

Effect of Education on Gross Domestic Product: A Case Study from US 'Mid-West'

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This paper examines the effect of secondary and tertiary education on the level and growth of real GDP per-capita to explain the increasing gap of average level of real GDP between the 'Mid-West' and the 'Non Mid-West' in the United States. Using the data for fifty one states in the United States between 1980 and 2010, this paper finds that both secondary and tertiary education have significant positive effect on the level of real GDP per-capita. However, tertiary education has a higher effect on the level of real GDP per-capita compare to the secondary education. Moreover, tertiary education has a higher effect on the level of real GDP per-capita in the 'Non Mid-West'. This paper also finds that tertiary education has a positive effect on the growth of real GDP per-capita in the 'Non Mid-West'. This effect is negative for the secondary education. This paper doesn't find any significant effect of secondary and tertiary education on the growth of real GDP per-capita in the 'Mid-West'.

JEL Classification: E24, J21, J62, O40, O51

1. Introduction

The average level of real Gross Domestic Product in the 'Mid-West' region of the United States is increasing over time. However, the pace of increment is much slower compare to the rest of the United States. The average level of real gross domestic product in the 'Mid-West' was higher than the 'Non Mid-West' until 1996 but it started to fall behind from 1997. The gap of average level of real gross domestic product between the 'Mid-West' and the 'Non Mid-West' has been increased by fifty four times between 1997 and 2010. The same trend is evident for the average number of high school graduates. The average number of high school graduates in the 'Mid-West' was higher than the rest of the US until 2000. It became lower than the rest of the US from 2001 and the gap has been elevated by almost twenty five times between 2001 and 2010. The average number of people with Bachelor's and advance degree was lower in the 'Mid-West' compare to the rest of the US from 1980. This gap has been increased by fifty six times between 1980 and 2010.

I contribute to the literature by examining the effect of education on the level and growth of real GDP per-capita to explain the gap of average level of real GDP between the 'Mid-West' and the 'Non Mid-West' in the US. I use the data for fifty one states of the United States between 1980 and 2010. I measure the quantity of secondary education by using the share of people with age twenty five and more have high school diploma. I

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use the share of people with age twenty five and more have Bachelor's and advanced degree to measure the tertiary education. I also include the share of non-White people and the share of people with age sixty five and over as explanatory variables. Additionally, I include a dummy variable for the 'Mid-West' and interact it with the share of high school graduates and the share of Bachelor's and advanced degree holders to separate the effect for the 'Mid-West' and the 'Non Mid-West'.

I use the OLS and GMM estimator to investigate the effect of secondary and tertiary education on the level of real GDP per-capita. I use the GMM estimator for dynamic panel data model proposed by Holtz-Eakin, Newey and Rosen (1988) and Arellano and Bond (1991) to examine the effect of secondary and tertiary education on the growth of real GDP per-capita.

I find that both secondary and tertiary education have significant positive effect on the level of real GDP per-capita. I find tertiary education has a higher effect on the level of real GDP per-capita compare to the secondary education. The effect of tertiary education is higher in the 'Non Mid-West' compare to the 'Mid-West'. Secondary education has negative effect on the growth of real GDP per-capita for the 'Non Mid-West' and its effect is not statistically significant for the 'Mid-West'. Tertiary education has significant positive effect on the growth of real GDP per-capita for the 'Non Mid-West' and has no significant effect for the 'Mid-West'.

The organization of this paper is as follows. Section 2 provides a review of literature. Section 3 provides stylized facts and summary tables. Section 4 discusses the data sources and the methodology to examine the effect of education on the level and growth of real GDP per-capita. Section 5 discusses the results. Section 6 concludes.

2. Literature Review

The relationship between education and growth is highly debated topic in economics. However, no paper describes the alarming gap of the average level of real GDP between the 'Mid-West' and the 'Non Mid-West' and analyzes the effect of education to explain the gap. This is the first paper that examines the effect of secondary and tertiary education to explain the real GDP gap between the 'Mid-West' and the 'Non Mid-West'.

A large number of works examine the effect of quantity and quality of education on growth of income in cross country set up. Barro (1991) investigates the effect of human capital on the growth rate of real GDP per-capita for ninety eight countries between 1960 and 1985. Human capital is measured by the 1960's school enrollment rate. He finds that growth rate of real GDP per-capita is positively related with the initial level of human capital. However, Bils and Klenow (2000) don't agree with Barro. They find that the effect of schooling on growth is weak and probably describes only one third of the relationship. To investigate the effect of education on growth more thoroughly, Barro (2001) includes both the quantity and quality of education for about hundred countries between 1965 and 1995 and examines their effect on growth. He uses the average years of schooling to measure the quantity of education and the scores of science,

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mathematics and reading are used to measure the quality of education. He finds that the average years of schooling of adult males at the secondary and higher levels has positive effect on growth. However, this effect is insignificant for adult females. He also finds that the scores on science positively affect the growth. He concludes that quality of education has more effect on growth compare to the quantity of education.

Pritchett (2001) explains three causes behind the diverse effect of education on growth across countries. The uncooperative institutional system may lead to a negative relationship between education capital accumulation and economic growth. The increase in supply of education with fixed demand for education may lead to negative marginal returns to education. The quantity of education (measured by the average years of schooling) doesn't automatically ensure the quality of education. Coulombe and Tremblay (2006) change the measure of quality of human capital. They use literacy scores as a measure of quality of human capital. They examine the effect of literacy scores on transitory and long run growth path for 14 OECD countries between 1960 and 1995. They find that literacy scores have significantly positive effect on transitory and long run growth path. Hanushek and Woessmann (2012) find that increase the number of people with universal basic education and with high quality education has significant positive economic effects.

No research has been done on the relationship between education and growth for the states in the US 'Mid-West'. However, works have been done on regional converge of US 'Mid-West' and the effect of demographic, economic and social factors on the growth of US 'Mid-West'. The work of Caselli and Coleman I (2001) examine the effect of structural transformation in the United States on regional convergence. They find that prompt decrease in the number of labor in the agricultural sector in the 'South' leads to the convergence of agricultural wages to non-agricultural wages in the United-States. Like the 'South', the 'Mid-West' also has comparative advantage in agricultural products. But over time, the decreases in number of unskilled labor in the agricultural sector and the increase in the number skilled labor in the industrial sector lead to an increase in wage in the 'Mid-West' and help the region to catch up with the 'North-East'.

Monchuk, Miranowski, Hayes, Babcock (2007) examines the effect of some demographic, economic and social factors on the economic growth for 734 counties in eight states in the 'Mid-West' between 1990 and 2001. They find that the level of population, change in livestock receipts, number of nonfarm proprietors per-capita in the county have significant positive effect on the growth of total county income. They also find that the percentage of people with age sixty five and more, per-capita property tax, per-capita revenue from state government and per-capita government wages and salaries in the county have significant negative effect on the growth of total county income.

3. Stylized Facts

In this section I will provide an overview of the level and growth of real GDP per-capita and education.

Diagram 1: Average Real Gross Domestic Product in the 'Mid-West' and the 'Non Mid-West' between 1980 and 2010

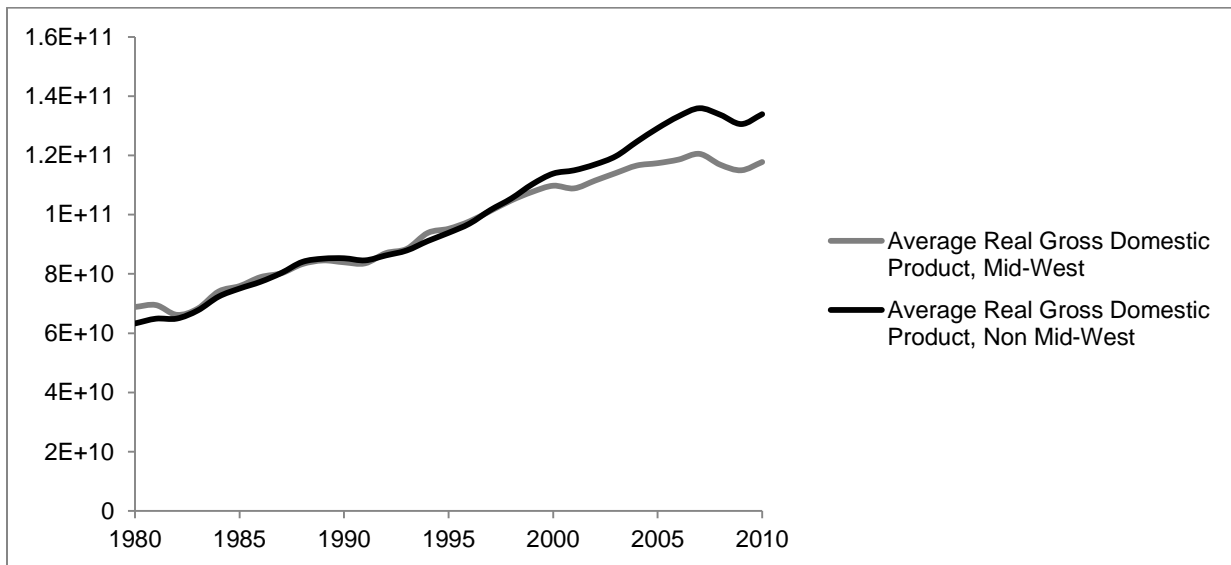


Diagram 1 represents the average real gross domestic product in the 'Mid-West' and the 'Non Mid-West'. The average real gross domestic product in the 'Mid-West' ('Non Mid-West') is the ratio of the sum of all twelve (thirty nine) states in the 'Mid-West' ('Non Mid-West') and twelve (thirty nine). The average real gross domestic product in the 'Mid-West' ('Non Mid-West') represents the mean product of each state in the 'Mid-West' ('Non Mid-West'). The average real gross domestic product of the 'Mid-West' was higher than the 'Non Mid-West' until 1996 but it started to fall behind from 1997. The gap of average real gross domestic product between the 'Mid-West' and the 'Non Mid-West' has been increased by fifty four times between 1997 and 2010.

Diagram 2 and Diagram 3 represent the average number of people with high school diploma and Bachelor's and advanced degree respectively. The average number of high school graduates in the 'Non Mid-West' outnumbers the average number of high school graduates in the 'Mid-West' from 2001. This gap has been raised by almost twenty five times between 2001 and 2010. The number of people with Bachelor's degree and more is higher in the 'Non Mid-West' from 1980. However, the gap between 'Non Mid-West' and the 'Mid-West' has been amplified by fifty six times between 1980 and 2010.

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Diagram 2: Average Number of High School Graduates in the 'Mid-West' and the 'Non Mid-West' between 1980 and 2010

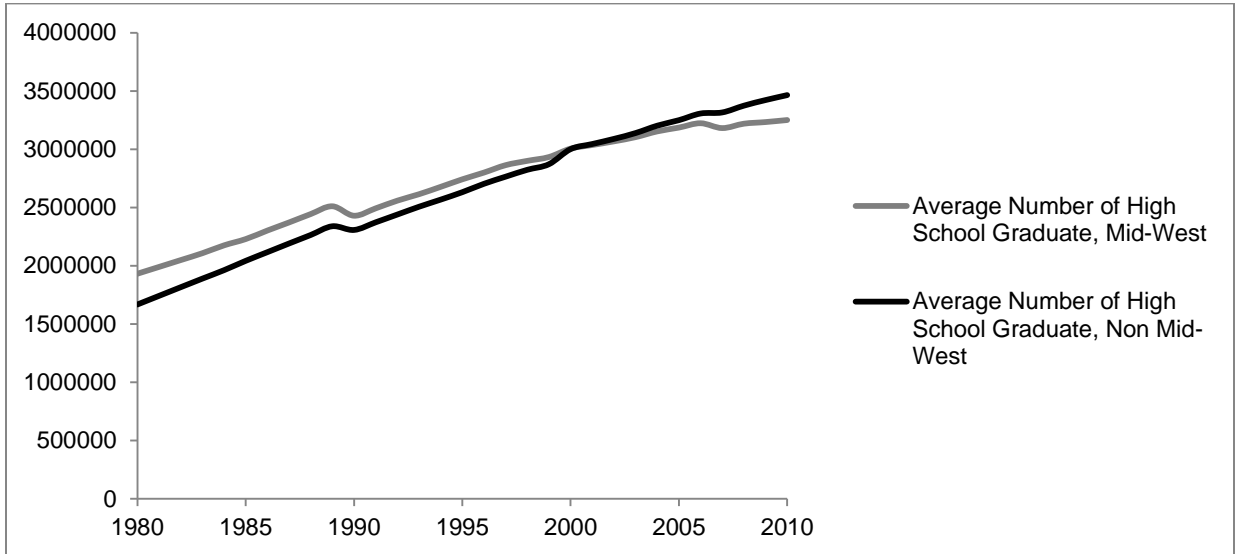


Diagram 3: Average Number of Bachelor's and Advanced Degree Holders in the 'Mid-West' and the 'Non Mid-West' between 1980 and 2010

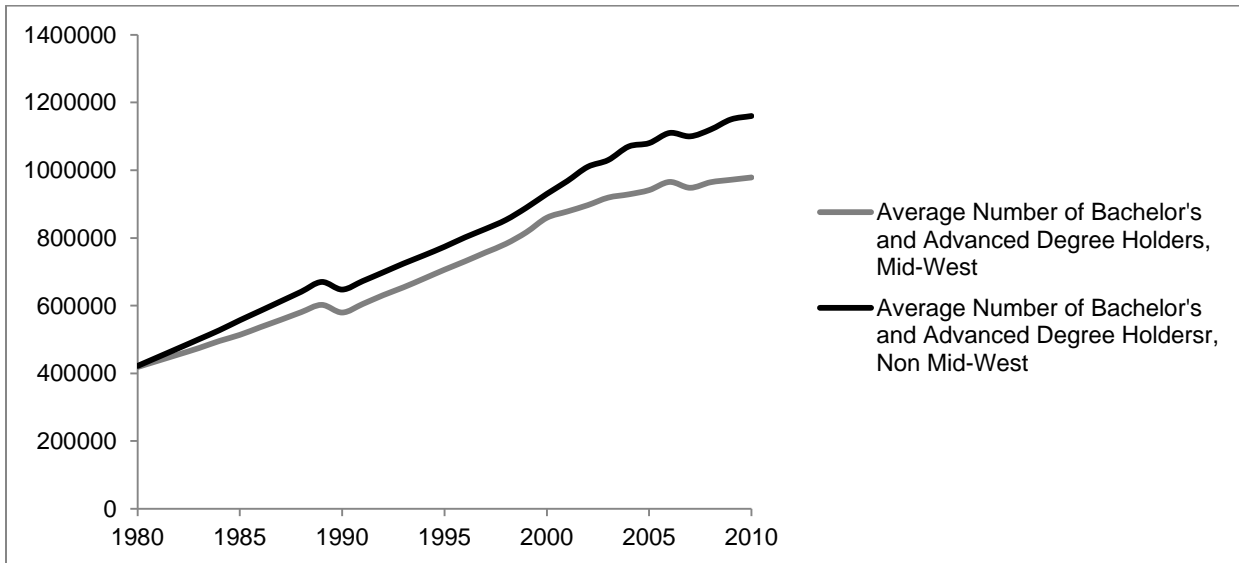


Table 1 represents the mean, standard deviation, minimum and maximum of the level and growth of real GDP per-capita and share and growth of secondary and tertiary education in the 'Mid-West' and the 'Non Mid-West' for the time period 1980 and 2010. The mean and the standard deviation of the level of real GDP per-capita are higher in the 'Non Mid-West' compare to the 'Mid-West'. The average growth rate and its deviation are higher in the 'Mid-West' compare to the 'Non Mid-West'. The mean share of secondary education is lower and its standard deviation is higher in the 'Non Mid-West' compare to the 'Mid-West'. The mean and the standard deviation of the growth of

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secondary education are lower in the 'Mid-West' compare to the 'Non Mid-West'. The mean and the standard deviation of the share of tertiary education are lower in the 'Mid-West' compare to the 'Non Mid-West'. The mean and the standard deviation of the growth of tertiary education are same for both 'Mid-West' and the 'Non Mid-West'.

Table 1: Summary Statistics of the 'Mid-West' and 'Non Mid-West'

	Mean	Std. Dev.	Min	Max
Mid - West				
<i>Real GDP Per-Capita - Level</i>	9.79	0.17	9.35	10.14
<i>Share of Secondary Education</i>	0.82	0.06	0.65	0.93
<i>Share of Tertiary Education</i>	0.22	0.05	0.13	0.34
<i>Real GDP Per-Capita -Growth</i>	0.02	0.03	-0.10	0.17
<i>Growth of Share of Secondary Education</i>	0.01	0.01	-0.05	0.03
<i>Growth of Share of Tertiary Education</i>	0.02	0.04	-0.20	0.19
Non Mid-West				
<i>Real GDP Per-Capita - Level</i>	9.81	0.30	9.21	11.30
<i>Share of Secondary Education</i>	0.8	0.08	0.54	0.93
<i>Share of Tertiary Education</i>	0.23	0.06	0.07	0.49
<i>Real GDP Per-Capita -Growth</i>	0.01	0.01	-0.06	0.06
<i>Growth of Share of Secondary Education</i>	0.02	0.04	-0.16	0.30
<i>Growth of Share of Tertiary Education</i>	0.02	0.04	-0.46	0.28

4. Data and Methodology

4.1 Data Sources

I collect the data on state nominal gross domestic product from the Survey of Current Business. I collect the data on regional annual consumer price index for all urban consumers from the Bureau of Labor Statistics. I deflate the state nominal gross domestic product by regional consumer price index to get state real gross domestic product. I collect the data on the number of non-White population and the age distribution of population from the Statistical Abstract of the United States. Data on high school graduates, Bachelor's and advanced degree holders have been collected from the Census on Population and Housing and the Statistical Abstract.

4.2 Methodology

To investigate the effect of quantity of education on state real GDP per-capita, I use the following model:

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$$\begin{aligned} RealGDPPC_{it} = & \alpha_i + \beta_1 HSG_{it} + \beta_2 HSG_{it} \times Dummy + \beta_3 TE_{it} + \beta_4 TE_{it} \times Dummy + \beta_5 NW_{it} \\ & + \beta_6 POP65_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

$RealGDPPC_{it}$ represents the natural log of state real GDP per-capita of state i at year t . HSG_{it} represents the share of people with age twenty five and above who complete the high school in state i at year t . BD_{it} represents the share of people with age twenty five and above who holds the Bachelor's and advanced degree in state i at year t . The dummy variable takes the one for the states belong to the 'Mid-West' region. It takes the value zero for all states belong to the 'Non Mid-West' region. NW_{it} represents the share of non- White population of state i at year t . $POP65_{it}$ is the share of number of people with age sixty five and more. ε_{it} is the error term.

I include a dummy variable and create an interaction of the dummy variable with education. The dummy variable takes the value of one for all twelve states in the 'Mid-West' and takes the value of zero for all states thirty nine states in the 'Non Mid-West'. The value of the coefficient β_2 and β_4 distinguishes the 'Mid-Western' states from the 'Non Mid-Western' states to explain the effect of quantity of education on state real GDP per-capita. I include two other explanatory variables: the share of non-white people and the share of people with age sixty five and more. I include the people of American Indian, Asian, Black, Hispanic, Two or more races as non-White people. Higher percentage of non-White people in a state represents higher level of cultural diversity and diffusion and lower degree of cultural rigidity. Studies show that cultural rigidity hinder the growth new technological innovation and human capital accumulation that deters the growth of production. A large percentage of people take retirement at the age of sixty five. Therefore, a major percentage of this group does not participate in production.

First, I assume that education as an exogenous variable and take pooled OLS of equation (1). However, education can be endogenous for at least two reasons. First, there may be omitted factors that affect both education and real GDP. Second, real GDP affect the prosperity of the economy and thereby affect education. In the time of prosperity the level education for some group of people may increase due to the easy availability of finance and higher expected return of education. Similarly, it is easier to get job in the time of prosperity and that may affect negatively to the level of education for some group. If education is endogenous, the coefficients of equation (1) would be biased and inconsistent. I use the GMM estimator to handle the endogeneity problem of education.

To examine the effect of share of high school graduates and the Bachelor's and advanced degree holders on the growth of real GDP per-capita, I use the following model:

$$y_{it-1} = \gamma_i + \delta_1 y_{it-1} + \delta_2 HSG_{it} + \delta_3 BD_{it} + \delta_4 NW_{it} + \delta_5 POP65_{it} + \varepsilon_{it} \quad (2)$$

Rearranging (2) I get,

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$$\Delta y_{it} = \gamma_i + (\delta_1 - 1)y_{it-1} + \delta_2 HSG_{it} + \delta_3 BD_{it} + \delta_4 NW_{it} + \delta_5 POP65_{it} + \epsilon_{it} \quad (3)$$

$$\epsilon_{it} = \mu_i + \tau_{it} \quad (4)$$

Δy_{it} represents the growth of real GDP per-capita in state i at year t . All the other variables are described before. ϵ_{it} is the error term. $\mu_i \sim IID(0, \sigma_\mu^2)$ and $\tau_{it} \sim IID(\sigma_\tau^2)$ are independent of each other and among themselves.

I use the GMM estimator for dynamic panel data model proposed by Holtz-Eakin, Newey and Rosen (1988) and Arellano and Bond (1991) to estimate equation (2). The lagged dependent variable on the right hand side makes the regressors endogenous (since y_{it} is a function of μ_i , so y_{it-1} is also correlated with μ_i). State-specific omitted variables also make the regressors endogenous. The GMM estimator takes the regressors as endogenous and generates additional instruments by utilizing the orthogonality condition between the lagged values of the regressors and the disturbance term ϵ_{it} .

5. Results

The effect of the share of high school graduates and Bachelor's and advanced degree holders on the level of state real GDP per-capita is presented in Table 2. The OLS estimates of equation (1) are presented in the second column of Table 2. Share of state high school graduates has significant positive effect on state real GDP per-capita. 1% increase in the number of state high school graduates will increase state real GDP per-capita by 0.42%. However, this effect is little higher in the 'Mid-West'. 1% increase of the number of state high school graduate will increase state real GDP per-capita by 0.77%. 1% increase in the share of state Bachelor's and advanced degree holders will increase state real GDP per-capita by 2.69% in the 'Non Mid-West' and 1.77% in the 'Mid-West'. 1% increase in the share of non-White people will raise state real GDP per-capita by 0.59%. Increase in the share of population with age sixty five and over by 1% will reduce state real GDP per-capita by 1.48%.

Third column of Table 2 provides the results from GMM method by using equation (1). 1% increase in the share of state high school graduates will increase state real GDP per-capita by 0.45% in the 'Non Mid-West' and 0.79% in the 'Mid-West'. 1% increase in the share of state Bachelor's and advanced degree holders will increase state real GDP per-capita by 2.69% in the 'Non Mid-West' and 1.89% in the 'Mid-West'. The results are very similar irrespective of econometric method.

Table 3 presents the results of the effect of share of high school graduates and the Bachelor's and advanced degree holders on the growth of real GDP per-capita for the US, the 'Mid-West' and the 'Non Mid-West' in column 2, 3 and 4 respectively. Negative signs of the initial income for all regions represent the convergence of income. The results are very similar for the US and the 'Non Mid-West'. High school graduates have negative effect on the growth of real GDP per-capita for both the US and the 'Non Mid-West' and these results are statistically significant. Share of Bachelor's and advanced

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degree holders have statistically significant positive effects on the growth of real GDP per-capita for both the US and the 'Non Mid-West'. Share of high school graduates and Bachelor's and advanced degree holders have no statistically significant effect on the growth of real GDP per-capita in the 'Mid-West'.

Table 2: Effect of Share of Secondary and Tertiary Education on the Level of Real GDP Per-Capita

	Pooled OLS	GMM
High School Graduate	<i>0.42***</i> (0.12)	<i>0.45***</i> (0.11)
High School Graduate × Dummy	<i>0.35***</i> (0.05)	<i>0.34***</i> (0.05)
Bachelor's Degree or More	<i>2.69***</i> (0.19)	<i>2.69***</i> (0.18)
Bachelor's Degree or More × Dummy	<i>-0.92***</i> (0.19)	<i>-0.89***</i> (0.18)
Non-White People	<i>0.59***</i> (0.05)	<i>0.59***</i> (0.05)
People with Age 65 and Over	<i>-1.48***</i> (0.38)	<i>-1.62***</i> (0.39)
R Squared	<i>0.64</i>	-

Standard Errors are in the Parenthesis. ***, ** and * represent significance at 1%, 5% and 10% levels, respectively.

Table 3: Effect of Share of Secondary and Tertiary Education on the Growth of Real GDP Per-Capita

Dependent Variable: Growth of State Real GDP Per-Capita			
	US-Total	Mid-West	Non Mid-West
Initial Income	<i>-0.03***</i> (0.01)	<i>-0.14***</i> (0.15)	<i>-0.04***</i> (0.01)
High School Graduate	<i>-0.04***</i> (0.01)	<i>0.26</i> (0.64)	<i>-0.05**</i> (0.02)
Bachelor's Degree or More	<i>0.12***</i> (0.03)	<i>0.10</i> (1.36)	<i>0.18***</i> (0.04)
Non-White People	<i>0.03</i> (0.04)	<i>-0.01</i> (0.76)	<i>0.01</i> (0.04)
People with Age 65 and Over	<i>0.26**</i> (0.10)	<i>-0.57</i> (2.09)	<i>0.15</i> (0.14)

Standard Errors are in the Parenthesis. ***, ** and * represent significance at 1%, 5% and 10% levels, respectively.

6. Conclusion

The gap of average level of real GDP between the 'Mid-West' and the 'Non Mid-West' in the US has been increased by fifty four times between 1997 and 2010. I explain the increasing gap of average level of real GDP by examining the effect of secondary and tertiary education on the level and growth of real GDP per-capita in the 'Mid-West' and the 'Non Mid-West'. I use the share of high school graduate with age twenty five and higher as a proxy of secondary education. I use the share of Bachelor's and advanced degree holders with age twenty five and higher as a proxy of tertiary education. Using the data for fifty one states for the period 1980 and 2010, I examine how education affects the level and growth of real GDP per-capita in the 'Mid-West' and the 'Non Mid-West'.

I find that both secondary and tertiary education have significant positive effect on the level of real GDP per-capita. The effect of tertiary education is higher than secondary education for both in the 'Mid-West' and the 'Non Mid-West'. However, tertiary education has a higher effect in the 'Non Mid-West' (2.69) compare to the 'Mid-West' (1.77–1.79). This is completely opposite for secondary education. Secondary education has a lower effect in the 'Non Mid-West' (0.42–0.45) compare to the 'Mid-West' (0.77–0.79). Secondary education has a negative effect and tertiary education has a positive effect on the growth of real GDP per-capita in the 'Non Mid-West'. Secondary and tertiary education has no significant effect on the growth of real GDP per-capita in the 'Mid-West'.

I find three reasons to explain the increasing gap of the average level of real GDP between the 'Mid-West' and the 'Non Mid-West'. First, the positive effect of tertiary education on the level of real GDP per-capita is much higher compare to the effect of secondary education both in the 'Mid-West' and the 'Non Mid-West'. Additionally, the share and the average number of people with tertiary education are higher in the 'Non Mid-West' compare to the 'Mid-West'. Higher share and average number of people added with higher positive effect of tertiary education increases the real GDP at a higher pace in the 'Non Mid-West'. Second, the share and the positive effect of secondary education on the level of real GDP per-capita are higher in the 'Mid-West'. However, the positive effect of secondary education in the 'Mid-West' is much lower than the positive effect of tertiary education in the 'Non Mid-West'. Therefore, the positive effect of secondary education in the 'Mid-West' can't compete with the positive effect of tertiary education in the 'Non Mid-West'. Last, tertiary education in the 'Non Mid-West' has positive effect on the growth of real GDP per-capita. This effect is not significant for the 'Mid-West'. Even if it would be significant, it has much lower effect in the 'Mid-West'. I find tertiary education is crucial for the growth of real GDP. The higher positive effect of the tertiary education in the 'Non Mid-West' increases the pace of real GDP and leads to the increasing gap of average level of real GDP between the 'Mid-West' and the 'Non Mid-West' in the United States.

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