arise from cities dominated by farm occupations and industrial associated occupations, a similar group to the cities discussed before. On the other hand, USA differentiation (vertical blue lines) arise from smaller college cities, such as Ann Harbor, Michigan, Columbia, Missouri and Boulder, Colorado, and the tech focused San Jose, California and government focused USA capital Washington, DC.

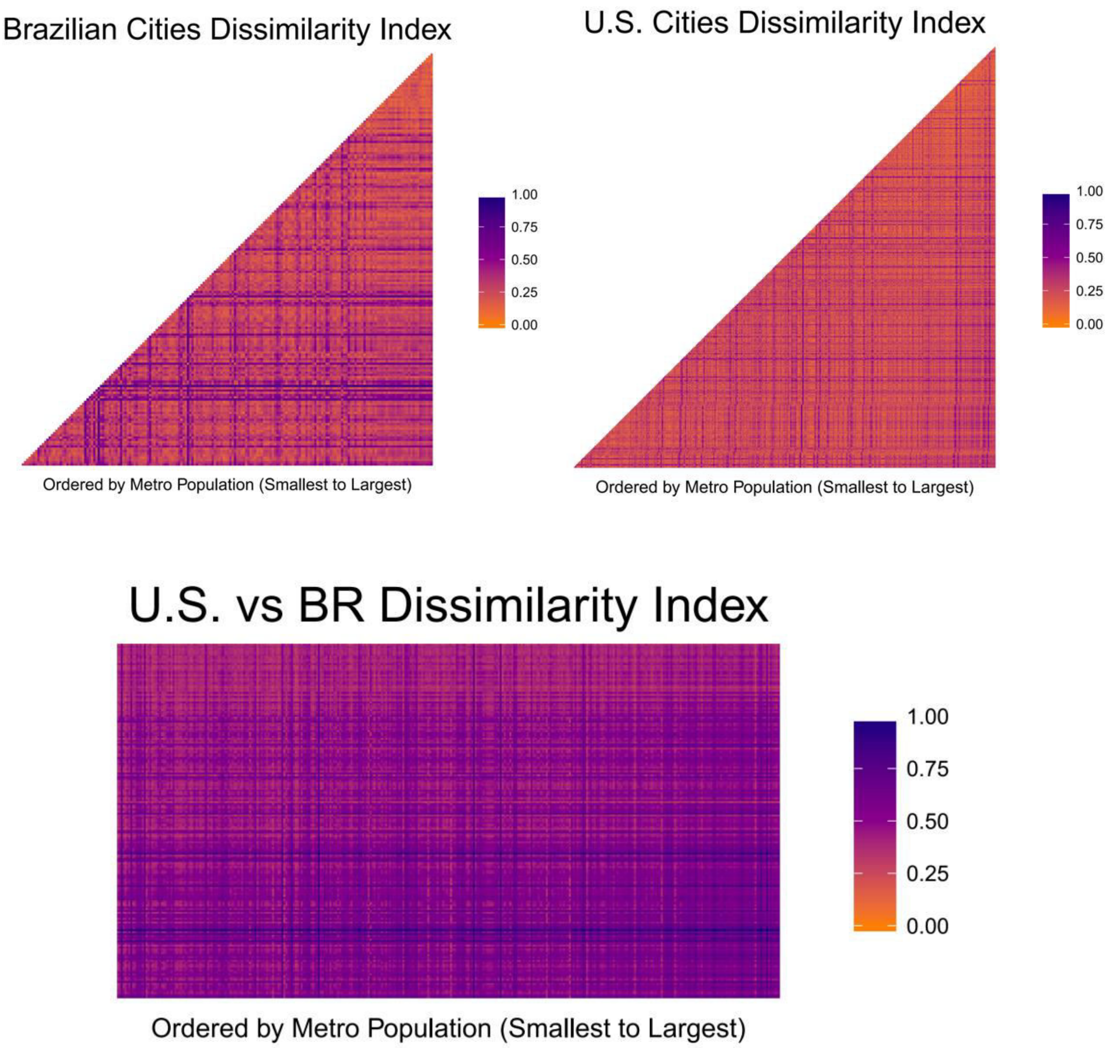

Figure 3. Krugman Index vs City Size (Occupational Structure for All Cities)

In figure 4, when ordered by their locational coefficient of high-skilled workers, it is possible to notice a clearer differentiation between the two countries. In Brazil, there is a graduation in colors starting with darker pattern in the base that become softer as move to the top, but in this movement, are a large amount of structural differently places. In USA, contrary to what happens in Brazil the triangle shows a sprawl pattern, with the dissimilarity in economic structure slowly becoming larger with human capital composition with a large block of medium positioned cities showing a large similarity. One exception came from the hot-spots (top of the triangle) that tend to all rest.

The cities with the largest dissimilarity patterns in Brazil arise from those with highest fraction of workers in agriculture, such as Braganca/PA, Codo/MA and Vitoria do Santo Antao/PE. In the USA, the largest discrepancies come from small places on both ends of the education spectrum, examples such as Lawrence/KS and Decatur/IL have small fractions of low educated workers, while Yuba/CA and Utica/NY have small fractions of high educated workers.

When we analyze the between country composition, in the rectangle it is possible to notice that half-top ranked cities in Brazil (up corner in y-axis) are at most like middle ranked cities in USA (x-axis) and bottom-ranked cities in Brazil are highly differentiated from all other places. USA top ranked had a dissimilarity that put them far differentiate from all other cities in Brazil. In overall, if compared with the between countries effect presented in Figure 3, Figure 4 shows a more distinct history, where highly educated cities in USA and low qualified cities in Brazil tending to be different then all others.

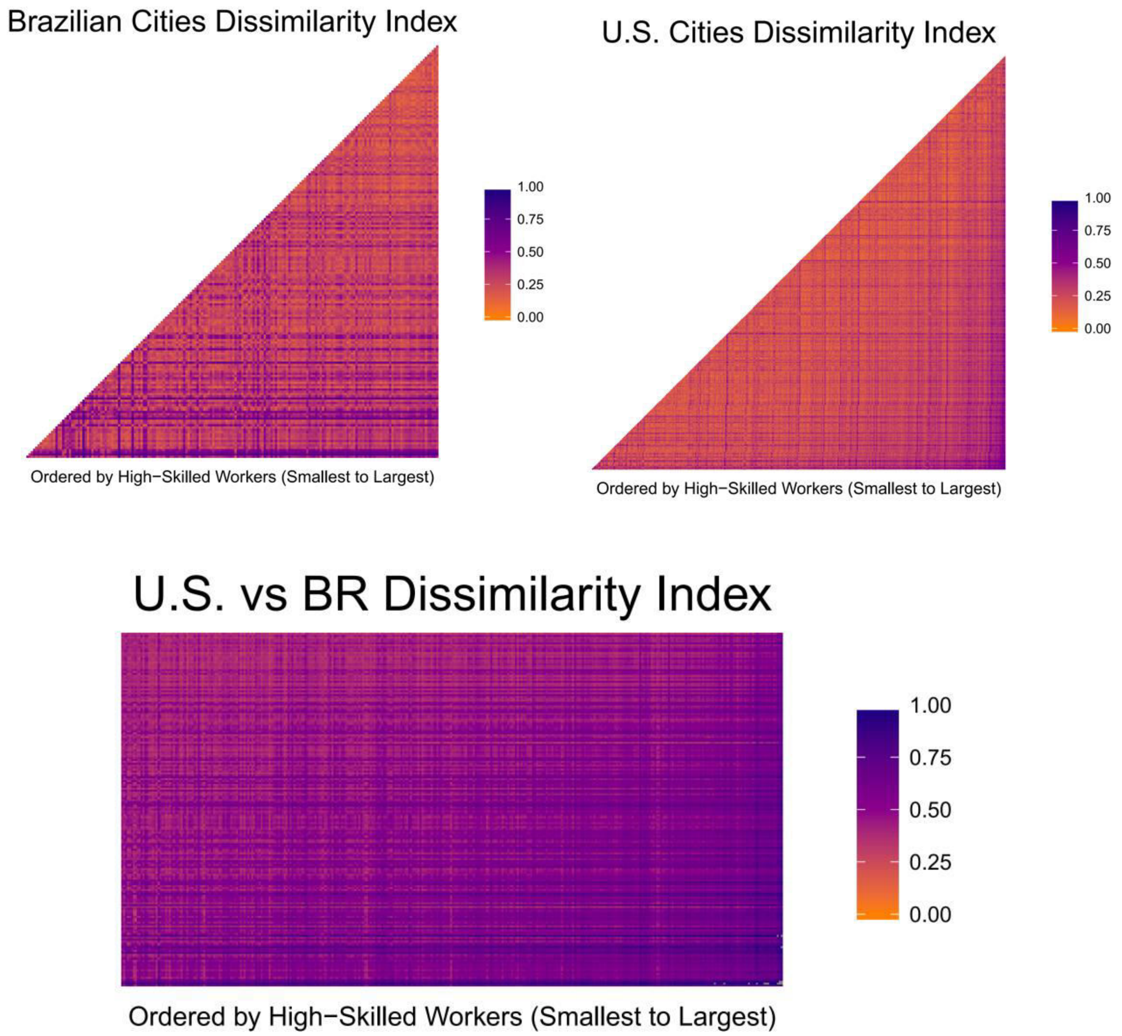

Figure 4. Krugman Index vs City Size (Human Capital Structure for All Cities)

As cities increase in size, generally it is expected that their economic structures become more diversified (Jacobs, 1969) by increasing participation of workers in more specialized services, for example. Therefore, as a final exploration it is interesting to analyze how the effects of urbanization economies are related to size in these two countries. To achieve that aim Florida's (2014) classification on Creative Class was employed[13].

These occupations that represent 25% in Brazilian's economy and approximately 30% in the USA contain, in both cases, the well payed and highly educated workers. While some correlation would be expected, human capital and the Creative Class do not necessarily capture the same people and, more important, Creative Class has a bigger effect on wages — a key element of regional productivity – whereas education tends to have a greater effect on income of people (Florida, 2014).

Figure 5 contains a biplot graph which uses Principal Components Analysis (PCA) outcome based on share distribution of each group of creative occupations for both countries. It is a useful tool since the angle formed by any two variables, represented as vectors, reflects their actual pairwise correlation. Also, on the graph the objects are distributed based on their similarity and attraction to each other.

Therefore, the size and direction of arrows represent the loadings for each one of the creative class occupations and the position of dots represents the combination of scores on the first two components for each city. Results were categorized accordingly with population classes previously employed in Maps 1 and 2, to analyze if a growth in population is related with a path in certain specialized group of occupations.

[13] It includes the following occupational groups: Computer and Mathematical; Architecture and Engineering; Life, Physical and Social Science; Education, Training and Library; Arts, Design, Entertainment, Sports and Media; Management; Business and Financial Operations; Healthcare Practioners and Technical.

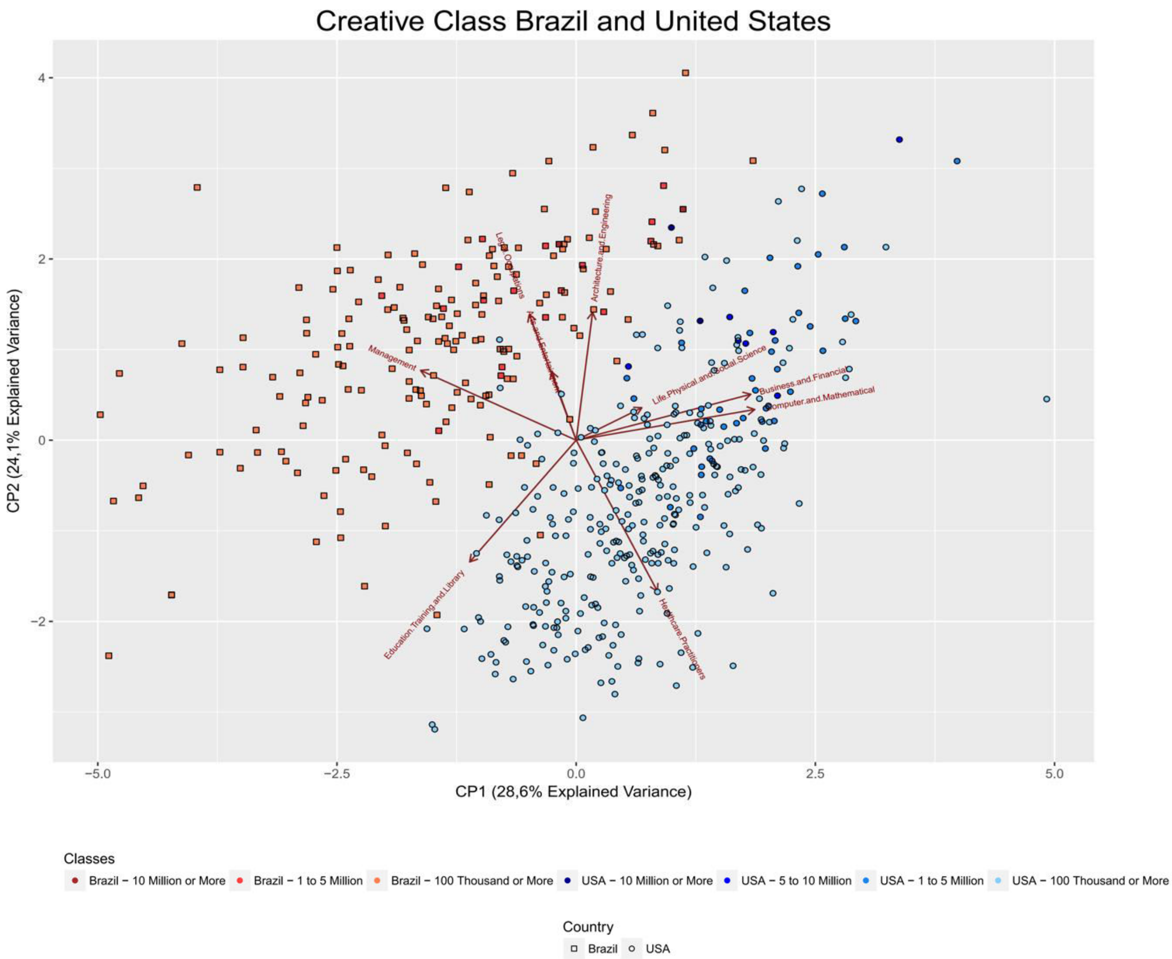

Figure 5. Biplot for principal component analysis for creative class (Brazil and USA)

In figure 5 above, it is possible to note that between countries exist an overall differentiation with Brazilian agglomerations concentrating in an upper-left diagonal triangle while USA cities concentrate in the down-right one. That distribution reflects a compositional differentiation between them for occupations considered here. While Management and Architecture/Engineering Occupations are the three activities most related with Brazilian cities, in USA Healthcare Practioners, Business/Financial and Computer/Mathematical are those more associated with that.

On the other hand, in both countries Education Training and Library occupations are associated with the smallest agglomerations. The small vectors are related to Art and Entertainment and Life Physical Social Science and indicate that these categories do not contribute significantly to explain this differentiation.

Table 3 presents the average score by country and class of cities based on the first two components. This is used as a proxy to analyze the average city on certain group based on the size for each country. If these results are seen as coordinates to a vector that follows city growth, it is possible to note that it has a different pattern between those two countries while its cities grow.

Their biggest cities (three classes running from 1 to 10 million) tend to be concentrated in the first quadrant which represents positive values for both Component 1 and Component 2. But while scores in USA reveals more influence of Business and Financial, Computer and Mathematical for Brazil it tends to be closer to Architecture and Engineering.

The largest difference between countries are associated with their agglomerations running from 100 Thousand to 1 Million groups where the average city has a different signal for Component 1 and Component 2. While in Brazil they are predominantly concentrated in second quadrant guided by Management and Legal Occupations in USA they are in the fourth quadrant which shares in Health Care Practioners play an important role. But in USA case, its position is not distance from Business and Computer vectors.

Table 3. PCA Average Scores by Group of Cities (First and Second Components)

	10 Million or More		5 to 10 Million		1 to 5 Million		100 Thousand to 1 Million	
	CP 1	*CP 2*	*CP 1*	*CP 2*	*CP 1*	*CP 2*	*CP 1*	*CP 2*
Brazil	0.469	2.356	-	-	-0.482	1.642	-1.583	0.975
USA	1.145	1.832	1.880	1.335	1.837	-0.697	0.601	-0.803

As results show, in terms of Creative Class these two countries have some similarity related with their biggest cities, also highlights by the closeness of scores for Sao Paulo and New York, the two biggest cities in both countries. On the other hand, they present an increasingly differentiation towards smaller agglomerations, which indicates that city growth does not necessarily mean specialization in terms of high order activities developed in cities.

Put all together these results point out the fact that in Brazil, city size plays a more central role for both economic composition and concentration of high-educated workers than it does for the United States. If big cities are converging to a same occupational structure which is related to high-skill/high-paid employees but is completely distinct for the rest of the country, this fact can be related with regional imbalance that tends to exacerbate with time showing a different pattern for developed and in development world.

Conclusion

This paper creates comparative parameters for cities in two global important but different national economies: Brazil and the United States. With that aim, this work offers an occupation category crosswalk that enables future studies to compare these two countries in other ways than those followed here. Furthermore, this paper investigates the city patterns of these two countries through size, occupational structure and human capital stock.

Understanding why and how cities are different in distinct contexts can be a useful approach to design more precise strategies.

At first glance, some signs of similarity can be identified, e.g., land area, population and overall occupational structure, but when analyzed at the city level differences between the countries arose. The patterns of these two nations diverge substantially when considering their city-network structure. The USA presents a smoother transition between its larger and smaller places then Brazil. In addition, in job composition and human capital, results show that in Brazil population size tends to play a much more important role then it does in the United States. Together, and considering the spatial distribution of cities in Brazil, these facts point to an important element of regional imbalance.

An interesting step forward would be to look at different patterns in wage inequality between the cities of these two countries. As a city grows, it makes sense to consider the possibility that wage inequality rises with that, since it reflects the divided job market of cities, where knowledge workers make much more money than service and working classes. But given the diverging patterns related to human capital in these two countries and the convergence of economic structure and high skill workers in big cities in Brazil, it would be interesting to investigate in what dimension this inequality can be disentangled from the tension between the growing concentration of talent workers and low paid service jobs.

As pointed out in the beginning of this paper, the highest rates of urban growth in the next few years will come from under and developing countries, places that in general urban economists have just a vague understanding of and how they relate to each other. This is a big challenge to academic researchers and policy makers around the world interested in cities. In that way, this paper contributes to bridging that divide.

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