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IMMIGRATION AND ECONOMIC GROWTH: FURTHER EVIDENCE FROM US DATA

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Abstract: *This paper uses annual US data to examine the causal relationship between immigration and real GDP. Despite its implications for policy, a statistically robust relationship between these two series has been difficult to pin down. Our tests reveal that both the series are break-stationary. Therefore, we apply the Gregory-Hansen (1996) residual based cointegration approach to these series to establish a long run relation between them in the presence of regime shifts. Standard Granger causality test shows that the relation flows from economic growth to immigration in the short run, but not the reverse. However, the Error Correction Models within Vector Error Correction framework shows a bidirectional feedback relationship in the long run which is intuitively more appealing.*

JEL classifications: *F20, E20*

Keywords: *Causality; Immigration; Cointegration, Structural-Break*

I. INTRODUCTION

The relationship between immigration, wage rate, and unemployment rate of the native workers has been a subjected to intense debate in labor economics over the last 30 years. And yet, despite its importance, the relation between immigration and economic growth has drawn relatively less attention. There are a few exceptions, however. Morley (2006) is the only empirical paper to date that has examined a long run relationship between immigration and economic growth for the US using ARDL bound testing approach to cointegration. In our paper, we use a different data set and methodology to study both the long and the short run relationship between immigration and economic growth in the US. To our knowledge, this paper is the only study that investigates a cointegrating relationship between these two series taking into account the possibility of structural breaks in the series.

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Morley (2006) found evidence to support long-run causality flowing from per-capita economic growth to immigration, but failed to establish the reverse causality. Morley's paper is of particular interest to us because it is plausible that growing economies attract immigrants, but at the same time it is equally plausible that, once the immigrants adjust to the new home-environment, they would also contribute to the long run economic growth in the host nation. Morley's findings suggest that immigrants do not contribute to economic growth in the host nation in the long-run appears not in line with the observed growth pattern, rising wages and productivity in the US over the past century. If sustained, Morley's results likely will have considerable implications for policies governing immigration.

The objective of this paper is to examine a possible long run relation between immigration and real GDP for the US economy using annual data. For the purposes of this paper, immigrants are defined as foreign born persons who have been admitted in the US as legal aliens through family union, employment or other means. The paper implements the Johansen and Juselius (1990) cointegration method and the error correction models (ECM) to ascertain the nature of the relation between these two series. Cointegration is used for the long run relation and Granger causality for the short run dynamics. While we are looking for possible structural breaks in our data, we also subjected the U.S. part of Morley's data to tests for such breaks. Specifically, we applied the Gregory-Hansen (1996) procedure to test for cointegration to both our and Morley's data sets, which helped us to establish a long run bidirectional relationship between immigration and real GDP within the Vector Error Correction Models framework.

The rest of the paper is organized as follows. Section II reviews the literature on the ongoing debate on the benefits of immigration. Section III describes the empirical framework and the data. Section IV reports the econometric results. Section V draws conclusions and provides a brief discussion of the issues involved here.

II. LITERATURE REVIEW

The ongoing debate over immigration, both legal and illegal, and the manner in which it is addressed is likely to have profound implications for the U.S. labor market. Many look at immigrants as 'stealing' jobs from US workers, or at least as depressing the prevailing native wage rates. Others argue that many immigrants take jobs that require less skill, which Americans would not take anyway. In the longer view immigrants have historically been a major driving force contributing to the American economic growth. The fact that immigrants do play an important role in a prosperous America has been a notable theme in the Economic Report of the President (2007) and corroborated by Hunt *et al.*, (2010).

Borjas (1996) notes that immigrants increase the number of workers in an economy, produce additional competition in the labor market, and thereby depress the prevailing wages of the native workers. Economists like Jaynes (2007) argue that business and consumers also gain, both in the short and the long run. First, immigrants add to the consumer base who demands more goods and services. Second, in the longer run, the increased labor supply lowers wages which allows firms to produce goods and services at lower costs; and pass them on to consumers. Some native consumers thus gain from increased real income from cheaper goods and services. So, as the size of the pie increases, the gains that accrue to those who use immigrant services likely will exceed the losses suffered by native workers. Indeed, if benefits from immigration

exceed costs in the aggregate, the gainers in society can adequately compensate the losers. In theory, if such compensation is paid, society as a whole would be better off.

As noted, the impact of immigrants on the native worker's wage rate and unemployment rate has been studied extensively. Islam (2007) used Canadian data to examine the postulated relation within vector error correction model. He found a long-run positive relationship between *per-capita* GDP, immigration rate, and real wages. Using Australian data, Tian and Shan (1999) also found that both GDP growth and immigration reinforce each other. Robertson (2002) examined the causality between these two series using Urzawa-Lucas approach in which unskilled and skilled labor perform distinct services. He found that an unanticipated increase in unskilled workers due to a population boom, or to an inflow of immigrants can result in a slowdown of human capital growth relative to the balanced path. Jones (1998) shows that rising population growth rate (including immigration) reduce transitional per capita economic growth. This however, may be due to the adverse effect of rising population on the capital labor ratio.

The modern debate echoes several issues raised earlier about the effects of population growth by economists such as Colin Clark and more recently by Julian Simon. Kremer's (1993) position is very interesting. He argues that more population adds to increased number of scientists, inventors and engineers who contribute to innovation and technological progress and thus to economic growth. Hunt *et al.* (2010) present facts on the role of immigrants in boosting technology in the US. The authors use the patents to measure innovation. The Economic Report of the President (2007, p. 199) reports that 40% of Ph.D. scientists working in the United States were born abroad — a testimony to the contribution made by immigrants to research and development and economic growth of the US. Galor (2004) noted that higher population may dilute resources per capita and lead to lower income per capita. He argues that the effect is neutralized by an acceleration of technological progress and capital accumulation. The positive forces allow income per capita to rise despite the offsetting effects of population growth. By taking three factors of production and using a constant elasticity of substitution (CES) production function, Chiswick (1982) suggested that immigration of either type of labor increases aggregate per capita income. Edward P. Lazear (2007) categorically reaffirms that immigrants not only help fuel the nation's economic growth, but also leave an overall positive effect on the income of native-born workers.

III. DATA AND METHODOLOGY

The data used in this paper are of annual frequency, from 1952 to 2000, transformed to natural logarithms. The real GDP data are from the Federal Reserve Bank, Saint Louis, and the immigration data are from the 2002 Yearbook of Immigration Statistics. As noted earlier, we also used Morley's (2006) annual data set for the US from 1930-2002. Morley (2006) used per capita real GDP from the Angus Madison's webpage: *http://www.ggdc.net/Maddison*. We restricted our data period until 2000 to insure that the tight immigration control following the events of 9/11 did not contaminate the series. In normal situation, we expect the growth in immigration and real GDP to determine each other by economic forces. However, after 9/11 immigration flows to the US might have been affected by non-economic forces due to the tight immigration policy. Thus the choice of our sample from 1952 to 2000 will help us better understand the relation between immigration and economic growth.

A bivariate cointegration methodology is used to investigate the hypothesized long-run equilibrium relationship between immigration and real GDP. As required for cointegration, we examine the order of integration (presence of unit root) in the time series by implementing the Augmented Dickey Fuller (ADF) (1981) and the Phillips-Perron (PP) (1988) procedures.

The study period covers almost 50 years during which both the economic policies and the macroeconomic and the political environment have changed substantially. Thus, all these changes likely have caused structural changes in the series. The conventional ADF and PP tests do not consider structural changes in the data, which might produce biased estimates of coefficients. For this reason, we use a framework which is appropriate to address this issue. Perron (1989) argues that conventional tests, in the presence of a break in the linear trend, produce a false conclusion in favor of a unit root. He suggests the inclusion of a dummy variable in the ADF tests to capture an exogenous point that corresponds to a predetermined structural break. This requires an a priori determination of the timing of the structural break. However, the Zivot-Andrews (ZA) (1992) test, an improvement over Perron's, can accommodate an endogenously determined structural break. In this paper, we implement the ZA test to check for a unit root in the series.

To predict the existence of a long-run equilibrium relationship between the two I(1) series, we estimate the cointegrating regression by applying the VAR approach provided by the Johansen (1988, 1991), and Johansen and Juselius (1990, 1992) procedure. The appropriate lag-length (p) is determined by the final prediction error (FPE) criterion (Akaike, 1969).

Because of the possibility of structural breaks, we also employ the Gregory-Hansen (GH) (1996) test to accommodate a single unknown structural break in the cointegration analysis. This residual based test for cointegration is capable of capturing structural breaks. As in the ZA test, the break point here is also empirically determined. In this sense, the GH (1996) test may be seen as the multivariate version of the univariate ZA test.

The next step involves testing for Granger causality between the variables. If the test establishes a cointegrating relationship, the relevant error-correction term (ECT), obtained from the cointegrating regression must be included in the standard causality test as another variable. This step is useful and helps avoid the potential problem of misspecification arising out of the omission of important constraints. Because of the advantage of combining the long-run relationship with the short-run dynamics of the model, it is desirable to use the Granger causality test within the Vector Error-Correction Model (VECM) environment. Further, the existence of cointegration implies that either unidirectional or bi-directional (or both) Granger causality must exist. The usual *t*-test is applied to the coefficient of the ECT, lagged by one period (ECT_{t-1}). A significant t-statistic indicates the existence of long-run relationships, and a significant F-statistic for the joint test suggests short-run causality. The error-correction models may take the following bivariate forms:

$$\Delta x_t = \beta_1 e_{t-1} + \sum_{i=1}^{k} \phi_i \Delta x_{t-i} + \sum_{j=1}^{k} \delta_j \Delta y_{t-j} + u_{1t} \tag{1}$$

$$\Delta y_t = \beta_2 u_{t-1} + \sum_{i=1}^{k} \pi_i \Delta x_{t-i} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + u_{2t} \tag{2}$$

We consider Equation 2 as the reverse specification of equation (1) to examine plausible bidirectional causality. The terms e_{t-1} and u_{t-1} are the error correction terms for the respective equations. The series x_t and y_t above are cointegrated when at least one of the coefficients β_1 or β_2 is not zero. If $\beta_1 \neq 0$ and $\beta_2 = 0$, then y_t will lead x_t in the long run (t-test). And if $\beta_2 \neq 0$ and $\beta_1 = 0$, then x_t will lead y_t in the long run (t-test). If δ_j's are not all zero, movements in y_t will lead those in x_t in the short run (F-test). If π_i's are not all zero, movements in x_t will lead movements in y_t in the short run (F-test). Table 7 provides the summary statistics of all the variables used in this study. Figure 1 plots the immigration and real GDP series, which shows a common positive trend between the two series.

III. RESULTS

We now report the results of unit root tests followed by testing for cointegration using both the Johansen and the Gregory Hansen procedures. The latter is useful when the series are break-stationary. The ADF and the PP unit root tests presented in Table 1 show that in the levels, both the series are non-stationary when considered with a trend. However, they are first differences stationary, i.e., I(1). The traditional ADF and PP tests are not the appropriate if the time series contains structural changes. So, we perform the ZA (1992) unit root test which considers endogenous structural breaks in the data. Table 2 reports the results of the the test. The results fail to reject the null hypothesis of unit root for all the series in levels at the 5% significance level.

The ZA test identified 1964 as break points for the real GDP and 1992 for the immigration series. The former break may have been caused by the changes in the economy due to the major escalation of the Vietnam War and the massive federal Medicare program about that time. For the immigration series, it is likely to have been caused by the amnesty (Immigration Reform and Control Act of 1986) which granted legal status to a large number of then illegal immigrants. Following the Immigration act 1986, the annual growth rate of immigration reached 34.27% in 1990 and started to decline thereafter (17.33% in 1991). However, the growth rate of immigration dropped drastically in 1992 (-62.93%) and remained negative until 1995. As can be seen from the figure in Appendix B, the breakpoint of the immigration series is clearly in 1992.

With two I(1) series, we now check for the possibility of a cointegrating relation between them by applying the Johansen procedure. Test results, presented in Table 3, affirm the existence of a cointegrating vector at the 5% level. Since the period of this study covers almost 5 decades during which both the economic policies and the macroeconomic environment have changed substantially, we need to control for the endogenous structural changes in the cointegrating relationship between the two series being studied. To do this we apply the Gregory-Hansen (1996) test which accommodates structural break in the data. The results are reported in Table 4. The results reject the null hypothesis of no cointegration. This confirms a long run relation between the series in the presence of structural break.

Having established a cointegrating relationship between immigration and real GDP, we now create the lagged error correction term E_{t-1}. An error-correction term between co-integrated variables shows the changes in the dependent variable as a function of the levels of dis-equilibrium in the co-integration relationship. The E_{t-1} term shows the short run divergence in the dependent variable from the long run equilibrium relationship; also called the Vector Error Correction

Figure 1: Immigration and Real GDP

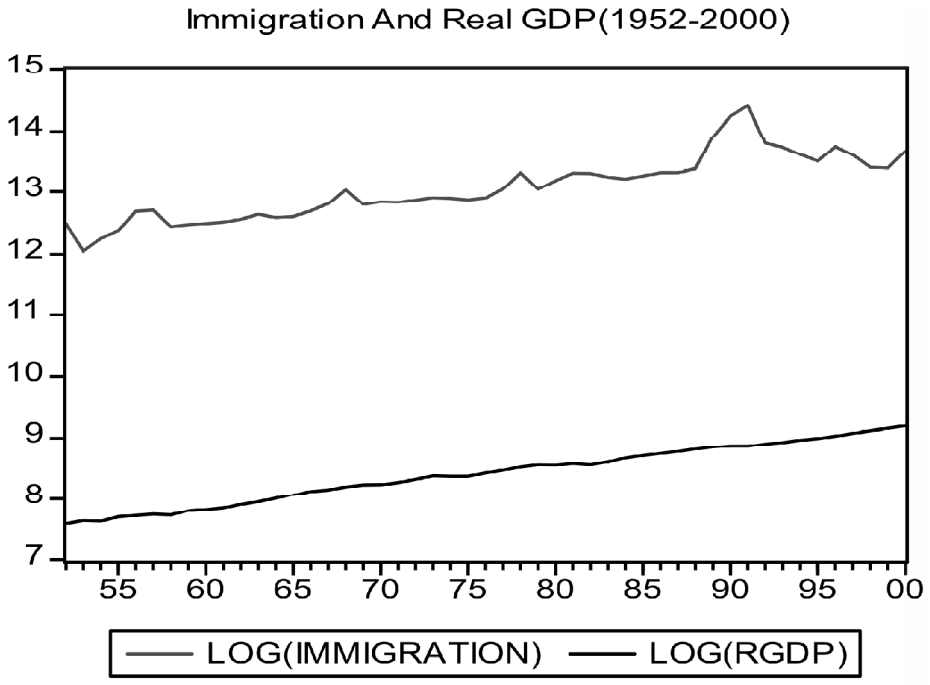

Figure 2: Immigration and Per Capita Real GDP (Morley's Sample)

Immigration and Per capita GDP (1930-2002)

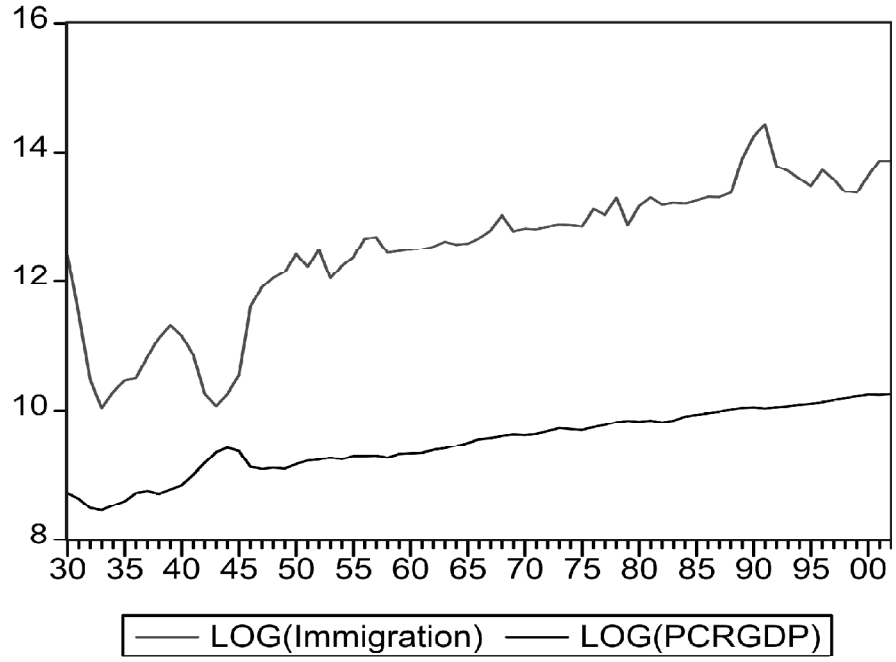

Table 1
ADF and PP Tests

	ADF-Test		*PP-Test*	
Variable	*Level*	*First-Difference*	*Level*	*First-Difference*
Immigration	-3.186	-6.663**	-2.201	-6.656**
RealGDP	-3.236	-6.755**	-2.220	-6.708**

The Phillips-Perron t-test is not sensitive to number of lags in the autocorrelation function. The reported test statistics are obtained by using 1 lags for both tests. (**) denotes the rejection of null hypothesis at the 1% level. ADF and PP test the null hypothesis of existence of unit root.

Table 2
Zivot-Andrews Unit-Root Test

	Immigration	*Real GDP*
T-statistics	-4.12	-4.27
Break-points	1992	1964

For Immigration, we assumed break in trend. The 5% critical value is -4.42. For RealGDP, we assumed break in intercept. The 5% critical value is -4.80. Test statistics are obtained by using 1-lag for both tests. Zivot-Andrews test the null hypothesis of unit-root.

Table 3
Johansen Cointegration Test

Null/Alternative Hypotheses	*Max-Eigen Statistic (λ_{max})*	*Trace (λ_{trace})*
H_0: r = 0 H_A: r ≤ 1	15.402*	15.631*
H_0: r ≤ 1 H_A: r = 2	0.000657	0.000657

The r indicates number of cointegrating vector and (*) indicates rejection of null hypothesis of no-cointegration at the 5% level.

Table 4
Gregory-Hansen Cointegration Test

Minimum T-statistics	-5.666**
BreakDate	1988

For Immigration, we assume break in trend. The 1% critical value is -5.47. Gregory-Hansen test reports the null hypothesis of no-cointegration. (**) indicates the rejection of the null hypothesis at the 1% level. The test assumes a full structural break. Reported statistics are obtained by using 1 lags.

Table 5
Granger Causality Test (VECM)

Dep.Variable	*Ind. Variable*	*F–Statistics*	*T-Stat:ECT_{t-1}*
Immigration	RealGDP	4.84**	-3.522**
RealGDP	Immigration	0.908	-1.649*

Optimal lag-length is 1, determined by FPE criterion. (**) indicates the significance at the 1% level while (*) indicates significance at the 10% level.

Model (VECM). Table 5 reports the Granger causality test results based on the VECM, with an optimum lag-structure of 1. The F-test statistics suggest a unidirectional short-run causality from real GDP to immigration, but not bi-directional feedback relationships between them. However, the results support long run bi-directional causality from immigration to real GDP. Both immigration and Real GDP cause each other in the long run. The error-correction terms (based on the results of the t-statistic) show that the burden of short-run endogenous adjustments toward long-run equilibrium, falls both on immigration and real GDP.

As noted earlier, we applied our methodology to the data of Morley to examine the time series properties of the series he used. For the US data, our tests confirmed that Morley's series indeed have structural break and is consistent with our results (1964 real GDP and 1993 for immigration series). The VECM results using Morley's dataset are reported in Table 6.

Table 6
Granger Causality Test (VECM): Morley Data

Dep.Variable	*Ind.Variable*	*F–Statistics*	*T-Stat:ECT$_{t-1}$*
Immigration	PerCapitaRealGDP	5.29**	-4.19**
Per CapitaRealGDP	Immigration	7.05**	-2.48**

Optimal lag-length is 1, determined by FPE criterion. (**) indicates the significance at the 1% level.

Table 7
Descriptive Statistics

Sample 1952-2002		
	Immigration	*Real GDP*
Mean	539889.1	4952.780
Median	454448.0	4540.900
Maximum	1827167.	9817.000
Minimum	170434.0	1988.300
Std. Dev.	325521.7	2239.577
Skewness	1.953602	0.467124
Kurtosis	7.601840	2.138030
Jarque-Bera	74.40481	3.298946
Probability	0.000000	0.192151
Observations	49	49
Morley's Sample 1930- 2002		
	Immigration	*Real GDP (per capita)*
Mean	417756.7	15009.76
Median	326867.0	14133.53
Maximum	1826595.	28534.69
Minimum	23068.00	4776.915
Std. Dev.	354737.4	6774.641
Skewness	1.500925	0.375853
Kurtosis	5.941436	2.068461
Jarque-Bera	53.72542	4.358186
Probability	0.000000	0.113144
Observations	73	73

IV. CONCLUSION

This paper applies cointegration methods which are capable of accommodating structural breaks in time series to examine the long and short term relation between immigration and economic growth. Our findings support long-run bidirectional causality between real GDP and immigration. A growing economy attracts immigrants. Over time, immigrants boost both demand and productivity in their new abode. Hunt *et al.* (2010) have demonstrated that immigrants promote innovation and thus technological progress. Both of these factors promote economic growth. However, new immigrants take time to overcome cultural attitudes and language barriers, as well as the specific training and skill to obtain a job in the host country. As a result the impact of immigrants on economic growth may not be perceptible in the short run and yet, as we have shown, be visible in the long run.

The challenges of the new century for the developed nations include a pro-growth immigration policy that can address the economics of shrinking populations. The standard neoclassical growth models assume that exogenous population growth determines labor supply. For the now developed nations, immigration can offer a viable solution to address labor market disequilibrium arising out of zero or declining population growth. An editorial in the Wall Street Journal wrote, "Immigrants bring vitality and skill to the US economy, whether in the tech centers of Silicon Valley or the farmlands of Midwest or Yuma Valley. We need more of both these days." [9/24/11, A 14]. Regulated immigration can help promote economic growth in the host nations, meet the labor market needs and still balance national security concerns. Suitable policies can help maximize the positive impact of immigration. An appropriate immigration policy must be based on emerging realities.

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