Journal of Applied Economics and Business Research
JAEBR, 12 (1): 20-31 (2022)

The Temporal Dynamics of Race and Employment: A Cointegration and Vector Error Correction Model

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Abstract

The disparity in unemployment rates among various racial communities of the United States labor market has long existed. Most of these works have focused on case studies or microeconomic models of steady state differences in unemployment rates. In this article, we use the Cobb-Douglas production function to develop a dynamic model to investigate the short-run and long-run temporal employment relationship between African Americans and their white counterpart. Empirically, we use annual and quarterly data to test for cointegration and develop error-correction models. Using annual employment data our central findings are that GDP, African American employment, and white employment are cointegrated. We find that white employment does not Granger-cause African American employment. On the contrary, we find that African American employment and GDP Granger cause white employment in the short run. With quarterly data, we find that employment in the white community Granger-causes employment in the African American community in the short term, but we find no feedback effect. Indeed, regardless of the frequency of data used, there appears to be a temporal dynamic relationship between African Americans and white employment in the U.S. labor market. These findings certainly have important policy implications.

Keywords: Labor markets; Employment; Cointegration; Granger causality; Vector Error-Correction Model

JEL Codes: E2, E3, J4.

1. Introduction

The disparity in unemployment rates among various racial communities of the United States labor market have long existed. There is a deluge of studies that analyze the existence and causes of differential unemployment rates in the African American community compared to the unemployment rates in other communities. Most of these works have focused on case studies or microeconomic models of steady state differences in unemployment rates that exist. However, to date, there are not many studies that analyze the temporal dynamics within the labor market. Holding all else constant, are laborers truly homogeneous? If so, why is there long-run persistence in the unemployment rates? Is there a preference in race on the part of employers? During economic expansion, is employment growth consistent among racial groups or is there temporal preference

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in hiring among racial groups? The Civil rights Act of 1964 was to end racial, religious, and other forms of biases in hiring practices. Has this law improved the situation?

The objective of this paper is to investigate the national labor market to determine if there exist a long-run and short-run employment relationship among African Americans and whites in the labor market. We investigate the dynamics within the labor market to determine if there is an apparent relationship in hiring practices of employers based on race. We investigate if white employees are hired first, followed by employees with other racial identities, or perhaps vice-versa. In other words, at a first pass, did the Civil rights Act of 1964 accomplish its objective?

To unpack this complex issue, we will explore a firm's production function and develop a dynamic model of expansion. Using national production related variables, we test for cointegration among the variables, followed by long-run and short-run Granger causality among the variables. The next section of this paper will proceed with a brief literature review, followed by the development of a stylized theoretical model using a Cobb-Douglas production function in Section 3. Using a closed-form equation, we test for cointegration and develop a vector error correction model. We proceed with a brief discussion of the results in Section 6, followed by a conclusion in Section 7.

2. Literature review

As noted in the introduction, the literature on causality and cointegration is nonexistent or scant at best. There is, however, a voluminous amount of literature on microeconomic models of frictional forces within the labor market to account for differences in unemployment rates among African Americans and other racial groups. While our objective is not to analyze level differences between the various sectors of the labor market, below are a sampling.

Differences in unemployment rates between African Americans and whites have been an ongoing discussion and research topic. Lynch and Hyclak (1984) analyze the disparities among various groups in the labor market, and they find that the level of the natural rate of unemployment has changed over time with a rising labor force participation among non-traditional groups in the labor market. Robinson (2010) explains differences in the levels of unemployment between Blacks and Whites from a cultural perspective, in the sense that employers engage in employment discrimination based on tastes derived from "infotainment" to bias their hiring practices and contribute to the wage gap between the two groups.

Realizing that the unemployment gap is only one facet of the overall inequities that occur between racial communities, researchers have incorporated many factors to explain overall inequities. Raymond (2018), for example, utilizes simple regression models to control for various factors and find that race remains the strongest predictor of persistent negative equity in the southeastern U.S. Further, Nkomo and Ariss (2014) show that the historical origins of White privilege explain persistence in the racial divide in organizations and the American labor market.

To peer into racial discrimination, various experiential studies have been conducted to determine if employers exercise biasness in their employment practices. Bertrand and Mullainathan (2004) conducted one such study. They used White-sounding and African Sounding names to see

 ISSN 1927-033X

if employers were more likely to call back applicant based on their names. They found that resumes with White sounding names received 50% more callbacks for interviews.

The second strand of the literature on racial discrimination, very deep and broad in scope, takes a macro approach to analyze the income differentials between African Americans and other sectors of the labor market. Raymond (2018) finds that race is the strongest predictor of persistent negative equity in the southeast of the U.S., even after controlling for factors relating to the 2008 crisis. Mouw (2000) analyzes unemployment rates in Chicago and Detroit by targeting spatial employment opportunities and residential housing. Using panel data and a fixed-effect model, he finds that decentralization of employment and the loss of manufacturing jobs resulted in spatial distribution of employment in the two cities. Immergluck (1998) looks at proximity of job opportunities in urban areas to explain unemployment rates among urban dwellers, and he finds that race and educational attainment have the largest effects on unemployment rates. Further, Hoynes *et al.* (2012) find that the net effect of the 2007-2008 recession on unemployment was not homogeneous across the various sectors of the labor market. Specifically, African Americans and Hispanics suffered higher levels of unemployment during this crisis.

Econometrically, cointegration and error correction models have been employed in analyzing long-run relationship between employment and various relevant variables. Altuzarra et. al (2019) examines long-run relationship between employment and labor force participation rates in Spain. They find no long-run relationship between those variables in aggregate and male series. Hasanov et al (2021) explored the impact of relevant production variables like output and labor demand in Saudi Arabia. They found that employment is positively related to output, but negatively related to wages. Employment Granger-causes wages. One of their major findings is that employment has various causal impact on other sector variables, but with different time dimensions. Apergis, Nicholas and Ibrahim Arisoy (2017) use a panel cointegration model to test for long run relationship between unemployment rates and labor force participation rates in the U.S. The panel study, for every state in the US, provides evidence that relationship that there is a negative between labor force participation and unemployment rates.

3. Methodology

Labor Model: We begin with a typical firm's Cobb-Douglas production function with constant returns to scale and diminishing return to each input. At any given time, the production function can be expressed as:

$$Y_t = {A_t}^{\gamma} {K_t}^{\alpha} {H_t}^{\beta} \left({L_t}^{AA} + {L_t}^{W} + {L_t}^{L} + {L_t}^{O} \right)^{1-\gamma-\alpha-\beta} \quad (1)$$

Where Y is each firm's temporal output; A is the level of multifactor productivity; H is the level of human capital embodied in each employee, such that $H = f(H^{AA}, H^{W}, H^{O})$ and H^{i} is the level of human capital embodied in each worker by race. L^{i} and is the level of employment of each racial sector, so that the sum of all racial sector makeup the total employed labor supply, L_t , for the firm. Each factor exhibits diminishing returns. That is: $\gamma, \alpha,$ and β are individually < 1. Except for their racial makeup, we assume workers are homogeneous.

 ISSN 1927-033X

To analyze the production function's short-run dynamics, we take logs and time differentials of Equation (1) (for example, $\dot{Y} = \frac{dY}{dt}$). Doing so yields

$$\frac{\dot{Y}}{Y} = \gamma\frac{\dot{A}}{A} + \alpha\frac{\dot{K}}{K} + (1-\gamma-\alpha-\beta)\left(\frac{\dot{L^{AA}}}{L} + \frac{\dot{L^{W}}}{L} + \frac{\dot{L^{L}}}{L} + \frac{\dot{L^{O}}}{L}\right) + \beta\frac{\dot{H}}{H} \quad (2)$$

Rearranging Equation (2) for the employment growth of African American employment leaves:

$$\frac{\dot{L^{AA}}}{L} = \frac{1}{(1-\gamma-\alpha-\beta)}\frac{\dot{Y}}{Y} - \frac{\gamma}{(1-\gamma-\alpha-\beta)}\frac{\dot{A}}{A} - \frac{\alpha}{(1-\gamma-\alpha-\beta)}\frac{\dot{K}}{K} - \frac{\dot{L^{W}}}{L} - \frac{\dot{L^{L}}}{L} - \frac{\dot{L^{o}}}{L} - \frac{\beta}{(1-\gamma-\alpha-\beta)}\frac{\dot{H}}{H} \quad (3)$$

To obtain the equation for the change in employment in the African American community, we multiply equation (3) by the level of employment (L) to arrive at Equation (4):

$$\dot{L}^{AA} = \frac{L}{(1-\gamma-\alpha-\beta)}\frac{\dot{Y}}{Y} - \frac{\gamma L}{(1-\gamma-\alpha-\beta)}\frac{\dot{A}}{A} - \frac{\alpha L}{(1-\gamma-\alpha-\beta)}\frac{\dot{K}}{K} - \dot{L}^{W} - \dot{L}^{L} - \dot{L}^{o} - \frac{\beta L}{(1-\gamma-\alpha-\beta)}\frac{\dot{H}}{H} \quad (4)$$

As Equation (4) indicates, except for output growth, the coefficients of all the right-hand-side variables are negative. Holding all other factors constant, output growth brings about growth in the level of employment of African Americans. Also, an increase in the employment levels of White and other classification of employees reduces the level of African American employment. Therefore, barring any other factors, to increase African American employment, economic output must grow more than employment in the other classification of employees. Moreover, Equation (4) provides a close approximation to an error-correction models, at least as it relates to the employment changes in the various sectors.

The dynamics of the labor market will be analyzed with a system of endogenous equations. According to Granger and Engle (1987), two non-stationary variables are cointegrated of order 1 if their levels are nonstationary, but stationary in their first difference. If the variables are cointegrated of order 1, CI (1,1), we can use the Johansen Method to test for the rank of the system of equation to determine long-run causal relationship. If the variables are cointegrated, then a Vector Error-Correction Model (VECM) can be used to test for long-run and short-run causality between the variables. Generally, if the system is cointegrated, a vector error correction model of the general form:

$$\Delta\bar{\mu}_t{}^{i} = \alpha + \sum_i^{k-1}\delta_i ec_{i,t-1} + \sum_i^{k}\beta_i\Delta\bar{\mu}_{i,t-1}{}^{i} + e_t \quad (5)$$

Can be estimated (where $ec_{i,t-1}$ is the error term from the previous period and e_t is the white noise error term in the current period, and $\bar{\mu}_t\ are\ endogenous\ explanatory\ variables$). If δ_i=0, albeit, a long-run relationship, there is no long-run causality. Similarly, $\beta_i \neq 0\ implies\ a\ short-run\ causality$. We shall use this model to test the null hypothesis that white and African American employees are perfect substitutes for one another.

4. Data

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We extract data from two databases. The employment data are from the Bureau of Labor statistics (BLS) and physical and human capital are from the Penn World databases (Feenstra et al, 2015). We use BLS to collect annual and quarterly data on the national employment figures. Our entire annual sample covers the period from 1972 to 2020. We use annual data to maximize the number of variables included in Equation (4) above. However, because annual data may not possess sufficient frequency to minimize standard errors of estimated parameters, we will also use higher frequency quarterly data.

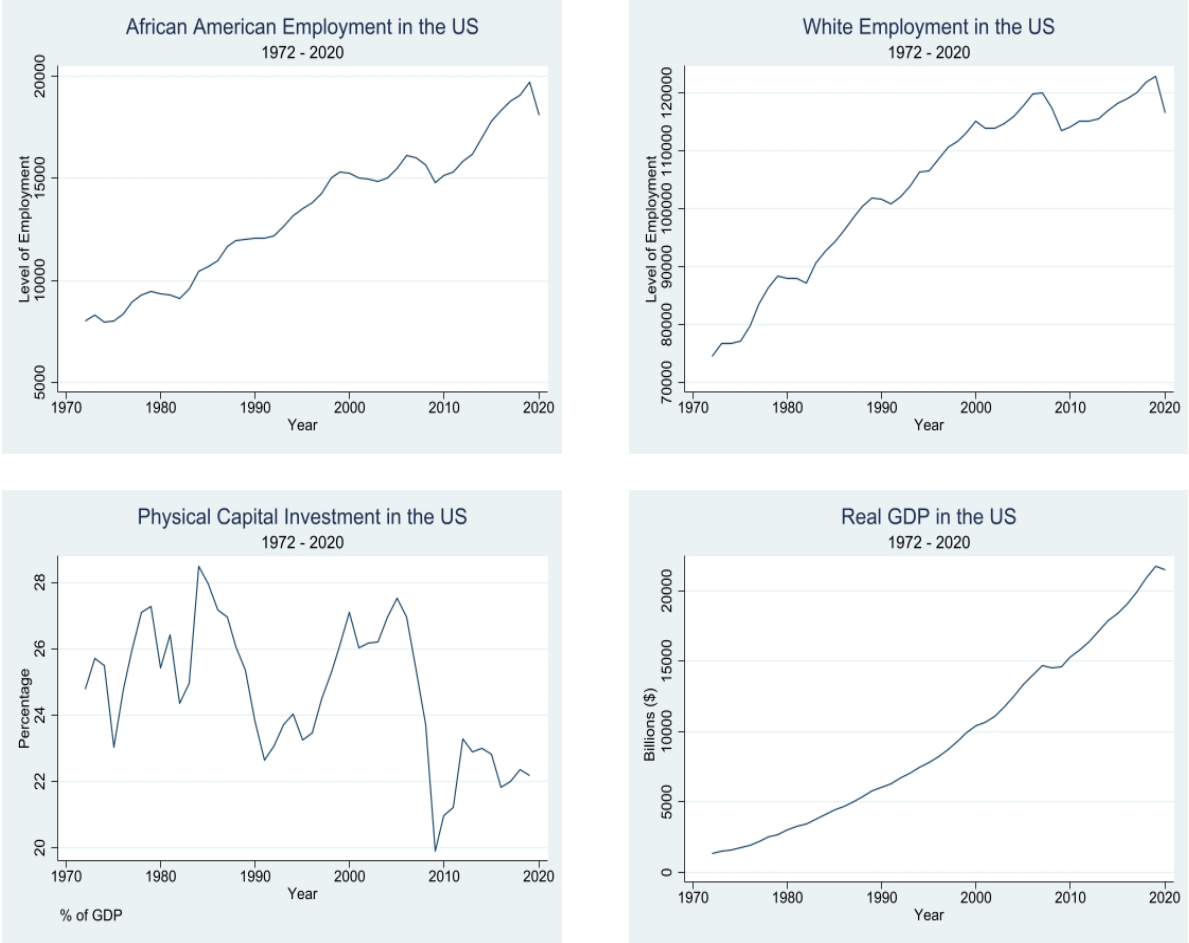

Figure 1 Relevant Annual Series

5. Empirical Results

The objective of this analysis is to empirically test for the existence of any dynamic relationship between the variables in the production function (Equation 1) above. To accomplish this, our goal is to incorporate all the relevant variables included in the equation to best model the effects on employment in the African American community. However, because of how the data are collected and reported, we are constrained to using series that report data annually. This will have some impact on our analysis. First, using annual data will reduce the number of observations and increase standard errors of our estimated coefficients and overall model. Second, because the sampling frequency is annual, detecting statistically significant interactions between variables that

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occur more frequently may present problems. Series with more frequent sampling rates are available, but they are not available for all variables of interest. Therefore, we will proceed with a baseline case that includes all relevant variables, followed by a case containing quarterly data, albeit with fewer variables.

5.1. Baseline Case – Annual data

5.1.1 Unit Root Tests and Cointegration

Cointegration requires that variables are nonstationary in their levels, but stationary in their differences. Therefore, a necessary condition is to perform unit root tests on the levels and first differences of the relevant variables. Because of the sensitivity of the unit root tests to lag length and other factors unique to each test, we shall conduct three separate unit root tests to minimize exposure to any specific test. Table 1 is the result of three unit-root tests: The Dickey-Fuller Generalized Least Squares; the Phillips-Perron; and the Adjusted Dickey-Fuller. We reject the null hypothesis of the existence of a unit only when at least two of the three tests so indicate. For the employment series, African American and white employment levels are non-stationary in their levels, but stationary in their first differences. We cannot reject the null hypothesis of a unit root at the 5% level in the levels--but reject the null hypothesis of a unit root at the 5% level in their first difference-- using the Phillips-Perron and Adjusted Dickey fuller tests. The same conclusion can be reached for the GDP and physical capital variables. These variables meet the minimum criterion for cointegration. On the contrary, we cannot reject the null hypothesis that the human capital series for African Americans and the white sectors contain a unit root. Therefore, we cannot include these variables in the test for cointegration.

Table 1. Unit Root Tests - Annual Data

Variable	Df-GLS tau statistic	Phillips-Perron Z(t)	Adj. Dickey-Fuller Z(t)
AA_Emp	-2.77	-0.76	-1.40
ΔAA_Emp	-2.97*	-3.66***	-3.91***
W_Emp	-0.85	-2.66	-2.81
Δ W_Emp	-4.06***	-3.21**	-3.09**
GDP	-1.36	3.86	2.28
ΔGDP	-4.32***	-3.16**	-3.05***
AA_HC	-0.53	-6.84***	-4.04***
ΔAA_HC	-5.34***	-4.47***	-2.51**
W_HC	-1.01	-9.9***	-5.14***
ΔW_HC	-2.30	-4.26***	-2.07
Phys_cap	-2.80	-2.19	-2.24
Δ Phys_cap	-4.27***	-6.22***	-4.38***

Note: *, **, *** indicate stagnation at 1%, 5%, 10% significance level, respectively. Optimal lag-length determined by the lag-length criteria: GLS lag length is determined by IC Tests

We performed a battery of tests to determine the optimal lag length of 2 (refer to Table A1 for results). The results of the Johansen test for cointegration are summarized in Table 2. The optimal rank is either 1 or 2, depending on the test. We can conclude the four variables are cointegrated – they have long run relationship. The Trace and Max statistics suggest a cointegration rank of 1, while the Information Criterion tests all point to a cointegration rank of 2. In keeping

 ISSN 1927-033X

with Enders (1995), we shall proceed in this fashion and fit a vector error correction model with a rank of 2.

Table 2. Johansen Tests for Cointegration – Annual data

Max Rank	Trace Stat	Max Stat	SBIC	HQIC	AIC
0	53.35	26.67	19.81	19.31	19.02
1	26.68*	21.20*	19.82	19.15	18.74
2	5.48	4.20	19.77*	18.98*	18.50*
3	1.29	1.29	19.93	19.06	18.54
4			19.99	19.09	18.56

Constant term included and max lag set at 2
Dependent Variables: AA_Emp, W_emp, GDP, Physcap
Yrs: 1974 - 2019
N = 46

5.1.2 Vector Error Correction Model

Table 3 displays the results of the vector error correction model (VECM) for the annual data. Specification (1) is the target model that best estimates Equation (4). The error-correction variables are statistically insignificant. Cointegration equation 1 is negative and statistically significant. A coefficient of -0.182 states that white employment, GDP and physical capital Granger cause African American in the long run. These variables explain long run equilibrium of African American employment levels and 18.2% disequilibrium caused by external shocks in African American employment levels will be restored in the following year. Contrary to popular belief, employment in the white community does not Granger cause employment in the African American community in the short run. As expected, there is short-run causality running from GDP to African American employment levels. African American employment increases by 800 when preceded by $1 billion increase in GDP, holding all relevant variables constant, statistically significant at the 5% level. A constant of -.433 suggest that without any changes in white employment, GDP, and physical capital, there is expected to be a reduction in employment from year to year.

Specification (2) models white employment changes. The error correction term is statistically insignificant. This implies that African American employment, GDP, and physical capital do not Granger-cause white employment in the long run. This also suggests that this model is divergent and does not react well to exogenous shocks. African American employment Granger causes white employment in the short run. Holding other variables constant, an increase in African American employment one year prior, increases white employment by 1.8 million. Real GDP appears to have a more robust effect on employment changes in the white community. African American employment and physical capital held constant, a $1 billion increase in real GDP Granger causes an increase in white employment by 4,000.

Diagnostically, Specifications (1) and (2) score very well. The null hypothesis of no serial correlation also cannot be rejected. For all but the GDP specification, the null hypothesis of normality among the residuals cannot be rejected. The contemporaneous error terms are white noise. According to Enders (1995) this brings much credence to the value of the models. We can advance to the cointegration and VECM models using quarterly data.

 ISSN 1927-033X

Table 3. Vector Error Correction Model -- Annual Data

	(1) ΔAA_Empl_t	(2) ΔW_Empl_t	(3) ΔGDP_t	(4) $\Delta Physcap_t$
$ce1_{t-1}$	-0.182***(.050)	-0.301(.223)	-19.307(30.471)	-0.719***(.203)
$ce2_{t-1}$	0.025***(.008)	0.023(.034)	3.668(4.645)	0.095***(.031)
ΔAA_Empl_{t-1}	0.421**(.200)	1.824**(.886)	184.79(120.740)	0.063(.805)
ΔW_Empl_{t-1}	0.042(.061)	-0.095(.272)	-62(36)	-0.065(.247)
ΔGDP_{t-1}	0.0008**(.0003)	0.004**(.002)	0.561(.224)	0.003**(0.001)
$\Delta Physcap_{t-1}$	-0.046(0.045)	-0.143(.202)	-0.108(27.54)	-0.053(.184)
Constant	-0.433***(0.290)	2.190*(1.284)	0.033(174.94)	-1.707(1.167)
Jarque-Berra Normality test Prob > X^2	.579	.204	.000	.578
LM Test of autocorrelation	H_o: $No\ autocorrelation$ =>	res_{-1}: Prob>X^2 = .22; res_{-2}: Prob>X^2 = .30;		

Note: *, **, *** indicate 1%, 5%, 10% significance level, respectively

5.2. Quarterly Data

As we discussed in the previous section, to improve on the interaction between variables, we use quarterly data. However, the gain in modeling that we obtain from the higher frequency is offset by losing the physical capital variable. This can potentially introduce omitted variable bias in our model.

We proceed in the same fashion with quarterly data as we did with the annual data. Tables A2 and A3 contain the results of the lag order selection criteria and unit root tests. The optimal lag length is 5. The results of the unit root tests suggest that the variables are integration of order one. The Johansen Cointegration tests (Table A4) all point to a rank of 1.

The results of the Error correction Model are found in Table 4. Specification (1) is again the target model of African American employment. GDP and white employment do not Granger cause African American employment in the long run. However, white employment does Granger cause African American employment in the short run. An increase in white employment in the previous 4 quarters, increases African American employment by a substantial amount. This is partially offset by a negative effect in the previous fifth quarter. The result of the Wald test strongly rejects the null hypothesis of no causal effect at the 1% level. Specification (2) includes the model for white employment. African American employment in the previous quarter strongly effects white employment. A one million increase in employment in the African American community increases white employment by 1.23 million. However, all five previous quarters, when tested jointly, fail to reject the null hypothesis on Granger causality in the short term. Again, there appears to be no serial autocorrelation of the residuals.

 ISSN 1927-033X

Table 4. Vector Error Correction Model -- Quarterly Data

	(1) ΔAA_Empl_t	(2) ΔW_Empl_t	(3) ΔGDP_t
ce_{t-1}	-.003(.004)	0.026*(.015)	-3.83(.3.182)
ΔAA_Empl_{t-1}	-0.149(.117)	1.23***(.467)	161.24(98.82)
ΔAA_Empl_{t-2}	-0.302***(.124)	0.034(.496)	-39.00(.104.8)
ΔAA_Empl_{t-3}	-0.048(.129)	0.077(.516)	-95.65(109.02)
ΔAA_Empl_{t-4}	0.113(.124)	0.314(.495)	-63.12(104.62)
ΔAA_Empl_{t-5}	0.229*(.118)	0.223(.471)	67.16(99.67)
ΔW_Empl_{t-1}	0.079**(.022)	-0.104(.132)	21.49(27.82)
ΔW_Empl_{t-2}	0.057**(.029)	-0.218*(.116)	5.59(24.43)
ΔW_Empl_{t-3}	-.006(.030)	-0.277**(.120)	-4.31(25.29)
ΔW_Empl_{t-4}	0.088***(.029)	0.611***(.116)	8.06(24.45)
ΔW_Empl_{t-5}	-0.067(**.034)	-0.279**(.134)	-33.04(28.33)
ΔGDP_{t-1}	-0.0001(.0002)	-.001(.001)	-0.533***(.143)
ΔGDP_{t-2}	-0.0000(.0002)	-.000(.001)	-0.337**(.157)
ΔGDP_{t-3}	-0.0001(.0003)	0.002(.001)	0.379(.277)
ΔGDP_{t-4}	-.000(.0003)	0.000(.001)	0.166(.281)
ΔGDP_{t-5}	-0.0002(.0003)	-.001(.001)	0.015(.268)
Constant	-0.029(.103)	1.03(.412)	.007(87.20)

LM Test of autocorrelation

$H_o: No\ autocorrelation \Rightarrow$ res_{-1}: Prob>$X^2 = .28$;
res_{-2}: Prob>$X^2 = .15$;
res_{-3}: Prob>$X^2 = .15$

Wald Tests		
	$\Delta W\_Empl_{t-1} = 0$	$\Delta AA\_Empl_{t-1} = 0$
	$\Delta W\_Empl_{t-2} = 0$	$\Delta AA\_Empl_{t-2} = 0$
	$\Delta W\_Empl_{t-3} = 0$	$\Delta AA\_Empl_{t-3} = 0$
	$\Delta W\_Empl_{t-4} = 0$	$\Delta AA\_Empl_{t-4} = 0$
	$\Delta W\_Empl_{t-5} = 0$	$\Delta AA\_Empl_{t-5} = 0$
	Prob>$X^2 = .00$	Prob>$X^2 = .12$

6. Summary and Conclusion

Our central finding is that there appears to be a dynamical force between the employment of African Americans and white Americans. This is not only obvious from the persistent unemployment rate differentials among whites and African Americans (refer to Table A8), but as identified by Granger causality tests. Quarterly and annual data suggest that African American employment Granger causes white employment in the short run. The quarterly model, albeit not controlling for physical capital and thus may contain some level of missing variable bias, seems to provide some evidence of reverse causality.

The major takeaway from our analysis is that there is a long-run association between white employment and African American employment, in the sense that African American unemployment Granger-causes white employment. Employment, when controlling for physical capital and GDP, does not appear to be randomly selected between the communities. However, given that employment in the African American community seems to have a positive effect on employment in the white community has policy implications. Policymakers have evidence to direct policy to increase employment in the African American community. Doing so has a major impact

 ISSN 1927-033X

on total employment. Aside from social benefits, and simply the just thing to do, it also makes for good economic policy as well.

When the economy is confronted with exogenous shocks such as the COVID-19, it is imperative to know that they affect the labor market in unbalanced ways. It is widely accepted that the effects of the coronavirus had a deleterious effect on the supply chains and labor markets (Karabag, 2020). Unemployment levels rose to levels not seen since the Great Recession. These serious and unpredictable shocks require both fiscal and monetary policies to restore the U.S. economy towards its long-run economic trend. Knowing the temporal relationship between the white and African American communities of the labor market will help Government Officials provide appropriate economic policies.

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Appendix

Table A1. Selection-Order Criteria (1975 – 2019) – annual Data

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-707.6				6.4E8	31.63	31.69	31.79
1	-399.0	617.1	16	0.00	1445.6	18.62	18.92*	19.43*
2	-380.3	37.5	16	0.00	1301.5*	18.50*	19.04	19.95
3	-365.5	29.6*	16	0.02	1438.5	18.56	19.33	20.64

Table A2. Selection-Order Criteria – Quarterly Data

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-2660				2.6E8	27.88	27.91	27.94
1	-1510	2299	9	0.00	1681.3	15.94	16.02	16.15
2	-1471	78.33	9	0.00	1226.1	15.63	15.77	19.97
3	-1446	49.64	9	0.00	1039.1	15.46	15.67	15.97
4	-13.94	104.6	9	0.00	660.6	15.01	15.28	15.67
5	-1325	138.1*	9	0.00	352.5*	14.38*	14.71*	15.20*
6	-1310	16.03	9	0.066	357.9	14.39	14.79	15.37

Table A3. Unit Root -- Quarterly Data

Variable	Df-GLS tau statistic	Phillips-Perron Z(t)	Adj. Dickey-Fuller Z(t)
AA_Emp	-2.55	-0.81	-0.80
ΔAA_Emp	-7.95***	-15.41***	-9.69***
W_Emp	-0.55	-2.62*	-2.56
Δ W_Emp	-2.26	-18.90***	-12.46***
GDP	-0.18	3.05	3.11
ΔGDP	-11.61***	-17.26***	--5.26***

Max Lag length determined by Information Criterion

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Table A4. Johansen Tests for Cointegration – Quarterly data

Max Rank	Trace Stat	Max Stat	SBIC	HQIC	AIC
0	61.30	55.47	16.01	15.80	15.65
1	5.833*	5.73*	15.86*	15.60*	15.42*
2	0.102	0.102	15.91	15.62	15.42
3			15.94	15.64	15.43

Constant term included and maxlag set at 3
Dependent Variables: AA_Emp, W_Emp, GDP
Yrs: 1972Q4 - 2020Q4
N = 193

Table A5. Correlation Matrix -- Quarterly Data

	AA_Emp	W_Emp	GDP
AA_Emp	1.0000		
W_Emp	0.9658	1.0000	
QDP	0.9668	0.9016	1.0000

Table A7. Correlation Matrix -- Annual Data

	AA Emp	W Emp	Physical Cap	GDP
AA Emp	1.0000			
W Emp	0.9682	1.0000		
Physical Cap	-0.4236	-0.3367	1.0000	
GDP	0.9657	0.9092	-0.5272	1.0000

Table A8. Descriptive Statistics on the Monthly National U.S. Unemployment Rates

	African American	White	Latin	Total
N	374	374	374	374
Mean	10.61	5.11	7.92	5.81
Median	10.50	4.70	7.50	5.40
S.D.	2.62	1.46	2.30	1.58
Max	16.8	9.20	13.00	10.0
Min	5.4	3.10	3.90	3.5

Jan/1/1989 to 2/1/2020

 ISSN 1927-033X