The Effects of STEM Degrees on Earnings In Metropolitan Statistical Areas

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Abstract: A series of recent economic studies have identified human capital as a key determinant of economic growth. This literature generally measures human capital using educational attainment (i.e., years of education or degree completion). This paper seeks to test whether education or degree type is also important. Toward that end, we analyze growth in a cross section of US metro areas as a function of human capital where human capital is decomposed by degree type. We focus on whether or not STEM degree holders (Science, Technology, Engineering, and Mathematics, and Related Fields) have a positive effect on MSA GDP and also whether this effect differs from other degree types. We find that increases in the percentage of STEM degree holders are associated with higher GDP levels and GDP growth. More importantly, we find that degree types do not behave homogeneously in regards to worker productivity. Some degree types are associated with decreases in per-capita GDP and lower GDP growth.

Keywords: economic growth, STEM, undergraduate degree, productivity, human capital

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Introduction

Today, billions worldwide live on less than $2 a day because their national government has been unable to foster consistent economic growth. If governments could increase growth, living standards, life expectancy, and literacy rates would rise. This would in turn reduce misery in poverty-stricken nations. Even in developed countries, economic growth is critical. Economic growth allows for higher wages, better living standards, and an increased ability of government to meet social welfare needs (e.g., Social Security, Medicare, and Medicaid).

One important focus of recent research on the causes of economic growth is human capital, particularly in metropolitan areas. Glaeser (2011) finds that U.S. metro areas with higher average educational attainment grew faster in the subsequent period than metro areas with lower levels of educational attainment. More specifically, a 10 percent increase in the percentage of the metro area labor force with a bachelor's degree in 1980, was associated with income growth between 1980 and 2000 that was 6 percent higher. In addition, this 10 percent increase in the share of the labor force with a BA degree was associated with a per capita gross metropolitan product rises that was 22 percent higher.

This acceleration in income growth in turn causes faster population growth as workers migrate to fast growing cities. The population of U.S. counties where 10 percent of the adult population (in 1970) had college degrees grow by 72 percent between 1970 and 2000. By contrast, the population of those counties where fewer than 5 percent of people had college degrees grew by only 37 percent (Glaeser 2011). To better understand the process through which education causes economic growth, we analyze growth in a cross section of US metro areas as a function of human capital where human capital is decomposed by degree type.

Glaeser (2011), along with much of the economic literature, measures labor market skills using educational attainment. Most often, attainment is measured using either degree completion (e.g., percentage of the workforce with a bachelor's degree) or simply years of education. But such an approach assumes that all educational experiences produce similar effects on growth. Anecdotal evidence suggests that this is unlikely. For instance, the Payscale College salary report for 2012-13 indicates that the top ten majors ranked by mid-career salary are all so-called STEM (science, technology, engineering, and math) degrees.[1] Consequently, we focus primarily on whether STEM degrees show larger increases in productivity compared to non-STEM degrees. However, our data also permits us to further decompose labor market skills by metro area to examine the effect of particular majors on economic growth.

We find that systematic differences in per-capita real GDP and GDP growth across Metropolitan Statistical Areas depend not only on the percentage of the workforce that completed a bachelor's degree, but also on the program of study (i.e. college major). STEM and non-STEM degree holders both produce effects on GDP in metropolitan statistical areas. Overall, our results show that STEM degree holders are associated with positive effects on GDP while non-STEM degree holders are associated with negative effects.

To better understand these human capital effects on per-capita GDP, we also disaggregated the two categories. We divided non-STEM undergraduate degree holders into three categories: business, education, and humanities. We found that humanities and education were associated with negative effects on GDP levels while business was associated with a positive effect. The results remained the same in the ten-year growth model except that business was associated with a negative effect on GDP growth. Our findings showed that STEM degree holders in both the annual GDP level model and growth

[1] The top ten are: petroleum engineering, aerospace engineering, actuarial mathematics, chemical engineering, nuclear engineering, computer engineering, applied mathematics, computer science, and statistics. See http://www.payscale.com/college-salary-report-2013/majors-that-pay-you-back

rate model were associated with positive effects.

We split STEM degree holders into two categories; science and engineering degree holders and science and engineering plus degree holders. These categories capture the workers that have undergraduate degrees in science and engineering disciplines and those in related fields (i.e. pharmacists, health services managers, and laboratory technicians) as denoted by the US Census. We found that science and engineering degree holders are associated with statistically significant positive effects on both GDP levels and growth in all scenarios. Surprisingly, the second component of STEM degree holders, the science and engineering-related fields, showed no significant effects on either GDP level or GDP growth. These results suggest that degree type does not have a homogeneous effect on GDP growth. Therefore, analyses of the causes of GDP growth should not treat all undergraduate degrees as equivalent.

Literature Review

Lucas (1988) shows that standard neoclassical growth models cannot explain recent growth patterns in the U.S. Consequently, Lucas offers a new model that included the effects of human capital. He argues that the system of economic development consists of two state variables: physical and human capital spillover. Lucas observed that physical capital is accumulated and utilized in the manner expected by the neoclassical model. However, he found that human capital enhances productivity through a multiplier effect.

This multiplier effect, also known as the “spillover effect” of human capital is the sum of all external benefits enacted on one person due to the actions of another person. To examine the magnitude of spillover effects on wage productivity, Lucas’ considered a set of goods that did not include the introduction of new goods. In this model, he found that learning benefits accumulated and workers became more productive due to the knowledge spillover effect from workers learning how to produce a good. This type of spillover effect is often associated with the assembly-line production model. Lucas realized that workers are faced with the regular introduction of new goods. Therefore, he described the spillover effect as being cyclical; with the introduction of a good associated with an increase in knowledge about that good. Similarly, the spillover effect associated with older goods would decline as the newer good took precedence. The spillover effect observed by Lucas offered new insight on comparative advantages and the shifts of a country's growth rate over time as new goods are introduced.

The existence of spillover effects increased economists' interest in metropolitan areas. Since metropolitan areas are densely populated they provided the most data to offer explanations for adaptation, economic growth, and trends. For instance, Glaeser (1992) examines knowledge spillovers due to population density and finds that the spillover frequently occurs between industries rather than within them. He also concludes that this knowledge spillover encourages competition and therefore industrial growth and productivity. Hence, the growth often observed in urban areas may be a result of increased education levels of the human capital experiencing knowledge spillover within their respective industries.

Glaeser (2001) follows this link and examined the relationship between wages and the size of urban areas. The goal of this study was to discover whether or not the wage premium existed in urban areas because of more able workers choosing to live in these areas or if it was because the workers present were highly skilled. This hypothesis would then offer insight into whether or not urban areas have a higher throughput of information. The reason for this is if the spread of information was significant then higher skilled workers may move to urban areas seeking more opportunities. These opportunities often come in the form of new technology and business ventures. Therefore, this abundance of opportunities would partially explain the wage premium that Glaeser observed in urban areas.

Moretti (2004) attempts to quantify the positive externalities associated with increases in the educational attainment of workers in metropolitan areas. Theory suggests that the increase in the share of college graduates would have a positive effect on other workers for two reasons: imperfect substitution and the spillover effect. That is, as the number of college graduates in a metropolitan area increases, producers are willing to pay the wage for the higher-skilled workers and the spillover effects from their education will benefit surrounding workers. Moretti finds that a 1% increase in the supply of college graduates raised high school dropout wages by 1.9%, high school graduate wages by 1.6%, and college graduate wages by 0.4%. Moretti explains that increases in college graduates produce a larger impact on less educated workers because of spillover effects are larger

To illustrate the importance of these effects, Moretti (2012) compares the growth experienced by Seattle and Boston with the economic decline of Detroit and Flint. Using the relocation of Microsoft to Seattle as an example, Moretti outlines the numerous benefactors ranging from highly educated software engineers to less-educated barbers. Moretti estimates that Microsoft created nearly 120,000 jobs for service workers such as taxi drivers and carpenters, and 80,000 jobs for workers with advanced degrees. These benefits introduced by what Lin (2011) would consider “new work” are the social benefits or spillover effect. As higher educated workers relocate to an area like Seattle they require services that therefore attract service workers to the same area. This demand entices lesser-educated workers to relocate in the hopes of higher wages. However, Glaeser (2011) finds that the wage gains experienced by these workers are not immediate. Therefore, the wage gains over time suggest that the knowledge spillover is the catalyst for the increased productivity of workers in metropolitan areas.

Jeffrey Lin (2011) finds that new work is more likely to be found in locations that are initially dense with college graduates and a variety of industries. These findings, once again, suggest that the spillover effect drives the adoption of new work in densely populated areas due to the ease of the spread of knowledge. Lin's observation of new work adoption in metropolitan areas suggests one reason for their relatively high productivity compared to other areas of a country.

In urban areas such as Flint, Michigan the lack of an educated work force led to their economic downturn. Those workers that were highly educated were able to relocate to areas offering higher wages, therefore stripping areas like Flint of their innovation. Moretti found that the average worker with a high school education in an innovation hub such as Seattle earned more than college graduates in areas such as Flint. At the same time, globalization allowed for cheaper production overseas. With no innovation occurring in these cities and cheaper manufacturing overseas, the demand for automobile workers declined. Cities such as Flint also do not have an abundance of academic institutions that supply the area with highly educated workers compared to areas such as Boston and Silicon Valley. The economic disparity endured by areas such as Flint worsened due to the relocation of less-educated workers.

Evidence also suggests that these spillover effects are becoming more important because of the dissolution of unionized industries in urban areas. Glaeser (2011) notes that prior to the 1970's, urban areas were concentrated with highly paid unionized factory workers. The factories had limited links with the world outside Detroit. They employed thousands of relatively unskilled workers who produced vast quantities of identical products. Following the collapse of unionized industries such as the automobile industry, cities such as Detroit and Cleveland began to decline due to their relatively low levels of human capital.

Human capital plays a decisive role in an area's rate of economic growth. Knowledge spillovers exhibit a multiplier effect on productivity that is compounded in densely populated areas. These spillovers demonstrate the social benefit gains from increases in educational attainment levels of an area's workers. Therefore, it is appropriate to examine the individual contributions of the various fields of study as they relate to the economic growth caused by knowledge spillover to better understand the drivers of an area's economic growth.

As a result of this knowledge spillover, policies impacting the supply of STEM graduates have become increasingly important as the United States' supply of STEM workers is falling short. For instance, Serra (2012) argues for a policy that used community colleges as a supply catalyst. This policy would offer attractive STEM programs for prospective students using community college as a stepping-stone to a four-year degree while building a professional network. Other research aims to boost STEM enrollments by analyzing the determinants of STEM enrollments. One such study of STEM determinants by Nicholls (2007) aimed to identify variables that were significant determinants for STEM enrollment by separating students into racial and ethnic groups. The study showed that minority groups, particularly Latin American, African-American, and female groups received a lower percentage of the total undergraduate degrees in Engineering. The study also found qualitative variables such as the student's self-rating in mathematics, computer skills, and academic ability were statistically significant determinants for whether or not the student pursued a STEM degree.

Other STEM determinant studies such as Wang (2012) have shown similar significant determinants such as high school math achievement, exposure to math and science courses, math self-rating, graduate degree aspirations, academic interaction, and financial aid receipt. While many studies produce statistically significant determinants for STEM enrollment, they do not focus on effect that these STEM graduates have on the Country's economic growth. In fact, Hanushek (2012) found that there is tremendous variation in math and science performance across individual states. His study voiced the concern that states with lower math and science proficiency levels are receiving the majority of educational funding. While this financial support does increase the state's educational proficiency, it may damage the economy of areas that do not receive the same amount of funding.

While some cities and states have instituted programs to attract and produce workers with STEM backgrounds, they are based on research that treats all degree types homogeneously. This is understandable as data concerning worker educational background attainment has been traditionally collected only by years of education or degree completion. Recently, however, the American Community Survey (ACS) has collected data by degree type for U.S. metro areas. This paper attempts use this data to determine whether degree type or program of study causes systematic differences in per-capita real GDP and GDP growth across Metropolitan Statistical Areas. We consider differences by disaggregating total bachelor's degrees into STEM and non-STEM degree holders. We also disaggregate non-STEM undergraduate degree holders into three categories: business, education, and humanities and STEM degree holders into two categories; science and engineering degree holders and science and engineering plus degree holders. These categories capture the workers that have undergraduate degrees in science and engineering disciplines and those in related fields (i.e. pharmacists, health services managers, and laboratory technicians) as denoted by the US Census.

Data, Method, and Hypothesis

To test whether STEM degree holders significantly impact a metropolitan statistical area's real GDP growth rate, we used annual data from the Bureau of Economic Analysis (BEA) on annual real GDP levels by metro area. We also calculated growth over a ten-year period (2000-2010) for each metro area in the data set. To measure education, we used data from the U.S. Census Bureau's American Community Survey (ACS). The educational attainment levels were the most critical in testing the impact of STEM degree holders on real GDP levels. We collected data from the ACS at increasing levels of separation ranging from total bachelor degree holders to the graduate's field of study.

We decomposed the education data at three levels. At the highest level of aggregation, we simply examined the impact of the percentage of bachelor degree holders in the population. Next, we split the bachelor's degrees into STEM degree holders and non-STEM degree holders. Finally, we split non-STEM degree holders into three components: humanities, business, and education degree holders and STEM degree holders into two components: STEM and STEM-related. This division was created by the US Census. STEM includes traditional STEM fields such as biology, chemistry, physics and math while STEM-related fields include pharmacists, laboratory technicians, etc.

The ACS also provided demographic data ranging from education levels, gender, employment, labor-force participation, and race. We included these variables as statistical controls. We ran identical regressions using both the level of per capita GDP and the ten-year growth rate of per capita GDP as our dependent variable. The objective of running the two sets of regressions was to examine if a similar trend was present in both cases. We report lagged and non-lagged estimates in each case. Although additional years of data are not readily available, we intend to revise the study using three-year lagged variables and first differences to better control for simultaneity when the BEA releases the 2011 data. The same basic specifications that we ran on the non-lagged variables were used with the lagged variables. The results of these regressions are reported in Tables 2-5.

The goal of this study is to test whether degree type is an important influence on economic growth. We focus on STEM disciplines in particular. Since STEM degree holders are often associated with technology and innovation driven industries it is important to determine whether or not these fields actually positively impact the real GDP of the area. Based on the idea that STEM degree holders are often associated with innovation and growth, our hypothesis is that a STEM degree holder will have a larger positive effect on real GDP of metropolitan statistical areas than other degree types. The results should guide policy makers, educators, and students towards making better-informed decisions regarding educational investments.

It is important to note that the number of years available for the educational attainment by degree type were less than desirable as they included only three years (2009 to 2011). In addition, the BEA has postponed the release of the 2011 GDP data by MSA until February 2013. Consequently, we plan to update the analysis in February. The overall lack of three-year data makes the findings of this study somewhat less desirable. With a longer time series, we would have more options to control for possible simultaneous relationships between education and growth. For instance, fast growing metro areas may attract individuals with certain degree types. However, the study maintains its importance by demonstrating that degree type does not have a homogenous effect on growth and that growth analyses that measure educational attainment using the percentage of the population with a bachelor's degree are potentially misleading.

Results

Table 1 reports means and standard deviations for the dependent and independent variables. The dependent variables, Per Capita Real GDP and Ten-Year Per Capita Real GDP Growth Rate have average values of $36,036 and 4.56%, respectively. In addition, the dependent variables show relatively large variation.

Table 2 reports regressions on per capita real GDP and growth of GDP as a function of total bachelor degree holders, unemployment, labor force participation, and race (*Total Bachelor Degree Holders, Labor Force, African American,* and *Asian*). Regressions on per capita real GDP appear in columns 2 and 3 while columns 4 and 5 report regressions on GDP growth. From columns 2 and 3, we see that all independent variables are significant. The results show that a 1% point increase in total bachelor degree holders in a metropolitan statistical area is associated with a $377.41 increase in its p.c. real GDP in the non-lagged specification. In the lagged specification, we see a similar result – a 1% point increase in total bachelor degree holders in a metropolitan statistical area is associated with a $401.42 increase in its p.c. real GDP. These results are consistent with prior research regarding human capital spillover effects that show an increase in worker education leads to GDP growth.

As expected we found that labor force participation (*Labor* Force) was statistically significant and associated with an $899.65 increase for each 1% point increase. This result is what we expected since labor force participation increases lead to an increase in workers contributing to an area's GDP. Similarly, we found that the percentage of workers unemployed (*Unemployed*) was associated with a $469.79 decrease in GDP for each percentage point increase. This is also as we expected since unemployed workers are unable to contribute to an area's GDP. Our results also showed that a percentage point increase in the total population that were Asian

(*Asian*) were associated with a $477.28 increase in GDP. We also found that a one percentage-point increase in the total population that are African American was associated with a $178.17 increase in GDP. The lagged specification yields similar results.

For the regressions on the ten-year growth rate reported in columns 4 and 5 of Table 2, the percentage of the population with a bachelor's degree was statistically insignificant in both of the ten-year growth rate models. However, these regressions did return statistically significant results for Asian, African American, labor force participation, percentage unemployed, and the year that were consistent with the GDP level regressions reported in columns 2 and 3 of Table 2.

Table 3 reports the first test of our hypothesis that STEM degrees have a larger impact on growth than non-STEM degrees. Columns 2 and 3 show that STEM degrees (*STEM Degree Holders*) show a significant and positive impact on p. c real GDP of $691.07 for each percentage point increase of workers that have STEM undergraduate degrees. The coefficient foe non-STEM degrees, however, was statistically insignificant. As we observed before, our regression returned statistically significant results for labor force participation (*Labor Force*) at $953.91 per percentage point increase and the percentage of workers unemployed (*Unemployed*) at -$479.15 per percentage point increase. These findings were again what we expected as they follow economic theory as it relates to GDP growth and labor involvement. Again, our regression returned statistically significant coefficients for our race variables with a 1% point increase in (*Asian*) associated with a $421.78 effect on p.c. real GDP and a 1% point increase in (*African American*) associated with a $195.01 effect on p.c. real GDP

Unlike our the results reported in column 2 and 3, the ten-year real GDP growth rate model returned statistically significant results for both our key variables. From columns 4 and 5 of Table 3, we see that a 1% point increase in *STEM Degree Holders* was associated with a 0.89%

increase in the ten-year real GDP growth rate. A 1% point increase in *Non-STEM Degree Holders* was associated with a -1.07% decrease in the ten-year real GDP growth rate. These results indicate that degree types at a broad level may not act homogenously as shown by the opposite signs for STEM and non-STEM degree holders. The regression also returned statistically significant values for the percentage unemployed (*Unemployed*) and percentage of the population that are Asian (*Asian*). A 1% point increase in the percentage unemployed was shown to have a -1.05% effect on the growth rate. This finding is what we expected as we found previously. As mentioned, a 1% point increase in the percentage of the population that is Asian was associated with a 0.2% increase in the ten-year growth rate. Again we chose not to draw conclusions regarding race and economic growth.

To further investigate our findings of the negative association between non-STEM degree holders and GDP, we decomposed non-STEM degrees into humanities degrees (*Humanities Degree Holders*), education degrees (*Education Degree Holders*), and business degrees (*Business Degree Holders*). Our results showed that two of the components: *Humanities Degree Holders* and *Education Degree Holders* were associated with negative effects on p.c. real GDP levels while *Business Degree Holders* was associated with a positive effect on p.c. real GDP as shown in Columns 2 and 3 of Table 4. For each one-percentage point increase in *Humanities Degree Holders* we found it had a -$500.84 effect on GDP levels. Similarly, each one-percentage point increase in *Education Degree Holders* returned a -$2,262.36 effect on GDP levels. Conversely, a one-percentage point increase in *Business Degree Holders* was associated with a $1,760.71 effect on p.c. real GDP levels. These findings reflect our earlier results that the overall effect of non-STEM degree holders is negative because the negative components sum to an effect larger than the positive component.

As noted above, *STEM Degree Holders* was found to be associated with a $764.28 effect on p.c. real GDP for each 1% point increase. We also found that the remainder of the independent variables used were statistically significant, particularly *Labor Force* which again had a $764.28 relationship with p.c. real GDP per 1% point increase as expected. The percentage of workers unemployed maintained its negative effect of -$743.40 on p.c. real GDP per 1% point increase as expected due to economic theory. Finally, our race control variables returned statistically significant values that were consistent with earlier regressions as shown in Column 2 of Table 4. Again, the lagged regression results were similar to the non-lagged results in coefficients and statistically significance, leading us to believe that our results remained consistent over time.

Once again our lagged estimates returned similar results in coefficient values, statistical significance, and standard errors. The lagged results produced results associating STEM degree holders with positive effects on p.c. real GDP and non-STEM degree holders with negative effects on p.c. real GDP. Our findings regarding labor force participation (*Labor Force*), unemployed percentage (*Unemployed*), and the racial characteristics were consistent with previous findings.

Next, we examined this level of disaggregation and its effect on the ten-year real GDP growth rate of MSAs as shown in Columns 4 and 5 of Table 4. The regression produced results showing that *STEM Degree Holders* were associated with a 0.896% effect on the ten-year growth rate for each one-percentage point increase. The model produced similar results as the GDP levels regression except for (*Business Degree Holders*) which was the opposite sign of -1.657% effect on the ten-year growth rate for each one-percentage point increase. One component of non-STEM degree holders (*Humanities Degree Holders*) remained negative at -

0.984% for each one-percentage point increase. To our surprise, *Education Degree Holders* did not return a statistically significant result. Also, the worker participation variables (*Labor Force*) and (*Unemployed*) returned statistically significant values of 0.21% and -0.949% respectively. In both cases of race (*Asian* and *African American*), we find statistically significant positive coefficients of 0.269% and 0.07%, respectively.

In our final scenario reported in Table 5, we disaggregated STEM undergraduate degree holders into two categories, science and engineering undergraduate degree holders and science and engineering plus undergraduate degree holders. This decision was made to disaggregate the category to a level equivalent to our disaggregation of non-STEM degree holders. In this scenario, the two components of STEM undergraduate degree holders are roughly made of those degree holders that are commonly thought of as STEM degree holders and those that are closely associated, as categorized by the US Census.

In our final model, the results from the disaggregation of STEM undergraduate degree holders surprised us. As shown in Columns 2 and 3 of Table 5, (*Science & Engineering Degree Holders*) were associated with a statistically significant $894.688 to $1,019.987 positive effect on p.c. real GDP levels per one-percentage point increase. These results were consistent with our prior findings that the overall effect of STEM degree holders is positive. However, the surprisingly result was that the other component of STEM used (*Science & Engineering Plus Degree Holders*) was statistically insignificant in all cases.

Our results regarding the components of non-STEM undergraduate degree holders, (*Humanities Degree Holders, Education Degree Holders,* and *Business Degree Holders*) were consistent with our prior findings at -$577.699, -$2,085.054, and $1,791.528 respectively as shown in Column 2 of Table 5. The lagged regression returned similar results and statistical significance, suggesting that our results are consistent over time. Again, we found that *Business Degree Holders* was associated with a negative coefficient of -1.623% in the ten-year real GDP growth rate model as shown in Column 4 of Table 5. While this finding does conflict with our GDP levels finding, it remains consistent with our previous regression in Table 4. As we found in the previous model, *Education Degree Holders* was not statistically significant in either ten-year growth rate models. While these two findings are surprising given our findings regarding GDP levels, we hesitate to draw conclusions since our recent data is limited.

Lastly, we found that *Labor Force* and *Unemployed* remained consistent with our prior findings at $812.23 and -$766.37 per percentage point increase as shown in Column 2 of Table 5. These findings held true in the ten-year real GDP growth rate model where the variables returned 0.225% and -0.974% respectively. Again, these results are what we would expect given their well-known effect on GDP growth. Our racial control variables returned statistically significant results consistent with prior findings, with (*Asian*) and (*African American*) associated with a $233.39 and $137.31 effect on real GDP levels as shown in Column 2 of Table 5. In the ten-year growth model we found (*Asian*) to be associated with a 0.256% effect on GDP growth and (*African American*) to be associated with a 0.076 effect on GDP growth. These findings remained consistent with all prior regressions. However, the lagged models did not return statistically significant results for both racial variables as shown in Columns 3 and 5 of Table 5.

Conclusion

Consistent with earlier research, we find that educational attainment (measured as the percentage of the population with a bachelor's degree) has a positive net effect on MSA GDP. In particular, we find that a 1% point increase in total bachelor degree holders in a metropolitan statistical area is associated with a $401.42 increase in its p.c. real GDP. However, our results show that degree type does not have a homogeneous effect on GDP growth. Thus, treating all bachelor's degrees as equivalent in analyses of GDP growth is likely to lead to misleading results. If we decompose worker education data into degree type, we find that STEM degrees are associated with positive and significant effects on both GDP levels and growth in MSAs. By contrast, we see mixed effects from non-STEM degrees on GDP levels and growth in MSAs.

Moreover, we find heterogeneity of effects on GDP level and GDP growth within the category of STEM degrees. We disaggregate STEM degree holders into two categories (science and engineering degrees; and science and engineering-related degrees) and find a positive and significant effect on GDP levels and GDP growth from increases in science and engineering degrees but not science and engineering related degrees. In particular, a one percentage-point increase in the percentage of the population with a science or engineering degree is associated with a statistically significant $894.688 to $1,019.987 positive effect on p.c. real GDP levels. In addition, a one percentage-point increase in the percentage of the population with a science or engineering degree was associated with a statistically significant increase in GDP growth of about one percentage point. By contrast, science and engineering-related degrees showed no statistically significant effect on either GDP levels or GDP growth.

Within the category of non-STEM degrees, we also find heterogeneity. Increases in the percentage of the population with a degree in the humanities were associated with a decrease in both the level and the rate of growth of GDP. A one percentage-point increase in the percentage of the population with a humanities degree is associated with a statistically significant $500.83 to $740.27 negative effect on p.c. real GDP levels. In addition, a one percentage-point increase in the percentage of the population with a humanities degree was associated with a statistically significant decrease in GDP growth of about one to one and a half percentage points. Increases in the percentage of the population with a degree in education were associated with a decrease in only the level of GDP. A one percentage-point increase in the percentage of the population with an education degree is associated with a statistically significant $1959.49 to $2262.35 negative effect on p.c. real GDP levels.

Finally, business degree estimates produced inconsistent results. Increases in the percentage of the population with a degree in business were associated with a increase in the level of GDP but a decrease in the rate of growth of GDP. This may be the result of student responses to slow growth. When growth slows, students may be more likely to choose the business major. A one percentage-point increase in the percentage of the population with a business degree is associated with a statistically significant $1656.72 to $1791.53 positive effect on p.c. real GDP levels and a decrease in GDP growth of about one to one and two-thirds percentage points.

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Table 1. **Means and Standard Deviations for Independent Variables**

Variable	N	Mean	Standard Deviation
Per Capita Real GDP[a]	727	$36036.16	11040.54
Ten-Year Per Capita Real GDP Growth Rate[b]	727	4.555%	10.942
Total Bachelor Degree Holders[c]	727	25.457%	7.916
STEM Degree Holders[d]	727	10.981%	4.516
Non-STEM Degree Holders[e]	727	14.476%	3.827
Science & Engineering Degree Holders[f]	727	8.523%	4.047
Science & Engineering Plus Degree Holders[g]	727	2.45%	0.784
Business Degree Holders[h]	727	4.77%	1.571
Education Degree Holders[i]	727	4.154%	1.008
Humanities Degree Holders[j]	727	5.559%	2.268
Labor Force[k]	727	63.966%	4.904
Unemployed[l]	727	10.194%	2.904
African American[m]	724	11.701%	10.925
Asian[n]	720	3.227%	4.412
Year[o]	727	2009.5	.5

[a] Per Capita Real GDP = per capita real GDP levels reported by the BEA
[b] Ten-Year Per Capita Real GDP Growth Rate = 2010 p.c. real GDP level – 2001 p.c. real GDP level / 2001 p.c. real GDP level
[c] Total Bachelor Degree Holders = Percentage of metropolitan statistical area with a bachelor's degree
[d] STEM Degree Holders = Percentage of population with a science, technology, engineering, or mathematics bachelor degree
[e] Non-STEM Degree Holders = Percentage of population with a bachelor degree that is not STEM
[f] Science & Engineering Degree Holders = Percentage of population with a bachelor degree in science or engineering
[g] Science & Engineering Plus Degree Holders = (Science & Engineering Related Fields as denoted by the U.S. Census) Percentage of population with a bachelor degree in science or engineering or closely related fields denoted by ACS classification system.
[h] Business Degree Holders = Percentage of population with a bachelor degree in business
[i] Education Degree Holders = Percentage of population with a bachelor degree in education
[j] Humanities Degree Holders = Percentage of population with a bachelor degree in humanities
[k] Labor Force = Percentage of population in the labor force
[l] Unemployed = Percentage of population that is unemployed
[m] African American = Percentage of population that is African American
[n] Asian = Percentage of population that is Asian
[o] Year = Years data is collected for, 2009 to 2010

Table 2. Analysis of Bachelor Degree Holders and Real GDP Levels / 10-Year Growth

Variable	Per Cap. Real GDP	Lagged Per Cap. Real GDP	10-Yr Real GDP	Lagged 10-Yr Real GDP
Total Bachelor Degree Holders	377.409***	401.42***	0.021	0.572
	(65.93)	(88.237)	(0.101)	(0.158)
Labor Force	899.653****	897.678***	0.006	0.057
	(75.75)	(104.777)	(0.131)	(0.183)
Asian	477.283***	482.503*	0.355***	0.319**
	(175.187)	(262.957)	(0.111)	(0.157)
African American	178.166****	170.903***	0.001	0.005
	(24.664)	35.211	(0.364)	(0.055)
Unemployed	-469.787***	-534.918***	-1.028***	-0.991***
	(133.101)	(181.234)	(0.15)	(0.222)
Year	1502.97**	-	2.116****	-
	(596.381)	-	(0.774)	-
R^2	0.5119	0.518	0.103	0.094
N	717	357	717	357

* >= 90% Statistical Significance
** >= 95% Statistical Significance
*** >= 99% Statistical Significance

Table 3. Analysis of STEM vs. Non-STEM Degree Holders and Real GDP Levels / 10-Year Growth

Variable	Per Cap. Real GDP	Lagged Per Cap. Real GDP	10-Yr Real GDP	Lagged 10-Yr Real GDP
STEM Degree Holders	691.072***	806.9529***	0.8943147***	.9466664**
	(156.758)	(243.151)	(0.282)	(0.411)
Non-STEM Degree Holders	-12.79717	-71.20565	-1.064939***	-1.023121***
	(200.686)	(300.288)	(0.234)	(0.301)
Labor Force	953.913***	962.0291***	.1570833	.2013277
	(81.657)	(112.345)	(0.111)	(0.161)
Asian	421.7816***	417.3856*	.2004166***	.1734065*
	(156.977)	(225.733)	(0.068)	(0.099)
African American	195.009***	193.5737***	(0.049)	.0558129
	(25.487)	(36.948)	(0.037)	(0.057)
Unemployed	-479.148***	-528.8802***	-1.054291***	-.9769574***
	(129.777)	(174.788)	(0.146)	(0.223)
Year	1601.286***	-	2.389526***	-
	(597.239)	-	(0.763)	-
R^2	0.518	0.526	0.15	0.135
N	717	357	717	357

* >= 90% Statistical Significance
** >= 95% Statistical Significance
*** >= 99% Statistical Significance

Table 4. Analysis of Disaggregated Worker Education and Real GDP Levels / 10-Year Growth

Variable	Per Cap. Real GDP	Lagged Per Cap. Real GDP	10-Yr Real GDP	Lagged 10-Yr Real GDP
STEM Degree Holders	764.282***	948.786***	0.896***	1.095**
	(159.194)	(253.415)	(0.324)	(0.514)
Humanities Degree Holders	-500.835*	-710.139	-0.984**	-1.472**
	(288.813)	(443.744)	(0.43)	(0.723)
Education Degree Holders	-2262.355***	-2087.621***	-0.174	0.683
	(353.422)	(490.976)	(0.581)	(0.982)
Business Degree Holders	1760.71***	1656.716***	-1.657***	-1.494***
	(307.597)	(441.662)	(0.422)	(0.478)
Labor Force	798.322***	810.815***	0.21**	0.249
	(81.166)	(113.717)	(0.107)	(0.161)
Asian	244.7187**	246.026	0.269***	0.304**
	121.0971	(185.456)	(0.08)	(0.123)
African American	132.2609***	141.931***	0.07*	0.074
	(25.183)	(35.487)	(0.038)	(0.059)
Unemployed	-743.4***	-751.231***	-0.949***	-0.779***
	(130.899)	(176.571)	(0.151)	(0.239)
Year	1672.856***	-	2.34***	-
	(567.029)	-	(0.786)	-
R^2	0.572	0.576	0.157	0.155
N	717	357	717	357

* >= 90% Statistical Significance
** >= 95% Statistical Significance
*** >= 99% Statistical Significance

Table 5. Further Analysis of Disaggregated Worker Education and Real GDP Levels / 10-Year Growth

Variable	Per Cap. Real GDP	Lagged Per Cap. Real GDP	10-Yr Real GDP	Lagged 10-Yr Real GDP
Science & Engineering Degree Holders	894.688***	1019.987***	1.04***	1.15**
	(178.186)	(279.193)	(0.401)	(0.581)
Science & Engineering Plus Degree Holders	-162.32	285.732	-0.121	0.567
	(465.597)	(638.733)	(0.636)	(0.792)
Humanities Degree Holders	-577.699**	-740.269*	-1.068**	-1.494**
	(289.143)	(443.803)	(0.457)	(0.745)
Education Degree Holders	-2085.054***	-1959.49***	0.021	0.786
	(359.655)	(496.441)	(0.645)	(1.079)
Business Degree Holders	1791.528***	1660.113***	-1.623***	-1.491***
	(306.045)	(440.065)	(0.405)	(0.475)
Labor Force	812.232***	819.429***	0.225**	0.255
	(81.656)	(114.344)	(0.105)	(0.159)
Asian	233.393**	242.009	0.256***	0.301**
	(116.735)	(182.284)	(0.077)	(0.121)
African American	137.311***	145.541***	0.076*	0.076
	(24.749)	(35.227)	(0.039)	(0.059)
Unemployed	-766.373***	-775.006***	-0.974***	-0.798***
	(132.085)	(177.191)	(0.153)	(0.238)
Year	1715.919***	-	2.387***	-
	(565.356)	-	(0.787)	-
R^2	0.575	0.577	0.16	0.156
N	717	357	717	357

* >= 90% Statistical Significance
** >= 95% Statistical Significance
*** >= 99% Statistical Significance