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The University's Janus Face:

The Innovation-Inequality Nexus

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Abstract

The university is a key source of talent and a key driver of innovation and economic growth in a knowledge based economy. But, in performing these very economic functions it also contributes to economic and spatial inequality. Our research uses a variety of new data to examine this Janus-face of the university in innovation and inequality across US metro areas. We find evidence that the university plays a role in both regional innovation, boosting local patenting and startup companies, and in economic inequality, with higher rates of income and occupational segregation in metros with highly rated universities.

Key Words: University, Innovation, Inequality, Segregation

Introduction

The university is a key source of talent and a key driver of innovation and economic growth in knowledge- based economic capitalism (Mansfield 1991; Rosenberg and Nelson 1994). However, the role of the university in promoting economic prosperity has been narrowly conceived so far, emphasizing its positive aspects and overlooking the potential for negative effects especially on local economies. In particular, because of its highly skilled talent base and ability to draw talent and high technology firms into its environment, universities may also contribute to economic inequality (Aghion et al. 2015, Florida and Mellander 2015).

While universities certainly affect national level innovation and growth, research has shown that they tend to affect innovation and growth by operating through more localized channels. The roles played by Stanford University in the rise and economic performance of Silicon Valley and of MIT in the Boston-Cambridge ecosystem are cases in point (Saxenian 1996). Indeed, universities constitute a rare, irreproducible asset at the local level. For this reason, cities or metro areas that are home to high-quality universities should have a considerable advantage in attracting and retaining talented workers and generating innovative startup companies.

At the same time, it is increasingly clear that the transition to the knowledge economy is raising challenges in terms of inequality, segregation, and a wide range of divides and disparate social outcomes, including in accessing healthcare and education (Chetty et al. 2016, Baum-Snow et al. 2017). Indeed, empirical research shows that knowledge-economy metros and so-called college towns suffer from relatively high levels of inequality and segregation (Florida 2017). Concerns related to those social outcomes emerge in the form of both equality considerations and efficiency considerations, including the sustainability of the knowledge economy in the long-run (Bell et al. 2017).

In this paper, we provide an empirical evaluation of the Janus face, or two-sided role, of the university in both spurring innovation and contributing to economic inequality. We track these divergent and contradictory roles of the university across and within all 350 plus US metro areas. To get at the role of the university in innovation, we use several novel, direct measures of innovation based on patents, patents to papers citations, and venture capital backed startup companies. To get at the role of university in inequality, we use data on income and occupational segregation. We examine the associations between the university and these factors across and within metropolitan areas, shedding light on the extent to which universities can explain differences in knowledge intensity between cities, and how innovation and universities interact in shaping the internal economic geography of cities.

The first part of the paper focuses on the role of the university in innovation. We begin by documenting a strong correlation between the presence and size of local research universities and local patenting intensity. We show that this correlation is more pronounced for universities with higher ranking, and in particular for subject rankings in engineering and sciences. We look separately at university and non-university patenting, and show that, other things being equal, the two are tightly connected.

We then examine one of the most commonly suggested channels behind this relationship – transmission of scientific knowledge from the university to the local industry. We do that by exploiting a unique dataset of matched patent-to-paper citations obtained by combining the USPTO with the Web of Science. Looking at citations of academic papers in local non-academic patents allows us to measure directly the extent to which locally generated science is adopted by local innovating firms. We find large heterogeneity in the technological impact of local science, and argue that the ability of transmitting knowledge locally is a critical factor for universities to work as catalyzers for the development of the local knowledge economy.

We next look at the role of universities on startup companies using data on venture capital investment from Thomson Reuters. Here, we document a strong correlation between the presence of research universities and the intensity of investment in technology-intensive companies. We also exploit the narrow geographical disaggregation of Thomson Reuters's data (at the level of the ZIP code) to show that the concentration of venture capital investment within cities consistently follows the location of major universities. Within metro areas, doubling the distance from a university in the top 100 of the world ranking decreases the amount of venture capital investment by roughly 45 percent.

The second major part of the paper turns attention to the role of the university in economic inequality. We ask whether universities play a direct role in the rise in urban inequality that previous studies have associated to the expansion of innovation activities. We use a measure of spatial inequality – that of economic segregation. Here, we find that metros with research universities are significantly more segregated by both income and occupation, that is, the degree of segmentation in the residential choices of workers in the knowledge economy, as compared to workers in other occupations.

To investigate more closely the role of universities in shaping the degree of economic segregation, we look at the pattern of relocation of knowledge workers within cities between 1990 and 2010. We find that neighborhoods that are geographically closer to research universities have experienced a significantly more pronounced inflow of residents working in knowledge-intensive occupations. Doubling a neighborhood's distance from a top 100 university decreases the 1990-2010 change in the percentage of knowledge workers by roughly 1.1 percentage points.

The picture that emerges from the empirical analysis is one in which universities contribute substantially to both faces of the knowledge economy. On the one hand, they promote the expansion and growth of innovation activities. On the other hand, they facilitate the emergence of social and economic inequalities within cities and metro areas.

Our findings highlight a set of rather serious tradeoffs facing both universities and local and national policy-makers. On the one hand, the ability to attract investment and tech companies, and to provide them with the essential inputs of innovation (scientific knowledge) makes universities more productive and prestigious, and the cities and metro areas that host them more prosperous. On the other hand, the contribution of the university to economic segregation – in particular, the significant increase in the geographic concentration of highly skilled, high income groups around major universities – suggests that universities play a role in socio-economic divides. It is time for both university leaders and public policy makers to take this face of the university seriously, and consider developing mechanisms to address it.

The remainder of the paper is organized as follows. The next section presents the related literature. The third part introduces data sources and measurement. The fourth part presents new evidence on the role of universities in promoting local innovation. After that, the fifth turns to the relationship between universities and urban inequalities. The last section presents our conclusions along with their implications for universities and related public policy.

Concepts and Theory

The role of universities in driving local innovation and economic development has been the subject of an extensive body of literature in both economic geography and economic growth. Ever since Solow (1956), Romer (1986), Lucas (1988) and Aghion and Howitt (1992), it is widely accepted that technological development and human capital accumulation are the main factors behind the rise in living standards over the long run. Rosenberg and Nelson (1994) are among the first to frame the question of the role of universities in aggregate technological development. Private industries are concerned with innovations that have immediate technological and commercial usefulness. In this context, universities' distinct focus should be focusing on basic research that has no immediate returns in the short term, but is essential for the development of technologies in the long term. Mansfield (1991) provides the first empirical estimates of the impact of academic research on industrial innovation, and finds that about one of ten new products and processes in a selected number of industries would not have been developed in the absence of the underlying academic research.

Innovation requires spatial proximity of a sufficiently large mass of firms and innovators who can share talents, inputs and ideas. According to this framework, universities can work as coordination devices to "select" which places will form innovation clusters. The validity of this hypothesis lies on the extent to which universities stimulate local innovation. In a groundbreaking paper, Jaffe et al. (1993) use patent data to show that knowledge spillovers from research universities are highly localized. More recent research provides causal evidence of the historical impact of universities on local innovation and economic activity. A 2014 study exploits stock market shocks interacted with data on university endowments and estimate strong knowledge spillovers to urban counties that are close to universities (Kantor and Whalley 2014). A 2017 study uses the historical selection of university sites in the United States and finds a strong treatment effect of the establishment of a university on local innovation over long time horizons, and identifies migration as the main channel behind this effect (Andrews 2017). A separate study exploits pre-determined variation in federal funding, combined with the effect of the Bayh-Dole Act of 1980, to analyze the effect of university innovation on local employment and economic outcomes (Hausman 2017).

A parallel strand of literature looks at the effect of universities not only on local innovation, but on a broader set of local economic and social outcomes. A 2010 study examines universities across U.S. metropolitan areas, and frames the role of academic institutions on local economic development around three related, but intrinsically different, channels: the supply of human capital, the provision of ideas and technical knowledge, and the promotion of openness to innovation, change, and diversity (Florida, Gates, Knudsen and Stolarick 2010). Another paper, which uses data on university intensity in a large number of countries across long time periods, finds that doubling the number of universities per capita is associated with over 4 percent higher GDP per capita, and also with preferences for more democratic political institutions (Valero and Van Reenen 2016).

A more recent strand of literature focuses on and documents the connection between the rise of the knowledge economy and the increase in social and economic inequalities. Aghion et al. (2015) use state-level variation to document that innovation activities are linked to the increase in top income shares. Florida and Mellander (2015) document the rise of economic segregation in US areas, and note its prevalence in areas with strong innovation and tech sectors. Berkes and Gaetani (2017) use georeferenced patent data to show that the connection between the expansion in innovation activities and the rise in economic segregation is indeed causal in nature. In this paper, we ask whether universities contribute to the increase in urban inequalities, and in particular to the changing geography of US cities, that results from the deep structural transformation of the economy.

Variables, Data and Methodology

In this study, we compare data on universities to measures of innovation and inequality across U.S. metro areas. Our dataset includes information on the location, number and ranking of research universities in the United States, gathered from publicly available sources. We only include universities that appear in the Carnegie Classification of Institutions of Higher Education as Doctoral Universities. The final list includes 316 universities and colleges. We link each university to a set of coordinates within the corresponding Metropolitan Statistical Area (MSA), based on the 2016 definition for MSAs, which allows us to identify the Census Tract or ZIP Code where the university claims its primary address. To proxy for size, we collect information on the total number of students enrolled. To proxy for university quality, we collect information on rankings (both absolute and by subject) from the 2017 Academic Ranking World Universities (available at: http://www.shanghairanking.com/ARWU2017.html).

We consider several measures of innovative activity. We use patent data based on the public releases of the United States Patents and Trademark Office (USPTO). We only include patents issued between 2000 and 2014, and geo-locate each patent according to the address of the first inventor. Since there is no convention of listing inventors in alphabetic order in patent applications, the location of the first inventor is likely to capture the place where most of the patent's contribution was developed. We then assign a unique MSA to each patent. We distinguish between patents whose original assignee is an academic institution from patents whose assignee is a company or another non-university entity. The choice of assigning each patent to the location of the first invention might generate bias in our estimate

We use data on scientific papers via the Web of Science database (that is available via Thomson Reuters), that includes 32 million scientific articles published between 1945 and 2010. In this paper, we consider only articles published between 2001 and 2010. We match them to citing patents according to the string-matching algorithm described in Gaetani and Li Bergolis (2015), that takes into account the name of the first author, publication year, article title, issue, volume, begin and end page.

In addition to data on patents and papers, venture capital backed startup companies are a useful measure of commercially relevant information. We use original and novel data on venture capital investment in startup companies by ZIP code. This data, from Thomson Reuters, is described in detail in Florida and King (2018).

To get at inequality, we use data on income and occupational segregation. These measures are based on the distribution of income and residents by occupation at the Census Tract level, and are assembled from the 1990 Census and the 2008-2012 American Community Survey available at the National Historical Geographical Information System (NHGIS). Income segregation is defined as the within-MSA, cross-Census Tract Gini coefficient, while occupational segregation is defined as the within-MSA, cross-CT index of dissimilarity between workers in knowledge-intensive occupations and workers in other occupations. The classification of occupations in knowledge-intensive and residual occupations is taken from Berkes and Gaetani (2017) and based on Florida (2017)'s definition of Creative Class as occupations spanning computer science and mathematics; architecture and engineering, the life, physical, and social sciences; the arts, design, music, entertainment, sports, and media; management, business and finance; and law, healthcare, education and training.

The University and the Geography of Innovation

We now turn to the results of our research. In this section, we present our results on the role of universities in local innovation, presenting out findings on universities and local innovation using data on patents, patents and papers and venture capital-backed startups. In the next section, we turn to our findings about the role of universities in economic inequality.

The literature has framed the role of universities in supporting and promoting local innovation around two major channels. First, creating and catalyzing the diffusion of basic science, producing applied research, and fostering innovation by local firms and inventors beyond the university boundaries. Second, creating and attracting human capital for the local economy itself.

In this section, we present novel data sources that can be used to inform quantitative and qualitative assessments of the former set of hypotheses. We look at local patenting and its connection to the presence and strength of local universities. We also provide novel, direct measures of knowledge transfer from universities to industry innovation, using a unique dataset of matched patent-to-paper citations. We then look at the relationship between local universities and venture capital investment. In this context, we document both correlations across metro areas, and new facts on the relationship between venture capital investment and universities within the internal geography of cities.

It is important to point out that the university plays a much broader role than simply as innovation as hub or catalyst in the knowledge economy. The university is also responsible for moving the world knowledge frontier forward, and increasing the aggregate supply of human capital. In addition, the university also lays important roles in developing an educated citizenry, and reinforcing norms of tolerance, meritocracy and democratic governance. We recognize that the role and importance of the university goes far beyond its instrumental effects on innovation and economic development, which, alongside its effects on inequality, are the focus of our research.

The main reason why universities are regarded as a major asset for the development of a strong local innovation economy is their ability to supply the basic inputs for the creation of new technologies. The transmission of knowledge and ideas has been shown to be highly localized in nature (Jaffe et al. 1993; Audretsch and Feldman 1996), which makes proximity to a knowledge hub essential for firms that want to acquire and develop cutting-edge technologies. Although this argument applies more strictly to tacit than to codified knowledge (Audretsch and Stephan 1996), the high concentration of innovation activities in space (Carlino and Kerr 2016) suggests that tacit knowledge plays itself a decisive role in making codified knowledge accessible.

Within the strict dimension of knowledge creation, universities act across three key channels. First, universities are responsible for developing basic research that is useful for local innovating companies. In principle, there is nothing that prevents scientific knowledge to be applied in places that are geographically remote from where it originated. However, in practice, local universities occupy a privileged spot: Being geographically close to the industry, they have a better understanding of the scientific problems that are relevant for the industry itself. Moreover, they can exploit synergies to share equipment, data, intellectual and financial resources across so-called university-industry-academia partnerships (Rosenberg and Nelson 1994; Cohen et al. 1998).

Second, universities work as knowledge hubs, through which scientific findings that originate elsewhere are diffused, and eventually adopted by the local industry (Bramwell and Wolfe 2008). In other words, proximity to a university facilitates access to the frontier of scientific knowledge, even if that knowledge is not generated by the local university itself. There is more than one channel that gives rise to this effect. Most obviously, knowledge transmission occurs via alumni's education and subsequent placement in the local industry. However, other channels such as industry-academia partnerships and university's direct effort to diffuse technical knowledge beyond the university's boundaries also play an important role in this dimension.

Third, universities contribute to the local technological development by producing and, in some cases, even commercializing their own technical applications (Mowery and Shane 2002, Mowery 2005, Breznitz and Feldman 2012). This can take the form of technology transfer to existing firms or in the generation of startup companies. This avenue is becoming increasingly relevant for universities. According to the Association of University Technology Managers (AUTM), U.S. Licensing Activity Survey, in 2016 U.S. academic institutions have released 8,208 federally funded inventions, and have accrued more than $2.9 billion in licensing income.

The University and the Geography of Patenting

But, how are local innovation outcomes related to the presence of research universities?

Patents provide high-quality, consistent information on technological innovation and creativity over a sufficiently long time-frame, and at a sufficiently narrow level of geographic disaggregation. We use the patent dataset described in Berkes and Gaetani (2017), but geo-locate each patent at the level of the MSA.

We restrict the dataset to patents issued between 2000 and 2014. A sizeable literature documents the effects of universities on local patenting (see Agrawal 2001 for a review). We look at both the combined patenting output of a metropolitan area, and also at patents according to whether the first assignee is an academic institution or a non-university entity.

We present our results with bin-scatter plots, that are built by dividing observations into equally heavy bins along the right-hand-side dimension, and plotting the average within each bin along the left-hand-side dimension. The line in the plot corresponds to actual underlying regression. To account for areas with zero patenting, we adopt the convention of taking the logarithm of one plus the total number of patents (issued between 2000 and 2014). Note also that since we are controlling for the logarithm of total population, the coefficient of the regression would be the same if the logarithm of total patents were replaced by the logarithm of patents per capita (with the same correction for MSAs with zero patents).

The bin-scatter plot in the left panel of Figure 1 shows the correlation between the logarithm of local patents and a dummy variable that is equal to one if the MSA has at least one research university, after partialling out the logarithm of total population. The correlation is positive and significant. Only 39.7 percent out of the 382 MSAs in the dataset are home to at least one research university. The right panel of the same figure considers only universities that are ranked among the top 100 in the world in the ARWU general ranking (9.1 percent out of 382 MSAs have at least one university in the top 100). The correlation is significantly stronger.

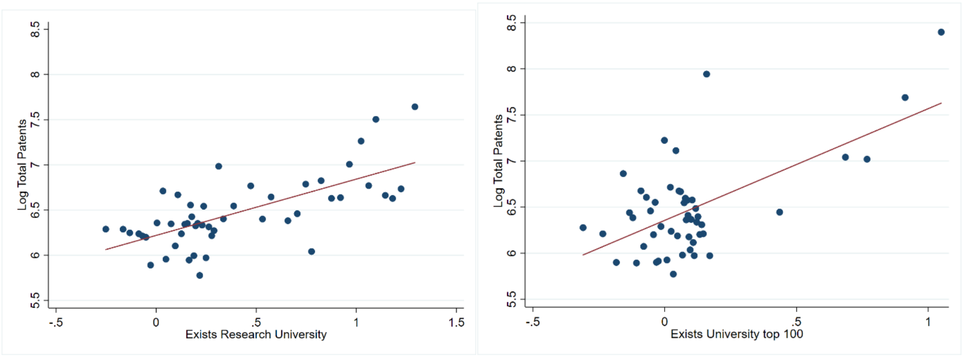


Figure 1: Universities and Patents across Metro Areas

Note: The bin-scatter plot is constructed by splitting the x-axis in 50 equally heavy bins, and plotting the average value of the y-axis variable within each bin. The red line corresponds to the actual underling regression. The bin-scatters control for the logarithm of total MSA population in 2010.

Table 1 reports the coefficients of the underlying regressions on universities and patents. Unless otherwise specified, in MSA-level regressions we cluster standard errors at the state level. The presence of a research university is associated with 62 percent more patenting. The figure for universities in the top 100 of the ranking is even higher (121 percent) and increases to 130 percent for universities in the top 50 (6 percent of the MSAs are home to at least one university in the top 50). The last three columns show that a similar pattern holds when taking the size of the university into account. Doubling the number of students as a proportion of the population is associated with 6.6 percent more patenting, that increases to 11.5 percent for students in top 100 and to 12.4 percent for students in top 50 universities.

Table 1: Regression Results for Universities and Patents

Dependent Variable: Log of Total Patents						
	University exists			Log of students enrolled		
	All	Top 100	Top 50	All	Top 100	Top 50
University	0.62***	1.21***	1.30***	0.066***	0.115***	0.124***
	(0.12)	(0.22)	(0.20)	(0.012)	(0.021)	(0.018)
Log Pop.	1.17***	1.17***	1.21***	1.14***	1.17***	1.20***
	(0.06)	(0.05)	(0.04)	(0.06)	(0.05)	(0.05)
N	382	382	382	382	382	382
R^2	70%	71%	70%	70%	70%	70%

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2 looks at the correlations separately for subject rankings. The ARWU publishes subject rankings in five broad, “macro” areas (Natural and Life Sciences, Engineering, Medicine and Social Sciences). The University variable for each subject is equal to one if the metro area is home to at least one university that is in the top 100 of the corresponding world subject ranking. As we would expect, the presence of universities that are highly ranked in Sciences and Engineering is associated with higher patenting than universities that are highly ranked in Social Sciences and Medicine (the latter is possibly explained by the focus on teaching of some of the highest ranked institutions).

Table 2: Regression Results for Universities and Patents by Field

	Dependent Variable: Log of Total Patents				
	University exists: Top 100				
	Natural Sciences	Social Sciences	Engineering	Medicine	Life Sciences
University	1.09***	0.95***	1.22***	0.91***	1.19***
	(0.16)	(0.18)	(0.19)	(0.24)	(0.21)
Log Pop.	Yes	Yes	Yes	Yes	Yes
N	382	382	382	382	382
R^2	70%	70%	69%	71%	70%

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

A related question is which technological areas (patent classes) display the highest correlation with the presence of research universities. Table 3 shows the corresponding regressions separately for patents in each of the eight macro areas (A to G) as the defined by the International Patent Classification. (The Appendix discusses how patents are linked to a unique IPC macro class). As independent variable, we use the presence of a university in the top 100 of the general ranking. In order to make results comparable across different classes, we standardize the dependent variable, so that the resulting coefficients can be interpreted as cross-MSA standard deviations in the logarithm of patents.

Table 3: Universities and Patents by Type of Patent

Dependent Variable: Log of Total Patents in Macro IPC Class (standardized)				
	University exists: Top 100			
	Human Necessities (A)	Performing Operations (B)	Chemistry and Metallurgy (C)	Textiles and Paper (D)
University	0.66***	0.45***	0.81***	0.26*
	(0.09)	(0.10)	(0.10)	(0.13)
Log Pop.	Yes	Yes	Yes	Yes
	Fixed Constructions (E)	Mechanical Engineering (F)	Physics (G)	Electricity (H)
University	0.21**	0.35***	0.78***	0.71***
	(0.09)	(0.11)	(0.14)	(0.15)
Log Pop.	Yes	Yes	Yes	Yes

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

Universities have the highest impact on macro areas A (Human Necessities, which includes Medicine), C (Chemistry), G (Physics, which includes Software and Computer Sciences) and H (Electronics). On the other hand, the weakest impact appears in classes D (Textiles and Paper) and E (Fixed Construction).

We now consider two distinct channels through which local university intensity can directly affect local innovation output. The first is university patenting, that is the direct production of applied knowledge by universities, that results into patented inventions. The second is the creation of scientific knowledge that is adopted by local innovating firms and other non-academic entities.

Universities are directly responsible for the production of technological innovation. Like firms, universities file for and are issued patents. The prevailing legal framework was heavily reshaped by the Bayh-Dole Act of 1980, that allowed universities and other non-academic entities making use of federal research funding to elect themselves as the owners of the intellectual property associated with the resulting inventions. There is a large literature documenting the impact of the Bayh-Dole Act on university innovation and its commercialization (see Thursby and Thursby 2003).

There is significant variation in terms of patent output across research universities. Table 4 highlights this variation by reporting the large metro areas (those with at least 1 million people and 30,000 students) with the highest and the lowest patents-to-student ratio (for the purpose of this analysis, we only consider patents filed by academic entities). The San Francisco-Oakland metro has the highest ratio (6.9 patents every 100 students), whereas the Greensboro-High Point, NC metro, has the lowest score (0.3 patents every 100 students).

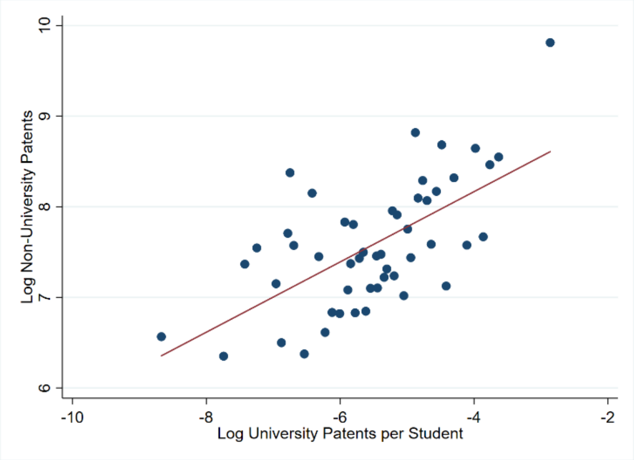
Table 4: Metros with Highest and Lowest University-Patenting Intensity

Highest University-Patenting Intensity		**Lowest University-Patenting Intensity**	
MSA	University Patents per 100 Students	MSA	University Patents per 100 Students
San Francisco–Oakland	6.9	Toledo	0.3
Baltimore	3.3	Miami	0.2
Boston–Cambridge	2.3	Milwaukee	0.1
Durham-Chapel Hill	2.3	Madison	0.1
Los Angeles	2.1	Greensboro–High Point	0.1

Note: Metro names are shortened.

A natural question is whether university patenting positively correlates with non-university patenting within the same metropolitan area. Figure 2 displays the correlation between the log of university patenting intensity (university patents per student) and the logarithm of non-university patents, after partialling out the logarithm of total population. Metros with higher university patenting also have a higher rate of patenting from non-university entities. The coefficient of the underlying regression is 0.39, which implies that increasing the patents-to-student ratio by 1 percent is associated with 0.39 percent higher patenting from non-university entities. The residual R2 is 19 percent.

Figure 2: University vs Non-University Patents by Metro



Note: The bin-scatter plot is constructed by splitting the x-axis in 50 equally heavy bins, and plotting the average value of the y-axis variable within each bin. The red line corresponds to the actual underling regression. The bin-scatter controls for total MSA population in 2010.

Universities promote local technological creativity by supplying the scientific background upon which applied knowledge builds. To get at this, we develop a novel metric of knowledge transfer using the matched paper-to-patent citation data built by Gaetani and Li Bergolis (2015). The data is based on the universe of scientific papers from the Web of Science (1945-2010) matched to citing patents from the USPTO (1976-2014), although in what follows we focus on papers published between 2001 and 2010. This data enables us to the significant variation in the extent to which research universities supply scientific knowledge to local innovation outside the university's boundaries. Here, we employ three different metrics. First, we measure the technological impact of local university papers on local patenting activity (measured as the average number of citations local university papers received by local non-university patents). Second, we look at the technological impact of local university papers on non-local patents, that is a relevant measure of the overall "usefulness" of local science. Third, we look at the ratio between the previous two, that provides a measure of how much of the locally created knowledge, stays locally. See Appendix for details on how we construct these variables.

Table 5 reports the MSAs with the highest and lowest transfer rate of local science on local production of applied technology, measured as local patent citations per local academic article. Note that since our objective is to measure knowledge transfer from the academia to the industry, for the purposes of these measures we only take into account citations coming from non-university patents.

Table 5: Metros with Highest and Lowest Rates of Knowledge Transfer

Highest Local Knowledge Transfer		**Lowest Local Knowledge Transfer**	
MSA	Local impact of local papers ×100	MSA	Local impact of local papers ×100
Boston–Cambridge	7.6	Virginia Beach-Norfolk–Newport News	0.2
San Diego	6.0	Detroit	0.19
San Francisco–Oakland	3.6	Buffalo	0.16
Austin	3.0	Nashville	0.06
Phoenix	2.2	Richmond	0.04

Note: Metro names are shortened.

There is significant variation in the extent to which the scientific production of local universities transfers to the local industry. For example, Boston and San Diego generate 7.6 and 6.0 citations for every 100 scientific papers produced by local universities, respectively. On the opposite end of the spectrum, the corresponding numbers for Richmond, VA and Nashville, TN are two orders of magnitude smaller (0.04 and 0.07, respectively).

Part of this variation in the strength in knowledge transfer can be explained as more efficient transmission of scientific production to local industry. However, a significant part can also be explained by the intrinsic characteristics of the local scientific production (for example, variation in applicability) that is not directly linked to the ability to transfer knowledge locally. To get at this, Table 6 shows the MSAs with the highest and the lowest transfer to non-local industry. San Diego, San Francisco and Austin are still in the top five, whereas Virginia Beach, Buffalo and Nashville again display low levels of scientific transmission.

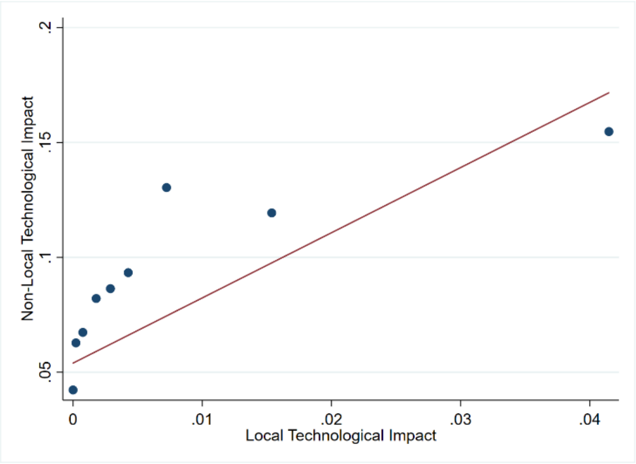
Table 6: Metros with Highest and Lowest rates of Knowledge Transfer to Non-Local Industry

Highest Non-Local Knowledge Transfer		**Lowest Non-Local Knowledge Transfer**	
MSA	Non-Local impact of local papers ×100	MSA	Non-Local impact of local papers ×100
San Diego	24.2	Cincinnati	6.8
Tucson	22.4	Virginia Beach–Norfolk– Newport News	6.8
Dallas–Fort Worth	20.6	Buffalo	5.8
San Francisco–Oakland	19.8	Nashville	5.5
Austin	19.7	Richmond	2.6

Note: Metro names are shortened.

Statistically, the two measures of local and non-local transmission are highly correlated. An increase in the local impact measure by one citation is associated with 2.6 more non-local citations (with an R2 of 34 percent). The bin-scatter in Figure 3 displays the correlation between the two measures. It is interesting to note that, in absolute terms, non-local transmission is on average higher than local transmission, suggesting that a significant component of the effect of local science on industry innovation does not occur locally.

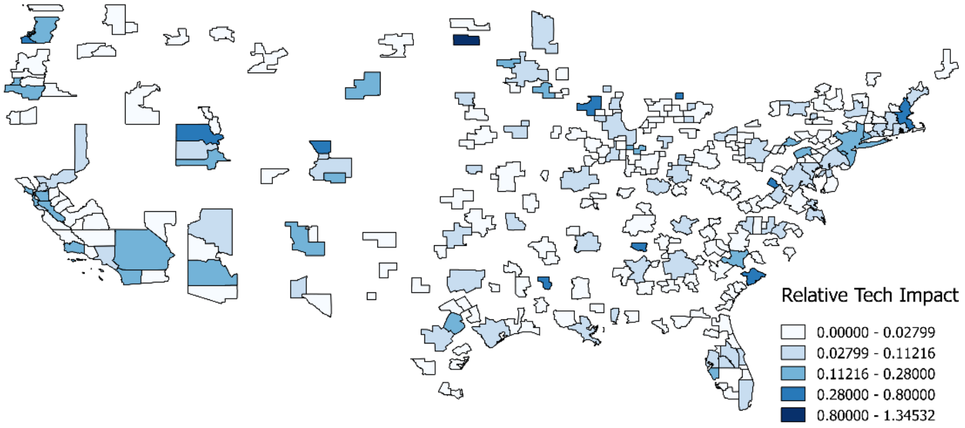
Figure 3: Local vs. Non-Local Knowledge Transfer



Note: The bin-scatter plot is constructed by splitting the x-axis in 50 equally heavy bins, and plotting the average value of the y-axis variable within each bin. The red line corresponds to the actual underling regression.

However, there is also significant variation in the extent to which scientific knowledge that is locally generated is mostly adopted by local innovating firms. The map in Figure 4 shows the distribution of the third measure (the ratio between local and non-local transmission). Among large MSAs (defined as areas with at least 1 million people and 30,000 students) Boston, San Diego, San Francisco and Austin have the highest ratio of local-to-non-local knowledge transfer, whereas Tucson, Nashville, Richmond and Detroit have the lowest.

Figure 4: Ratio of Local vs Non-Local Knowledge Transfer



The picture that emerges here suggests that universities can position themselves in three alternative ways with respect to local innovation. A first way is to focus on the production of scientific knowledge that is transmitted locally and adopted by nearby innovating firms. This approach is revealed by a high impact of scientific production on local patenting, as measured by patent-to-paper citations. A second way is to produce scientific knowledge that is mostly adopted elsewhere. This approach is revealed by high impact of scientific production on non-local patenting. The third way is to attempt to directly utilize the scientific knowledge via technological applications within the university itself. This approach is revealed by high rates of university patenting. Importantly, each of those positions have peculiar benefits and disadvantages, and, at the aggregate level, a combination of the three is likely to be optimal from the perspective of aggregate innovation and growth.

The University and Venture Capital-Backed Startups

Venture capital-backed startup companies provide a robust measure of commercially-validated and relevant innovation. A large literature in corporate finance and innovation causally links venture capital investment to innovation outcomes (see, among others, Kortum and Lerner, 2000, and Dessi and Yin, 2012).

In this section, we examine how research universities are connected to venture capital-backed startups across US metros. We use data on venture capital investment in high-tech startups from Thomson Reuters, covering $35 billion funding episodes in 2012 and 2013, geo-located at the level of the ZIP code (see Florida and King 2017 for a detailed description of the dataset). We use this unique dataset to document both correlations between university intensity and venture capital investment across MSAs, and the geography of venture capital investment and research universities within metro areas.

Table 7 displays the MSA-level correlation between the logarithm of venture capital investment and a dummy variable that is equal to one if the MSA hosts at least one research university, controlling for the logarithm of total population. Again, we use the convention of taking the logarithm of one plus total venture capital investment (in millions) to account for the presence of MSAs with zero investment. Since we control for the logarithm of total population on the right-hand-side, coefficients would be identical if the logarithm of investment per capita was used on the left-hand-side. In columns (b) and (c), we replicate the same regression using only universities in the top 100 and top 50 of the ARWU ranking. The correlation is highly significant, and increases in magnitude as the university ranking improves. MSAs with universities in the top 50 have 274% higher venture capital investment, after controlling for the effect of population.

Table 7: Venture Capital Investment and Universities across US Metros

	Dependent Variable: MSA-level Venture Capital Investment								
	All	Top 100	Top 50	All	Top 100	Top 50	All	Top 100	Top 50
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
University	0.74***	2.47***	2.74***	0.72***	2.05***	2.28***	0.47***	1.77***	1.96***
	(0.07)	(0.33)	(0.37)	(0.12)	(0.28)	(0.28)	(0.13)	(0.24)	(0.23)
Log income per capita				3.61***	2.68***	2.83***	2.34***	1.67***	1.77***
				(0.66)	(0.51)	(0.52)	(0.43)	(0.36)	(0.40)
Log patents							0.41***	0.36***	0.37***
							(0.10)	(0.07)	(0.07)
Log pop.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	382	382	382	382	382	382	382	382	382
R^2	65%	72%	71%	72%	76%	75%	74%	78%	77%

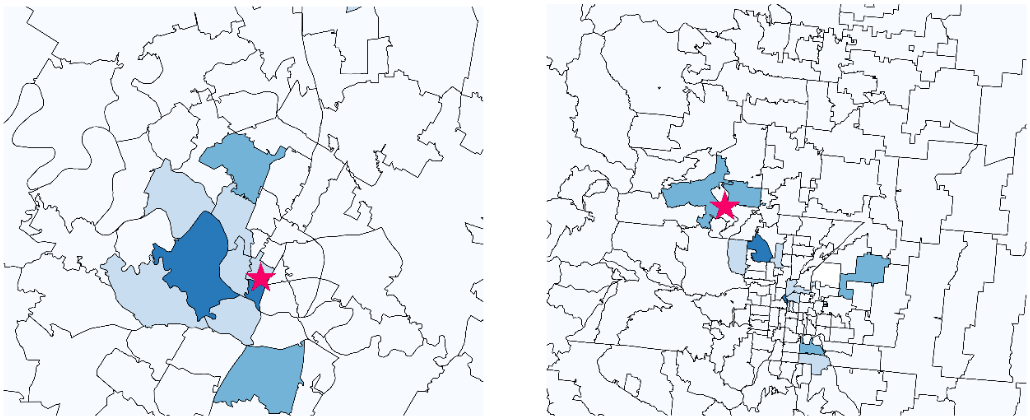
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

It is important to stress that this correlation does not reveal the direction of causality, and does not exclude the presence of confounding factors that affect at the same time the quality of local universities and the level of venture capital investment. In order to partially account for those factors, in columns (d)-(f) we replicate the same regressions controlling for the logarithm of income per capita. The coefficient on top 50 universities drops from 2.74 to 2.28. Moreover, to verify that venture capital investment contains variation that is not fully correlated with other measures of innovation, in columns (g)-(i) we replicate the same regressions controlling for the logarithm of total patents. Coefficients decrease slightly for all categories of ranking, but they remain economically large and statistically significant.

The Thomson Reuters data contain information on venture capital investment at the level of the ZIP Code, so they can be used to explore the connection between investment and the presence of research universities within metro areas.

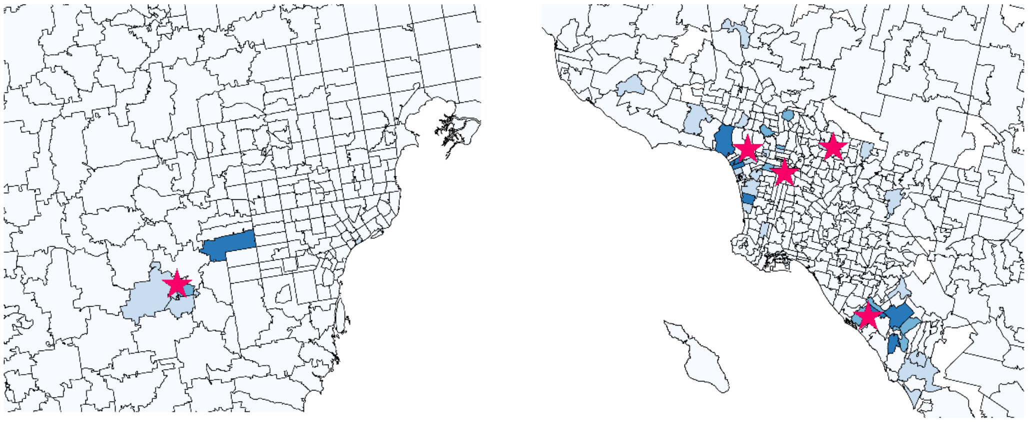
The maps in Figure 5 show the concentration of venture capital investment recorded in the Thomson Reuters data for a selection of metropolitan areas in the United States. Top 100 research universities are marked with a star. The picture that emerges suggests that venture capital investment tends to concentrate around major university centers. In Los Angeles (panel d), venture capital funding is clustered in the northern part of the metro area, that is, around the major centers of UCLA, USC and Caltech. In the Detroit metro area, investment concentrates in the ZIP Codes surrounding the University of Michigan at Ann Arbor (panel c). Denver and Boulder (panel b) show a concentration of venture capital-backed startups in the area surrounding the University of Colorado. In Pittsburgh (panel f), the downtown area, home to the University of Pittsburgh and CMU has the highest concentration of venture capital deals.

Figure 5: The University and Venture Capital Investment in Selected Metros



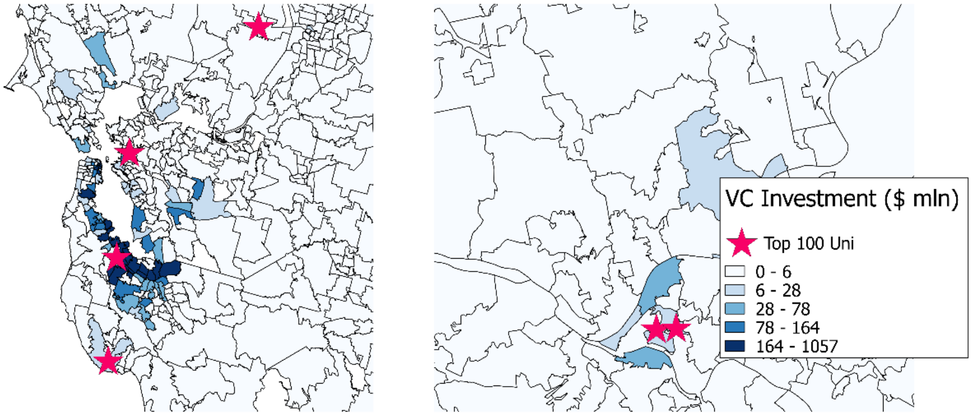
Austin, TX (a)

Denver - Boulder, CO (b)



Detroit - Ann Arbor, MI (c)

Los Angeles, CA (d)



San Francisco - San Jose, CA (e)

Pittshburgh, PA (f)

To test this, we regress the logarithm of venture capital investment for each ZIP Code on an MSA fixed effect, the logarithm of total ZIP Code employment, and the logarithm of the distance of each ZIP Code from the closest research university in the top 100 ranking. We weight observations by total ZIP Code employment, and cluster standard errors at the level of the MSA. Table 8 reports the results.

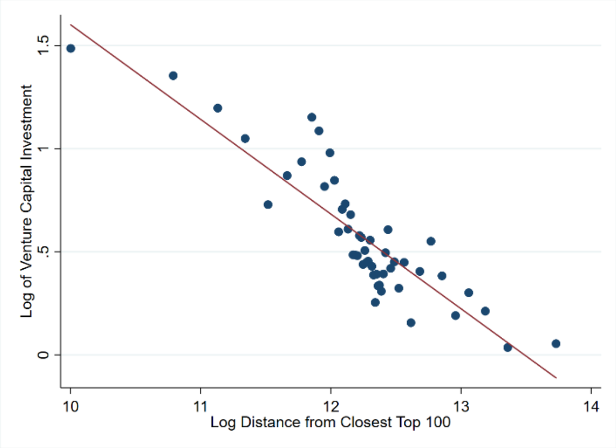
Table 8: Venture Capital Investment and Highly Ranked Universities across US Metros

	Dependent Variable: **Log Venture Capital Investment**			
	(a)	(b)	(c)	(d)
Log distance from top100	-0.33***	-0.65***	-0.51***	-0.45***
	(0.04)	(0.09)	(0.069)	(0.05)
Log total employment			0.39***	0.34***
			(0.05)	(0.04)
Log Income per Capita				0.69***
				(0.07)
MSA fixed effects	No	Yes	Yes	Yes
N	18,042	18,042	18,042	17,711
R^2	15%	33%	40%	45%

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Within metro areas, doubling the distance from a university in the top 100 of the world ranking decreases venture capital investment by 51 percent, after controlling for the logarithm of total employment. This elasticity decreases slightly to 45 percent once we control for the logarithm of average ZIP Code income.

Figure 6: Venture Capital Investment and Highly Ranked Research Universities



Note: The bin-scatter plot is constructed by splitting the x-axis in 50 equally heavy bins, and plotting the average value of the y-axis variable within each bin. The red line corresponds to the actual underling regression. The bin-scatter controls for the logarithm of ZIP code employment and income per capita, and for MSA fixed effects.

Figure 6 displays this correlation graphically via a residual bin-scatter plot, revealing a clear linear relationship between venture capital investment and proximity to research universities within metro areas.

The patterns documented here suggest that research universities are an important factor that shapes the internal economic geography of cities. The concentration of innovation activities around major universities can be explained both by supply-side factors, such as access to talent and ideas, and by demand-side factors, such as preferences for living in areas with a high concentration of high-income, high-education residents who tend to cluster around universities.

Whatever the underlying reason, this pattern suggests that, by reshaping the internal geography of cities, universities can contribute to the rise in urban inequality. This is the issue to which we now turn.

The University and Inequality

We now turn the second face of the university, examining its role in inequality. Recent studies have argued that the rise of an innovation-based economy is one of the main factors behind the increase in economic and social inequalities experienced in advanced economies throughout the last decades (Aghion et al. 2015, Florida and Mellander 2015, Berkes and Gaetani 2017). This urban spatial component is one of the most relevant dimensions of this phenomenon, since it affects a large range of outcomes, including equality of opportunities, education, health, and intergenerational mobility.

The reasons behind this connection are still not fully understood. Some of the explanation may have to do with knowledge spillovers, and the fact that spatial proximity is disproportionately powerful in boosting productivity in occupations where returns to learning are high. Those occupations tend to be concentrated in knowledge-intensive sectors. When the knowledge economy develops locally, incentives among high-education, high-salary workers to cluster in close neighborhoods increase (Moretti 2004, Bacolod et al. 2009), and economic segregation emerges as a natural consequence. Another class of explanations is concerned with the demand for local amenities, and how this demand is affected by the rise of the knowledge economy (Moretti 2012, Florida 2017). Workers in knowledge-intensive occupations are disproportionately sensitive to residential amenities, some of them critical (such as high-quality schools) others more frivolous (such as coffee shops and organic grocery stores) that lead to higher house prices and work as an amplifier to initial shocks to urban segregation (Baum-Snow and Hartley 2017, Berkes and Gaetani 2017, Couture and Handbury 2017).

In this section, we investigate to what extent universities contribute to economic inequality. We use a measure of spatial inequality, economic segregation which we measure two ways in terms of both income and occupational segregation. In particular, we ask whether MSAs with a higher incidence of research universities are associated with a higher level of income and occupational segregation. The first indicator refers to the extent to which income in a metro area is geographical concentrated in a limited number of neighborhoods. The second indicator refers to the extent to which residents in knowledge intensive occupations tend to cluster in the same neighborhoods in the city.

We find a significant correlation between the presence of research universities and both income-based and occupation-based measures of economic segregation across MSAs. We also find a consistent pattern of relocation of residents working in knowledge-intensive occupations towards neighborhoods around main universities, which suggests that universities can be one of the driving factors behind the changing economic geography of cities in the knowledge economy.

The University and Income Segregation

To measure income segregation at the MSA level, we use the cross-Census Tract, within-MSA Gini index, that captures the dispersion of income across Census Tracts within a given metro area. Census Tract-level information on income is based on the 2008-2012 waves of the American Community Survey.

Table 9 shows results of regressions of income segregation on a dummy variable that is equal to one if the MSA is home to at least one research university (depending on the specification, regardless to ranking, only in the top 100, and only in the top 50). A standard set of controls, comprising the logarithm of population, average income and the logarithm of the number of Census Tracts within the MSA (to account for the possible dimensionality bias in the construction of the segregation measures), is included in the regression.

Table 9: Universities and Income Segregation

	Dependent variable: Income Segregation in 2010					
	(a)	(b)	(c)	(d)	(e)	(f)
	All	Top 100	Top 50	All	Top 100	Top 50
University	3.87***	1.29	0.97	3.80***	1.86**	1.33*
	(0.43)	(0.82)	(0.75)	(0.45)	(0.69)	(0.70)
Log population	1.32***	2.10***	2.17***	-3.20**	-3.11**	-2.88**
	(0.16)	(0.18)	(0.17)	(1.28)	(1.29)	(1.28)
Log income per capita				-1.79	-2.42	-2.03
				(1.88)	(1.97)	(2.00)
Log # of CTs				4.71***	5.36***	5.22***
				(1.18)	(1.23)	(1.22)
N	382	382	382	382	382	382
R^2	44%	32%	31%	48%	36%	35%

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Columns (a) and (d) display the results when all university, regardless of ranking, are included in the construction of the University variable. The coefficient is large and economically significant: The presence of a research university is associated with higher income segregation, in the order of 3.8 Gini points, compared to metro areas without research universities. To fix ideas on the magnitude of the coefficient, the standard deviation across MSAs in income segregation is 4.3 Gini points.

Columns (b) and (e) display the results when only universities in the top 100 of the world ranking are included in the construction of the University variable. The estimated coefficients are still economically large (1.29-1.86 depending on the specification). Analogously, columns (c) and (f) shows the results when only universities in the top 50 of the world ranking are included. Results are consistent in sign and economic and statistical significance.

It is important to stress that income segregation can be due to either higher levels of overall inequality, or to a more pronounced sorting of residents across neighborhoods, along the income or occupational dimensions. Assessing inequality in the distribution of income is particularly problematic in so-called college towns, because of the presence of many students with very low income (see Casselman 2014). In order to overcome these limitations in the income-based measure of segregation, in what follows, we look at occupational segregation, that is, the extent to which residents in similar occupations tend to cluster geographically within a metro. We also look at the relationship between research universities and the evolution of the internal economic geography of US metros in the last decades. We find a consistent pattern of relocation of workers in knowledge-intensive occupations towards the neighborhoods that surround research universities, suggesting that universities play an important role in the increase in urban inequality and segregation spurred by the rise of the knowledge economy.

The University and Occupational Segregation

Income segregation in cities with large universities is only an approximate measure for the state of urban inequality. First, despite universities being one of the cradles of the knowledge economy, they tend to pay relatively lower salaries, and display relatively lower levels of internal inequality, than other entities of comparable innovation or knowledge intensity such as private tech companies. Second, a large presence of students implies an income distribution with a large share of household with low levels of recorded income but a high potential in driving up urban economic segregation.

In this section, we look at occupational sorting directly. We use data from the 2008-2012 American Community Survey to compute the number of residents in each Census Tract who work in knowledge-intensive occupations. The definition of knowledge-intensity is adapted from Berkes and Gaetani (2017), and is based on Florida (2017) (Also see the Appendix for variable definitions). We then define occupational segregation (OS) as the within-MSA index of dissimilarity between residents categorized as knowledge workers, and residents in residual occupations:

$$OS_{MSA} = \sum_{ct} \left| \frac{K_{ct}}{K_{MSA}} - \frac{R_{ct}}{R_{MSA}} \right|$$

whereK_{ct} (R_{ct}) denotes the number of residents in Census Tract ct employed in knowledge-intensive (residual) occupations, and K_{MSA} (R_{MSA}) denote the total number of residents in metro area MSA in the two occupational classes.

Table 10 display results of regressions of MSA-level occupational segregation and the University dummy variable defined as above. The presence of research universities is consistently associated with higher occupational segregation. The range of coefficients (1.77-2.68 depending on the specification and the university ranking considered) suggests a relationship that is economically large (the cross-MSA standard deviation in the index of dissimilarity is 4.42). Differently from the results in Table 8, universities of higher ranking are associated with more pronounced occupational segregation.

Table 10: Universities and Occupational Segregation

	Dependent Variable: Occupational Segregation in 2010					
	All	Top 100	Top 50	All	Top 100	Top 50
University	1.80***	2.23***	2.15**	1.77***	2.68***	2.49**
	(0.40)	(0.66)	(0.97)	(0.40)	(0.59)	(0.93)
Log population	2.23***	2.39***	2.48***	0.39	0.17	0.47
	(0.20)	(0.19)	(0.18)	(1.72)	(1.63)	(1.62)
Log income per capita				-1.22	-2.36	-2.01
				(1.65)	(1.57)	(1.52)
Log # of CTs				1.95	2.37	2.15
				(1.62)	(1.55)	(1.55)
N	382	382	382	382	382	382
R^2	44%	43%	43%	45%	44%	44%

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The findings presented in Table 10 suggest that metro areas with research universities are the ones that display a more pronounced segmentation in the residential choices of individuals with different occupational backgrounds. A possible explanation is that universities contribute to attracting firms in technology intensive industries, that are more likely to rely on spatial proximity and build innovation clusters around major academic institutions, as shown in Section 4. Residential choices of knowledge workers respond to such concentration of jobs, driving up occupational segregation.

The University and the Changing Geography of US Cities

The question now becomes this: To what degree the university itself play any major role in determining the patterns of such residential segregation?

To get at this, we look at the evolution of the internal economic geography of US metro areas, and how it is related to the presence of research universities. In particular, we ask whether neighborhoods that are geographically closer to universities in the top 100 of the world ranking have experienced a larger increase in the share of residents in knowledge-intensive occupations. As we showed using data on venture capital investment, innovation activities tend to cluster within cities around major universities. Since residential choices are linked to employment opportunities, it is reasonable to expect that neighborhoods around major universities have also experienced a more pronounced relocation of knowledge workers. Moreover, as argued, among others, by Diamond (2016), Baum-Snow and Hartley (2017), an even bigger impulse to the process of relocation is provided by the quick evolution of residential amenities.

Empirically, we proceed as follows. First, we compute the distance from each Census Tract's centroid to the primary address of the closest top 100 research university. Then, we regress the 1990-2010 change in the percentage of knowledge-intensive residents in the Census Tract on the logarithm of the distance from the closest university (including, in the preferred specification, an MSA fixed effect). We weight our regressions by the total number of residents in 1990 and cluster standard errors at the MSA level.

The key results are displayed in Table 11 and, visually, in the bin-scatter plot of Figure 7. Columns (a) and (b) show that, unsurprisingly, neighborhoods that are closer to top 100 universities have a larger share of residents in knowledge occupations. This pattern is more pronounced in 2010 (within MSA, doubling the distance decreases the share of knowledge workers by 3.33 percentage points) than it is in 1990 (2.25 percentage points).

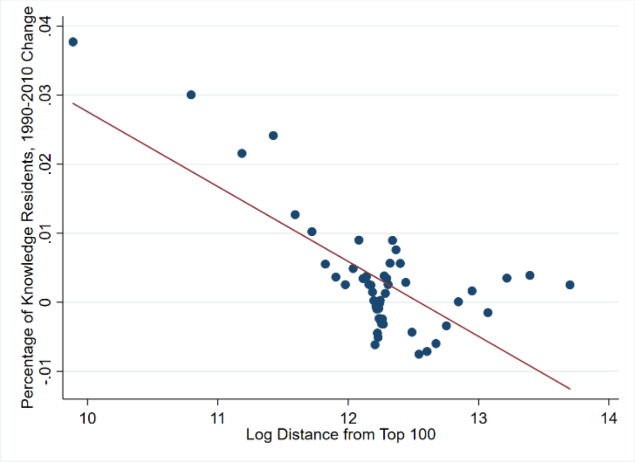
Our preferred specification with MSA fixed effects (column d) implies that neighborhoods that are twice as distant from a top 100 university have experienced a change in the percentage of knowledge-intensive residents that is 1.08 percentage points lower. The bin-scatter in Figure 7 reveals that the decreasing relationship is very clear for neighborhoods in the left of the log-distance distribution, and is somewhat confounded for neighborhoods in the right of the distribution. This suggests that the effects of proximity to universities is very strong in the immediate surroundings, and decreases rapidly with distance.

Table 11: The University and Occupational Segregation

	Dependent Variable:			
	Percent Residents in Knowledge-Intensive Occupations		**Change in % Residents in Knowledge-Intensive Occupations**	
	(a) - 1990	(b) - 2010	(c)	(d)
Log distance from top100	-2.25***	-3.33***	-0.54***	-1.08***
	(0.43)	(0.47)	(0.09)	(0.19)
MSA fixed effects	Yes	Yes	No	Yes
N	47,794	47,731	47,731	47,731
R^2	14%	17%	2%	9%

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

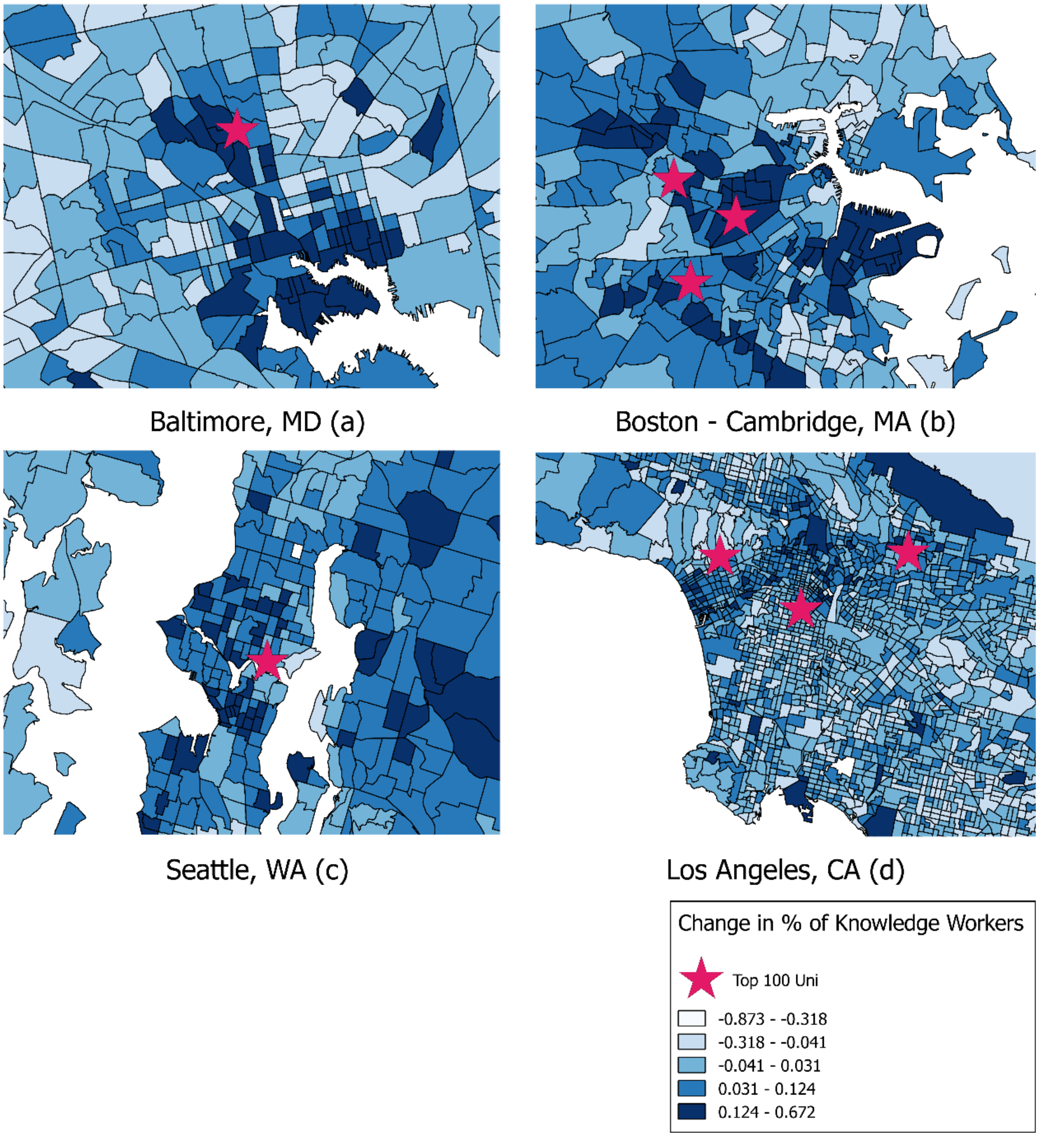
Figure 7: The University and the Geography of Knowledge Workers



Note: The bin-scatter plot is constructed by splitting the x-axis in 50 equally heavy bins, and plotting the average value of the y-axis variable within each bin. The red line corresponds to the actual underling regression. The bin-scatter is weighted by total CT residents in 1990 and controls for MSA fixed effects.

The maps in Figure 8 depict a selection of visually interesting cases. Baltimore (panel a) had a pronounced increase in knowledge workers in the downtown area and in the area around Johns Hopkins University. . Boston (panel b) experienced a strong relocation towards, among others, the Census Tracts surrounding Cambridge (home to Harvard and MIT) and Boston University. Seattle (panel c) experienced a sharp increase in the share of knowledge workers in the neighborhoods around the downtown area, that coincides with the location of the University of Washington. Visually, the most striking example appears in Los Angeles (panel d), where the line connecting UCLA, USC and Caltech display a dark band of neighborhoods with very strong relocation of knowledge intensive workers.

Figure 8: The University and Knowledge Workers in Selected Metros



Baltimore, MD (a)

Boston - Cambridge, MA (b)

Seattle, WA (c)

Los Angeles, CA (d)

Discussion and Conclusion

In this paper, we have used novel data sources to examine the Janus face of the university in both innovation and economic inequality. To do so, we examined a wide variety of data on the geography of patenting, patent-to-paper citations and venture capital-backed startups.

Generally speaking, our findings show that metro areas with larger concentrations of universities and of more highly ranked universities are more innovative and more unequal or economically segregated. On the one hand, metros with higher concentrations of universities and of more highly ranked universities have higher rates of patenting, higher patent-to-paper citations, and greater levels of venture capital-backed startups. On the other hand, metros with higher concentrations of universities and of more highly ranked universities have higher levels of urban spatial inequality, measured in terms of income and occupations. These two contradictory roles of the university may at least in part be related to the same underlying concentration and clustering of talented knowledge workers around universities. Our findings have important and potentially useful implications for national and especially for local level policy makers and for university executives and administrators as well. The past several decades have seen national-level policies like Bayh-Dole and perhaps even more importantly state and local innovation policy leverage universities as sources of innovation and economic development. Universities and university-affiliated medical centers, or "eds and meds" have figured prominently in local economic development strategies. These strategies have sought to leverage these so-called "anchor institutions" as sources of innovation, startups, job creation, and overall economic development.

But, our findings suggest that the very success of these policies and initiatives may also come with a cost. We find that universities', and especially highly ranked and high-quality universities, contribute to economic inequality, in the form of higher levels of both income and occupational segregation. Here it makes little sense to throw the proverbial "baby out with the bathwater,' by seeking to limit or constrain the university's role in innovation and economic development. What would seem to make more sense is to encourage universities, anchor institutions and public policy makers to undertake programs, policies and initiatives to more completely take into account and mitigate the negative effects of the university local economic and communities. Universities could become more directly involved at generating more inclusive and fully shared prosperity by paying closer attention to and undertaking initiatives to upgrade low-wage routine service jobs, including importantly their own service employees, and provide affordable housing for their lower-paid workers (Florida and Pedigo 2017).

Universities, unfortunately, have already become lightning rods for conservative and populist politicians who see them as both elitist, overly liberal, and undermining traditional family values. If their role in spurring inequality is left unaddressed, our universities which play such a necessary and vital role in innovation, talent development and attraction, and economic development, not to mention democratic norms, are likely to be further undermined to all of the detriment of our economy, society and all of us.

Bibliography

Association of University Technology Managers (2016). U.S. Licensing Activity Survey.

Adler, P., Florida, R., King, K. & Mellander, C (2017). The City and Innovation. Martin Prosperity Institute Working Paper.

Aghion, P., & Howitt, P. (1990). A model of growth through creative destruction (No. w3223). National Bureau of Economic Research.

Aghion, P., Akcigit, U., Bergeaud, A., Blundell, R., & Hémous, D. (2015). Innovation and top income inequality (No. w21247). National Bureau of Economic Research.

Agrawal, A. K. (2001). University - to - industry knowledge transfer: Literature review and unanswered questions. International Journal of management reviews, 3(4), 285-302.

Andrews, M. (2017). The Role of Universities in Local Invention: Evidence from the Establishment of US Colleges.

Audretsch, D. B., & Feldman, M. P. (1996). R&D spillovers and the geography of innovation and production. The American economic review, 86(3), 630-640.

Audretsch, D. B., & Stephan, P. E. (1996). Company-scientist locational links: The case of biotechnology. The American Economic Review, 86(3), 641-652.

Bacolod, M., Blum, B. S., & Strange, W. C. (2009). Skills in the city. Journal of Urban Economics, 65(2), 136-153.

Baum-Snow, N., Freedman, M., & Pavan, R. (2017). Why has urban inequality increased. Forthcoming.

Baum-Snow, N., & Hartley, D. A. (2016). Accounting for Central Neighborhood Change, 1980-2010. Forthcoming.

Bell, A. M., Chetty, R., Jaravel, X., Petkova, N., & Van Reenen, J. (2017). Who Becomes an Inventor in America? The Importance of Exposure to Innovation (No. w24062). National Bureau of Economic Research.

Berkes, E. (2017). Patents in History: A New Dataset. Dataset available upon request to the author.

Berkes, E. & Gaetani, R. (2017). Income Segregation and Rise of the Knowledge Economy.

Bramwell, A., & Wolfe, D. A. (2008). Universities and regional economic development: The entrepreneurial University of Waterloo. Research policy, 37(8), 1175-1187.

Breznitz, S. M., & Feldman, M. P. (2012). The engaged university. The Journal of Technology Transfer, 37(2), 139-157.

Carlino, Gerald and William R. Kerr (2016). Agglomeration and Innovation. Handbook of Regional and Urban Economics, 5, 349-404.

Casselman, B. (2014). Inequality in College Towns. FiveThirtyEight.

Chetty, R., Stepner, M., Abraham, S., Lin, S., Scuderi, B., Turner, N., Bergeron, A. & Cutler, D. (2016). The association between income and life expectancy in the United States, 2001-2014. Jama, 315(16), 1750-1766.

Cohen, W. M., Florida, R., Randazzese, L., & Walsh, J. (1998). Industry and the academy: uneasy partners in the cause of technological advance. Challenges to research universities, 171(200), 59.

Couture, V., & Handbury, J. (2017). Urban revival in America, 2000 to 2010 (No. w24084). National Bureau of Economic Research.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. Research policy, 29(2), 109-123.

Florida, Richard (2002). The Rise of the Creative Class. New York: Basic Books.

Florida, Richard (2017). The New Urban Crisis. New York: Basic Books.

Florida, R., Adler, P., & Mellander, C. (2017). The city as innovation machine. Regional Studies, 51(1), 86-96.

Florida, R., Knudsen B. & Stolarick, K. (2010). The University and the Creative Economy, in Daniel Araya and Michael A. Peters, (eds.), Education and the Creative Economy, New York: Peter Lang, pp. 45-76.

Florida, R. & King, K. (2018). Urban startup districts: Mapping venture capital and startup activity across Zip codes. Economic Development Quarterly, Forthcoming.

Florida, R. & Mellander, C. (2015). Segregated City – The Geography of Economic Segregation in America's Metros. Martin Prosperity Institute Working Paper.

Florida, R. & Pedigo, S. (2017). The Case for Inclusive Prosperity. NYU Schack Institute of Real Estate, September.

Hausman, N. (2017). University Innovation and Local Economic Growth. Unpublished Manuscript.

Hughes, A., & Kitson, M. (2012). Pathways to impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the factors constraining its development. Cambridge Journal of Economics, 36(3), 723-750.

Gaetani, R. & Li Bergolis, M (2015). The Economic Effects of Scientific Shocks. Unpublished Manuscript.

Jacobs, Jane (1969). The Economy of Cities. New York: Vintage Books.

Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations. the Quarterly journal of Economics, 108(3), 577-598.

Mansfield, E. (1991). Academic research and industrial innovation. Research policy, 20(1), 1-12.

Manson, Steven, Jonathan Schroeder, David Van Riper, and Steven Ruggles (2017). IPUMS National Historical Geographic Information System: Version 12.0 [Database]. Minneapolis: University of Minnesota.

Moretti, E. (2004). Workers' education, spillovers, and productivity: evidence from plant-level production functions. The American Economic Review, 94(3), 656-690.

Moretti, E. (2012). The New Geography of Jobs. New York: Houghton Mifflin Harcourt.

Mowery, D. C., & Shane, S. (2002). Introduction to the special issue on university entrepreneurship and technology transfer. Management Science, 48(1), v-ix.

Mowery, David C (2005). The Bayh-Dole act and high-technology entrepreneurship in US universities: Chicken, egg, or something else? In University entrepreneurship and technology transfer, pp. 39-68. Emerald Group Publishing Limited, 2005.

Powell, Walter W. and Kaisa Snellman (2004). The Knowledge Economy. Annual Review of Sociology. 30. 199-220.

Romer, P. M. (1986). Increasing returns and long-run growth. Journal of political economy, 94(5), 1002-1037.

Rosenberg, N., & Nelson, R. R. (1994). American universities and technical advance in industry. Research policy, 23(3), 323-348.

Saxenian, A.L. (1994). Regional Advantage. Cambridge, MA: Harvard University Press.

Valero, A. & Van Reenen, J. (2016). The Economic Impact of Universities: Evidence from Across the Globe.

Thursby, J. G., & Thursby, M. C. (2003). University licensing and the Bayh-Dole act. Science, 301(5636), 1052-1052.

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