

## The relationship between unemployment and immigration with linear and nonlinear causality tests: Evidence from the United States

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### Abstract

This paper investigates the relationship between the immigrant population and the unemployment rate in the United States for the period 1980-2013. For this purpose, firstly, coefficients of long and short run relations are estimated by using Autoregressive Distributed Lag (ARDL) method and then, linear and nonlinear causality tests are applied. **Findings/Originality:** According to ARDL test results, there is a positive effect of immigration to the United States on the unemployment rate in the long run. In other words, while there is no statistically significant relationship between the two variables in the short run, an increase in the immigrant population increases the unemployment rate by 0.14 percent in the long run. The bootstrapped Toda-Yamamoto linear causality test results imply that there is no causal relationship between immigration and unemployment. Also, there is no nonlinear relationship between immigration population and unemployment rate in the United States.

## Introduction

The number of people moving away from the country regions they live in due to various reasons, especially political and economic instability, is increasing day by day. The primary reason is that war and political pressure push people to seek safer living conditions. Expectations about living conditions are usually related to income level, actual and expected unemployment rate and accommodation opportunities (Layard, Blanchard, & Krugman, 1992). Hence, the United States has been hosting a lot of immigrants for such reasons from past to present, and characterized as one of the main countries of immigrant destination since its foundation. Immigration, which is the reason for the existence of the United States, is the most continuous and common factor in the development of this country, and the history of immigrants and the history of the United States are inseparable. The United States has experienced four major immigration waves in the historical process. The first wave is the migration from northern Europe between the colonial period and the 1880. In the second wave Africans forcedly came in to the United States as slaves and at the end of which immigrations from China began to come. The third wave covered the period from 1880 to 1920 where immigrants came from primarily southern and eastern Europe and then Mexico and Japan. Long run policies were implemented to restrict the explosion of immigration, but the United States, from the middle of the 1970s, faced a new wave of immigration and migrants especially from Asia and Latin America, thereby changing the structure of societies (Jimenez, 2011). Apart from these great migration movements, the United States continues to welcome immigration

from different regions until today. In this context the immigrant population and their possible effects are crucial for the United States.

It is inevitable that immigrants have some benefits and costs to the United States, which has a large proportion of immigrant population. Migrants, which likely mean extra labor force, might play an important role in contributing to the productivity increase of the country. In fact, immigrants in the United States have been able to seize and benefit from the opportunities provided by this country, thereby contributing to tighter competitions in such areas as higher education and entrepreneurial activities. Undeniably, having a dense immigrant population also has some disadvantages, usually associated with illegal immigration and border security. Borjas (1994) tries to deal with the economic benefits of immigrants in a theoretical framework. Immigrants provide extra labor and contribute to the host country's economy through low wages and specialization in production. This will likely create a net increase in GDP, even if some of the income from the production goes to the immigrants as labor earnings. On the other hand, the emergence of long run economic growth is also related to the level of education of immigrants as a factor contributing to innovation (Hunt, 2011; Hunt & Gauthier-Loiselle, 2010). Also, immigration under the flexible wage regime causes different conclusion. The fact that migration tends to lead to an excess supply of labor in the host country likely produces a downward pressure on the labor price. This lower wage level in turn increases labor demand. A possible consequence is an increase in unemployment and job losses among native workers who have comparable skills and experiences with migrants, while those who have a complementary relationship with immigrant workers and employers might end up winning (Weyerbrock, 1995). The impact of immigrants on both the labor market and total output will indirectly affect the general level of prices. The starting point of this mechanism is that immigrants reveal a surplus of labor and cause a reduction in costs. Therefore, in order to examine the impact of immigrants on the host country, it is inevitable to first consider the effect of immigrants on the labor market.

The possible impact of the immigrant population on unemployment rate of host country depends primarily on whether the relationship between the domestic and migrant workers is of substitution or complementary. Secondly, the direction and degree of this impact relate to the degree of flexibility the labor market has (Esposito, Collignon, & Scicchitano, 2020). Accordingly, if both labor force groups are fully substitutes, the immigrant population is expected to have a negative impact on unemployment. In addition, inelastic labor markets are another reason for the negative impact. Another approach to this relationship corresponds to the traditional migration theories. According to this approach, when the immigrant workforce has the qualities to compete with full employment, it can be an opportunity for the host country in terms of productivity and economic growth. However, if the employment of the workforce is realized at insecure employment and low wage levels, migration may cause unemployment and lower wages in the labor market (Müller, 2003). Therefore, there are many theoretical approaches to explaining the impact of the immigrant population on the host country's unemployment rate indicator. However, beyond all these reasons, revealing the relationship in question using data covering a certain time period for any country or group of countries is critical for the policy making processes of the host countries such as the United States.

The aim of this paper is to investigate the relationship between the immigrants' population and the unemployment rate in the United States. Hence, this study contributes to the literature from different ways. First, there are few studies in the literature investigating the impact of immigrants on the American economy, considering that the United States is a country with a high immigration rate (Birgier, 2017; Kiguchi & Mountford, 2017; Rios-Avila & Canavire-Bacarreza, 2016). So, the study is a contribution to this deficiency. Secondly, unlike previous researches, this work explores this relationship for the first time using Autoregressive-Distributed Lag (ARDL) model and Toda-Yamamoto linear and nonlinear causality approaches. This represents the

methodological contribution of the study. The ARDL approach is useful because it provides both short run and long run dynamics in the coefficient estimation without data loss. Toda-Yamamoto causality test is important to be compatible with the ARDL method. In addition, the development of the nonlinear version of this test is important for the more reliable causal relationships between variables. Thirdly, the study reveals a different perspective of the interaction between immigration and unemployment for the United States. Addressing this relationship with new and up-to-date methods would be a good idea to unearth the benefits and costs of the immigration problem facing many countries today.

The paper is organized as follows. In the next section, both theoretical and empirical literature reviews are presented. While the subsequent section describes the dataset and methodology used in this study, the section that follows presents and discusses the findings. The final section offers a conclusion and some policy implications.

Studies investigating the relationship between migration and unemployment are mainly based on Todaro (1969) and Harris and Todaro (1970). Also, Wooton (1985) used a dynamic general equilibrium model. This paper showed that migration may produce benefit for both the host and area of origin. Another theoretical study is Brücker and Jahn (2011) that relies on a wage-setting framework where wages tend to decline with the unemployment rate, with the aim of testing the effects of immigration in Germany. They concluded that immigration had a moderate impact on the labor market. According to their findings, a one percent increase in the immigrant labor force increases the unemployment rate by less than 0.1 percent. Lozej (2018) illustrated that an emerging migration shock first increased unemployment, and then decreased it.

Although they deal with this relationship with a theoretical approach, over time, econometric studies have come to the fore to investigate this nexus. Empirical studies generally explain the relationship between the immigrant population and unemployment rate through wages, but there are also studies in the literature that directly deal with the immigration-unemployment nexus. In addition, the existing studies fall into two groups according to the method used, namely those that employ the time series framework and those that adopt panel data analysis. Admittedly, the results of all these studies differ depending on the method used, the country or country group addressed, and the period studied. Therefore, no consensus has not been reached on this issue.

Pischke and Velling (1997) aimed to investigate the effect of immigration on employment and unemployment rate in Germany for the period from 1985 to 1989. They used regional dataset for 328 regions, and concluded that there is no adverse effect of immigration on unemployment and employment rate. Winter-ebmer and Zweimüller (1999) investigated the impact of immigrants on youth native workers in Austria, and found that migration have a significant but trivial effect on native workers. Gross (2002) studied for France covering the period from the mid-1970s to the mid-1990s. Employing a system of equations for unemployment, labor force participation, the real wage and the immigration rate, the study found that there is negative relationship between immigration and labor market in the long run. Dustman, Fabbri, and Preston (2005) tackled the impact of immigration on the British labor market. Using the panel data analysis, the results suggested a slight positive relationship between employment and the immigrant-native population ratio. Islam (2007) examined the relationship between immigration and unemployment in Canada by using Johansen and Juselius cointegration and causality tests based on the vector error correction model. The cointegration test results imply that migration does not cause an increase in aggregate unemployment in the long run. Relying on provincial level panel data of Canada, Latif (2015) applied panel econometric methods that include FMOLS, DOLS and panel VECM approaches and found that permanent immigration has a positive impact on unemployment in the short run, but insignificant negative impact in the long run. Galloway and Jozefowicz (2008) tested the effects of immigrants on unemployment rate in the Netherlands by using regional dataset for the period from 1996 to 2003. They used OLS analysis approach, and found that a change in the immigrant

population in the labor force lead to an increase in unemployment rates. An analysis for Cyprus data from 1999 to 2005 by Christofidesa, Cleridesa, Hadjiyiannisa, Michaela, and Stephanidesb (2009) showed no effect of foreign workers on total unemployment. Similarly Troschchenkov (2011) investigated the same relationship for Denmark by using ordinary least square (OLS) for the period from 2007 to 2009 and concluded that immigrants do not lead to significant changes in the unemployment rate. Kwok (2011) studied on the relationship between immigration and unemployment of low-skilled working force in China covering the period from 1982 to 2009 by using Johansen test and OLS. The results suggested that immigration is related to low-skilled unemployment in Hong-Kong. Fromentin (2013) analyzed the relationship between immigration and unemployment in France and implied that there is no relationship between immigration and unemployment in the long run. Chletsos and Roupakias (2012) studied the relationship between migration, unemployment and growth for Greece data from 1980 to 2011, by using cointegration and Granger causality tests. The finding indicated that GDP growth and unemployment cause migration, but the opposite is not true. Frattini (2014) is one of the few studies investigating the impact of immigrants on the price level of the host countries. Using the United Kingdom data covering the period 1997-2012, the results suggested that the low-wage immigrant population has a reducing effect on the price levels. A study of macroeconomic impacts of external migration shocks using Norwegian 1990-2014 data by Furlanetto and Robstad (2016) revealed that migration shocks reduced unemployment and affected prices positively. Further, using the firm-level panel data for Portugal, Martins, Piracha, and Varejao (2018) found that immigrant labor force has a positive impact on natives in the same firm and occupation.

From panel country studies, Boubtane, Coulibaly, and Rault (2011) investigated the nexus of immigration, unemployment and economic growth for 22 OECD countries spanning from 1980 to 2005 and provided findings that unemployment negatively affects immigration in Portugal but immigration does not cause unemployment and growth in any country. Similarly, Ortega & Peri (2009) investigated the economic effects of immigration in 14 OECD countries over the period 1980-2005, with a finding that immigration increases employment and immigrants do not cause a decrease in capital intensity and factor productivity. Employing 24 OECD countries data covering the period 2004-2007, Heid and Larch (2011) adopted dynamic panel data estimators and revealed that immigration has a negative and statistically significant effect on unemployment. Also, Jean and Jimenez (2011) reinvestigated the nexus between unemployment and immigration in OECD countries for the 1984-2003 data period and found no significant effect of immigration on unemployment in the long run. Relying on a trivariate VECM model for OECD countries, Damette and Fromentin (2013) found positive effects of migrants on wages in host countries in the short run and no such effects in the long run. Grossman and Stadelmann (2013) used a gravity model to investigate the effect of international migration of high-skilled workers, with the results suggesting a significant positive impact of skilled labor force in developed economies. D'Amuri and Peri (2014) examined the nexus between immigration, jobs and employment protection in 15 Western European countries for the period from 1996 to 2010 and reached a conclusion that there is a complementarity relationship between native and immigrant workers. Likewise Esposito et al. (2020) used a Panel Error Correction Model to test the direction and persistence of the impact of immigration on domestic unemployment for 15 European Union countries, with the data covering the period 1997-2016. While the long run results for full sample suggested immigration inflows have a negative impact on unemployment, the effect is positive in the short run for the whole EU. According to the country-specific findings, short run impacts are larger in Scandinavian and Anglo-Saxon countries, but smaller in Italy, Greece and Portugal.

While there are numerous studies investigating the impact of immigrants on unemployment in the current literature, the number of studies for the United States is limited. Chiswick and Hurst (2000) analyzed the employment, unemployment and unemployment compensation benefits of

immigrants. The short and medium run results showed that the employment level of immigrants is lower than that of native workers, but the gap tended to shrink in the long run. Card (2005) attempted to address the two questions for the United States that include the effect of immigration on prices in the native labor market and the assimilation of immigrants. The result confirmed that immigrants have no impact on the wages of less-skilled native workers, despite the increase in the supply of the dropouts to labor market. Ottaviano and Peri (2008) estimated the impact of immigration on wages of native workforce in the United States covering the period from 1990 to 2006. The results suggested that immigrants have a small negative impact on native workers with no high school degree in the short run, but small positive impact in the long run. Peri and Sparber (2009) investigated the nexus between task specialization, immigration and wages, and demonstrated that immigrant workers tend to specialize in occupations requiring manual-physical labor skills, while most native workers pursue jobs associated with communication-language tasks. This implies modest wage consequences of immigration for less educated natives. Smith (2012) studied the relationship between non-qualified labor immigration and youth labor market for the United States and found that immigration reduces youth employment. The study of Birgier (2017) provided a conclusion that immigrants work mainly in low-wage jobs and do not reduce the wages of local people, based on the data for the period 1970-2010. Another study for the United States is Rios-Avila and Canavire-Bacarreza (2016) that investigated the effects of immigration on labor market outcomes of unemployed citizens in the United States. The results suggested that immigration has no effect on the availability of jobs for unemployed citizens and on the probability of attrition. Kiguchi and Mountford (2017) analyzed the effects of immigration shocks using a dynamic estimation model for the United States, suggesting that immigration shocks lead to a temporary rise in unemployment and a temporary fall in GDP per capita.

## Methods

This paper attempts to investigate the nexus between immigration and unemployment for the United States. The dataset of annual number of immigrants for the United States is available in the United Nations Population Division database for the period 1980 - 2013. The unemployment rate as independent variable is obtained from the World Bank database for the same period. This variable denotes the share of the labor force that is without work but available for and seeking employment.

The basic model expressing the relationship between the number of immigrants and the unemployment rate is of the following form:

$$\log \text{unemp}_t = \alpha + \beta_1 \log \text{img}_t + \mu_t \quad (1)$$

where  $\log \text{unemp}_t$  and  $\log \text{img}_t$  are the unemployment rate and total immigration population, respectively.  $\mu_t$  denotes error correction term, and  $\alpha$  implies constant term. Both variables are stated in logarithmic in the model.

The stability of the series is tested using the ADF (Augmented Dickey-Fuller) and PP (Phillips-Perron) tests before the model is estimated, because stability is important in giving more reliable and consistent results (Dickey & Fuller, 1979, 1981). After the unit root tests, the Autoregressive Distributed Lag (ARDL) bound testing approach developed by Pesaran and Shin (1997), Pesaran, Shin, and Smith (1996, 2001) is used since it provides consistent estimates of asymptotically normal long run coefficients regardless of whether the baseline estimators are of I(0) or I(1). The ARDL bound test equation is mainly formulated as follows (Pesaran & Shin, 1997):

$$\Delta \log \text{unemp}_t = \alpha + \sum_{i=1}^n \beta_{1i} \Delta(\log \text{unemp})_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta(\log \text{img})_{t-i} + \beta_3 (\log \text{unemp})_{t-1} + \beta_4 (\log \text{img})_{t-1} + \mu_t \quad (2)$$

$\Delta$  represents the change in dependent and independent variables and indicates short run dynamics. The error correction term is defined to obtain short-run dynamics as follows:

$$\Delta \log\_unemp_t = \alpha + \sum_{i=1}^n \beta_{1i} \Delta(\log\_unemp)_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta(\log\_img)_{t-i} + \beta_{3i} ECT_{t-1} + \mu_t \quad (3)$$

A negative and significant  $ECT_{t-1}$  coefficient means that the short-run imbalance between the dependent and explanatory variables will return to the long-run equilibrium relationship.

After the long and short run coefficients are made, the mutual causality of the variables is investigated. The linear causality relationship between unemployment and immigration is tested with the Toda and Yamamoto (1995) approach, which is often preferred in recent years. Toda-Yamamoto approach is a causality test that does not require prior knowledge of stationary and cointegration of relations between series. In this study, the critical values of Hacker and Hatemi-J (2008) and the modified Wald test (MWALD) proposed by Toda and Yamamoto (1995) are used. The VAR model used to test the direction of causality between immigration and unemployment rate is formulated as below:

$$\log\_unemp_t = \alpha_1 \sum_{i=1}^k \theta_{11i} \log\_unemp_{t-i} + \sum_{j=k+1}^p \theta_{12j} \log\_unemp_{t-j} + \sum_{i=1}^k \delta_{11i} \log\_img_{t-i} + \sum_{j=k+1}^p \delta_{12i} \log\_img_{t-i} + \varepsilon_{1t} \quad (4)$$

$$\log\_img_t = \alpha_2 + \sum_{i=1}^k \theta_{21i} \log\_img_{t-i} + \sum_{j=k+1}^p \theta_{22j} \log\_img_{t-j} + \sum_{i=1}^k \delta_{21i} \log\_unemp_{t-i} + \sum_{j=k+1}^p \delta_{22i} \log\_unemp_{t-i} + \varepsilon_{2t} \quad (5)$$

where  $k$  is the appropriate lag length of the estimated VAR model. The model suggests extra additional lags to the model ( $d_{max}$ ) in addition to  $k$  lags and  $p=k+d_{max}$ .

In addition to the linear causality test, the nonlinear causality test developed by Nishiyama, Hitomi, Kawasaki, and Jeong (2011) is also included in the analysis. The nonlinear causality test supposes that all variables in the study are stationary. The standard linear Granger causality test for  $A$  and  $B$  stationary series (from  $A$  to  $B$ ), is defined as:

$$E[B_t - P(B_t | B_{t-1}, \dots, B_t)]^2 > E[B_t - P(B_t | B_{t-1}, \dots, B_t, A_{t-1}, \dots, A_t)]^2 \quad (6)$$

where  $P$  is the optimum linear estimator in expression (7). Nishiyama et al. (2011) included an analysis of the conditional expectation rather than  $P$  estimator and defined model as follows:

$$E[B_t - E(B_t | B_{t-1}, \dots, B_t)]^2 > E[B_t - E(B_t | B_{t-1}, \dots, B_t, A_{t-1}, \dots, A_t)]^2 \quad (7)$$

where  $E$  is the conditional expectation.

## Results and Discussion

In this section, the results of unit root test, ARDL coefficient estimation, linear and nonlinear causality test are presented respectively. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used and the results are reported in Table 1.

**Table 1.** ADF and PP unit root test results

Series	ADF		PP	
	Level	First Difference	Level	First Difference
log_unemp	-3.179(0.030)**	-5.008(0.000)*	-1.824(0.362)	-2.820(0.066)*
log_img	-2.595(0.104)	-4.902(0.000)*	-2.073(0.256)	-7.630(0.000)***

\*\*\* and \* denote 1% and 10% significance level respectively.

Based on the ADF test  $\log\_unemp$  is stationary at level, while  $\log\_img$  is stationary at first difference. In contrast, PP test results showed that both variables are stationary at first difference. In this case, whenever the variables are of different degree of integration, the most appropriate model for testing long run relationship is the ARDL method. First, the most suitable ARDL model is determined according to Akaike Information Criteria, which suggests an ARDL (3, 0). The long and short run coefficient estimation results of the ARDL (3,0) model are given in Table 2 below.

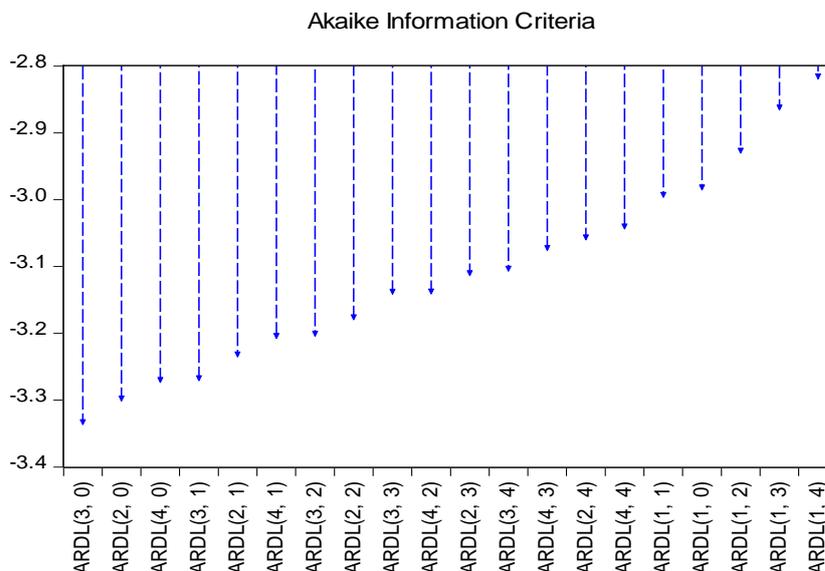


Figure 1. Model selection criteria

Table 2. ARDL cointegration, long and short run test results (dependent variable:  $\log\_unemp$ )

Co-Integration	F-statistic	$[I(0) - I(1)]$
ARDL(3,0)	4.026	3.02-3.51*
Long Run	Coefficient	T-statistic(Prob.)
$\log\_unemp(-1)$	-0.149	-1.643(0.112)
$\log\_img$	0.142	2.245(0.033)**
$D(\log\_unemp(-1))$	0.600	4.358(0.002)***
$D(\log\_unemp(-2))$	-0.281	-1.746(0.092)*
Error Correction Model		
ECM (-1)	-0.149	-6.205(0.001)***
Diagnostic Tests Results	F-statistic	Prob.
Breusch-Godfrey LM Test	0.000	0.980
Heteroskedasticity Test	0.377	0.822
Ramsey Reset Test	1.798	0.192

\*\*\*, \*\* and \* denote 1%, 5% and 10% significance level respectively.

F-statistic value is greater than critical value at 10% significance level suggesting that the null hypothesis (there is no co integration) is rejected. According to ARDL coefficient estimation results; there is a positive effect of immigration to the United States on the unemployment rate to in the long run. This result is consistent with Christofidesa et al. (2009), Kiguchi and Mountford (2017), and Latif (2018) but inconsistent with Esposito et al. (2020). From the theoretical point of view, it is valid that for the United States immigrants provide cheaper labor and lower costs for

enterprises than domestic labor. This result is not surprising for the United States, although raises concerns about the possible future costs associated with the notion that immigrants likely lead to excessive labor supply, resulting in an increase in unemployment, which in turn causes wages to drop. The estimated error correction model results suggest that the error correction coefficient [ECM(-1)] is negative and statistically significance. This indicates that the deviations from the long run equilibrium are being corrected rapidly.

In this study Breusch-Godfrey Serial Correlation LM test and Heteroskedasticity test are applied to diagnosing the model's specification. The results imply that the model is correctly specified. In addition, Ramsey Reset stability test results imply that the model has the desired econometric properties, namely the residues are not consecutively dependent, have normal distribution, and the model is in a correct functional form.

The bootstrapped Toda-Yamamoto linear causality test is applied and test results are presented in Table 3. It is found that there is no causal relationship between immigration population and unemployment rate in the United States.

**Table 3.** The bootstrapped Toda-Yamamoto causality test results

Null Hypothesis	MWALD Statistic	p-value	%1 bootstrapped critical value	%5 bootstrapped critical value	%10 bootstrapped critical value
$\log\_img \nrightarrow \log\_unemp$	2.133	0.344	11.878	7.118	5.284
$\log\_unemp \nrightarrow \log\_img$	2.109	0.348	11.781	7.178	5.225

The optimal number of lags was selected based on HJC criteria. “ $\nrightarrow$ ” stands for “does not Granger cause”

In addition, the nonlinear causality analysis introduced by Nishiyama et al. (2011) is also applied. The first differenced variables are taken for the causality test, with the result suggesting that the variables are integrated of degree one or I(1), and a short run causality can be implied. Table 4 reports that there is no nonlinear relationship between immigration population and unemployment rate.

**Table 4.** The bootstrapped Toda-Yamamoto Nonlinear causality test results

Null Hypothesis	Test Statistic
$\Delta \log\_img \nrightarrow \Delta \log\_unemp$	3.400
$\Delta \log\_unemp \nrightarrow \Delta \log\_img$	3.400

“ $\Delta$ ” stands for “first differencing”. “ $\nrightarrow$ ” stands for “does not Granger cause”

## Conclusion

The United States has been hosting arguably the largest number of international immigrants. Therefore, it is of critical importance to examine the possible effects of immigrant population on the economy, especially its effect on the labor market and unemployment rate. Although many factors might be responsible for unemployment in both developed and developing countries, immigrant population is suspected to be one of the most important determinants of unemployment especially in developed countries such as the United States.

This study examines the effect of immigrant population on the unemployment rate in the United States between 1980 and 2013. The findings of the ARDL analysis shows that the increase in the number of immigrants in the long run has a positive effect on the unemployment rate. This result supports the notion that immigrants are cheaper laborers that may cause unemployment among native laborers. This result also implies that immigrants tend to have detrimental effects on

the labor market in the United States. An appropriate policy proposal could be for the United States to ensure that immigrants receive adequate education and training so that they can contribute to more value added and jobs creation.

This study needs to be improved and extended in the future studies. A comparison between states may be a good idea in the future studies for the United States by employing time series data for each state or relying on panel data. It may also be important to include immigration factor in the growth and employment models in studies for countries or group of countries with large proportion of immigrant population.

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