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The Effects of Relative Wages and Border Enforcement on Illegal Immigration

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ABSTRACT. The flow of illegal immigrants into the United States cannot be accurately measured because any successful illegal immigrations will not be detected. This paper uses an apprehensions function developed by Hanson and Spilimbergo (1999) to estimate a lower bound for illegal immigration. An OLS regression model is employed to examine the effect of relative wages and border enforcement on the number of apprehensions at the U.S.-Mexico border from 1999-2017. These results are compared with findings from Hanson and Spilimbergo (1999) who studied apprehensions from 1976-1995.

I. Introduction

Since the creation of community there has been the concept of a border – a natural, physical, or social barrier that separates communities from one another. Some are considered necessary, others unnecessarily divisive. The southern border of the United States of America has been an issue for quite some time. In 2016, President Donald Trump campaigned heavily on the promise of a barrier on the border with Mexico to address the issue of illegal immigration. He and millions of his supporters saw this as one of the most important issues of the election because approximately 11 million Mexican immigrants were living illegally in the United States in 2015 (Krogstad, Passel, and Cohn 2017).

Two of the most popular forms of addressing illegal immigration are border enforcement and employer monitoring. While some forms of employer monitoring are currently in place, border enforcement is the main method of controlling the flow of immigrants across the U.S-Mexico border. The proper method of border enforcement is controversial. Empirical results will help to determine the marginal benefits of a particular method of enforcement. These findings could either reinforce current policies or draw them into question and demand a change in the procedure for border enforcement. Yet simply trying to regulate the flow

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of border crossings falls short of addressing any underlying issue.

What is it that leads millions of immigrants to leave everything behind and migrate? Numerous studies have pointed to the relative wage gap between a source country and a destination country as a driving factor behind these decisions (Butcher and Card 1991; Mishra 2007; Card 2009). But to what extent have relative wages and border enforcement affected the flow of illegal immigration from the United States to Mexico since 2000? Hanson and Spilimbergo (1999) performed an empirical analysis measuring illegal immigration via apprehensions from 1976-1995. My replication of this paper shows that the effect relative wages have on the decision to migrate has decreased since 2000 compared to the period from 1976-1995. Enforcement of the border, however, has had an increased effect on the number of apprehensions at the U.S-Mexico border.

II. Background Information

According to History.com, the modern U.S.-Mexico Border was established on December 30, 1853 under President Franklin Pierce. This settled the dispute over the location of the Mexican border west of El Paso, Texas and solidified the U.S. southern border.

The country of origin of immigrants flowing into the United States changed significantly following the *Immigration and Nationality Act of 1965.* The bill repealed the national-origins quotas used since the 1920s. Previously, the immigration system was designed to admit mostly immigrants from Western and Northern European countries. President Lyndon B. Johnson did not expect this bill to bring about significant change. The bill, however, did not have the predicted effect in the succeeding years. There was a large spike in the number of new lawful permanent residents. "The number of new lawful permanent residents (or green-card holders) rose from 297,000 in 1965 to an average of about 1 million each year since the mid-2000s" (Chishti, Hipsman, and Ball 2015). The increase in immigrant population exceeded the growth rate of the population of natives. This is seen in Figure 1 where the share of the immigrant population has risen from 4.7% in 1970 to 13.5% in 2016.

Not only did the overall number of immigrants rise, but their source also changed. Lawmakers believed that the new law would encourage European families to cross the pond and immigrate to the United States. History shows the opposite happened and European immigration as a

percentage of total immigration has plummeted from nearly 75% in 1960 to about 15% in 2013 (Chishti, Hipsman, and Ball. 2015). The global region that displayed the largest uptick in immigrant numbers was Latin America, specifically Mexico.

Figure 1. Immigrant Share of Total U.S. Population

Year	Size of Immigrant Population (Millions)	Immigrant Share of Total U.S. Population
1970	9.6	4.7%
1980	14.1	6.2%
1990	19.8	7.9%
2000	31.1	11.1%
2010	40.0	12.9%
2016	43.7	13.5%

Source: Migration Policy Institute (MPI) tabulation of data from the U.S. Census Bureau 2010 and 2016 American Community Surveys (ACS), and the 1970-2000 decennial Census data.

Another controversial immigration bill was the 1986 Immigration Reform and Control Act (IRCA). This legislation included the largest amnesty provision in U.S. history. This pardon for illegal entry into the United States applied to 2.7 million of the 3.2 million illegal immigrants living in the U.S. at the time (NumbersUSA.com). The bill itself had a three-legged approach including "tougher border enforcement, penalties for employers who hired unauthorized immigrants, and legalization for unauthorized immigrants who had been in the U.S. for five years or more" (Chishti, Meissner, and Bergeron 2011). Additionally, IRCA included an increase in border enforcement, creating a unique testing environment to measure the marginal product of border enforcement. All indications pointed to a future that entailed fewer illegal immigrant crossings under the new programs.

Espenshade (1990, 1995) finds that there was a decline in apprehensions at the U.S. border in the year after IRCA was implemented, but there was no lasting effect. Further, IRCA is believed to have had little or no effect on illegal immigration based upon survey data of

communities in Mexico (Cornelius 1989; Donato, Durand and Massey 1992). Regardless of the legislation's effect, IRCA is commonly viewed as an example of the benefits of the democratic process and how a functioning government ought to operate.

III. Literature Review

Most research pertaining to the effects of relative wages on immigration focus on the effect that the immigrants have on a host economy. However, these studies look at legal, rather than illegal, immigration. For both legal and illegal immigration, it is understood that wages are the driving force for a migration decision from Mexico to the United States (Butcher and Card 1991; Card 2009). The extent to which wages affect illegal immigration is the question at hand.

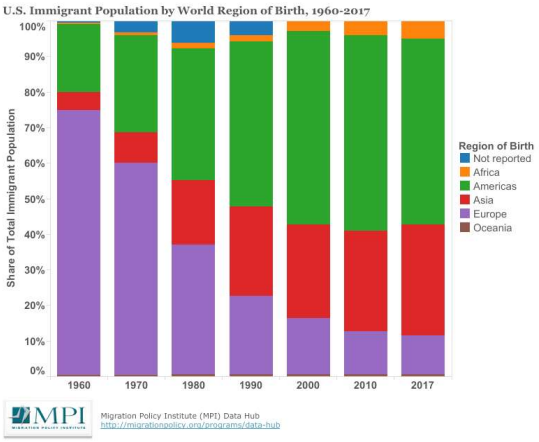
The first fence to jump pertains to the impossibility of accurately measuring illegal border crossings because the number of successful crossings is unknown. Consequently, an apprehensions function is used to estimate the number of illegal immigrations. Hanson and Spilimbergo (1999) developed a very useful apprehension function to estimate a lower bound for illegal immigration.

They expressed the number of apprehensions at the destination-country border as a function of the number of attempts to cross the border, the relative wage of the United States and Mexico, and the level of border enforcement. This model used monthly data on total apprehensions, the number of person hours policing the border, and data on current and expected U.S. and Mexican wages. Hanson and Spilimbergo found through an OLS regression that a 10% decrease in the Mexican real wage leads to a 7.5% to 8.8% increase in apprehensions at the border. A larger gap in wages between the United States and Mexico leads to increased immigration.

The 1999 Hanson and Spilimbergo study provided specific results and took a unique approach to the problem through developing its own apprehensions function. It provided evidence for the theory suggesting an increase in the destination country's wage relative to the source country's wage would lead to higher levels of illegal immigration. The model accounted for 93.7% of the variation in the data. This study included data collected from December 1976 through August 1995. Now the data is outdated and new technologies are applied to border enforcement that were previously unavailable.

Furthermore, the demographic composition of the United States as the destination country has changed. The number of immigrants in the United States born in Mexico has grown from 759,711 in 1970 to 11,796,926 in 2017 (Migration Policy Institute). The change in the composition of immigrants from mostly Europeans to mostly Latin Americans can be seen in Figure 2.

Figure 2



It is important to realize the unique nature of immigration from Mexico to the United States. Many countries see their emigrants going to a variety of countries. Mexico sees a uniquely high percentage of its emigrants going to the United States. This allows the model to isolate the analysis of relative wages to only the two countries of the United States and Mexico. Geography also plays an important factor in studying immigration between the United States and Mexico specifically. When it comes to the decision to migrate, distance matters (Clark, Hatton, and Williamson 2002). If the distance to migrate increases, then the associated costs will increase as well. With a large land border between the countries, it means that many immigrants crossing the U.S.-Mexico border will be from Mexico due to the costs associated with migration.

The typical immigrant has changed. Today, it is most likely that an immigrant coming to the U.S. is from Latin America. As previously mentioned, the best available measure of illegal immigration is the number of apprehensions. Inevitably, there will be some successful

illegal attempts to cross the border. This means that the number of apprehensions is an underestimate of total illegal immigration. When changes in apprehensions are observed, it is a mistake to automatically assume that the flow of illegal immigrants is changing in the same way. Apprehensions by the U.S. border patrol are positively correlated with U.S. expenditure on border enforcement and the current U.S. real wage (Borjas, Freeman, and Katz 1991). Where there are greater human, physical, and technological resources available to apprehend illegal immigrants crossing the border, the marginal product of these resources is positive.

Lessem (2017) studied the locations of illegal immigrant crossings. Prior to 1995, 63% of illegal immigrants at the southern border crossed at San Diego. Stronger border enforcement was implemented in 1995 and the percentage of crossings at the San Diego border location fell to 31%. The number of illegal immigrant crossings in other areas increased at the same time. This implies that enforcement may alter where the crossings occur but may not affect the overall number if areas of the border have varying levels of security.

Apprehensions as measured for this study only track the occurrences. They do not take into account the particular individual, or individuals, apprehended and how many times they have previously been apprehended. Espenshade (1995) finds that immigrants will continue trying to immigrate until they succeed. This is largely because the fixed costs of immigration are a sunk cost at this point. Often times the most expensive part of immigrating is getting to the border itself prior to attempting to cross. Once at the border, it is relatively inexpensive to cross the border with a very low cost to getting apprehended as current policy is simply to be sent back across the border into Mexico.

IV. Model

The model for this paper will follow the ordinary least squares (OLS) model used in the Hanson and Spilimbergo (1999) paper, but with some adjustments.

$$\ln APP_t = \beta_0 + \beta_1 lnH_t + \beta_2 lnH_{t-1} + \beta_3 lnW_t + \beta_4 lnW_{t-1} + \beta_5 Recession + \sum_{i=1}^{n} \beta_i lnAPP_{t-i} + \sum_{s=1}^{11} \phi_s d_s + \pi t + \mu_t$$

The current replication study uses a log-log model where APP is the number of apprehensions made by the U.S. Customs and Border Patrol (CBP) at the US-Mexico border. The U.S CBP refers to the U.S.-Mexico land border simply as the "Southwest Sector" since they patrol all border areas of the U.S. The apprehensions made at the U.S.-Mexico border is the measured response variable of the model.

Next the model includes both current enforcement hours (H) and lagged values of enforcement hours. These are the hours spent by employees of the U.S. Border Patrol enforcing the Southwest portion of the border. Looking specifically at this sector of the border ensures that the apprehensions value does not look at apprehensions made at other sector's border checkpoints or in the interior of the United States. The previously discussed migration displacement effect in (Lessem 2017) does not apply here. Both the additional enforcement hours and recorded apprehensions are for the entire U.S-Mexico land border. If migration were to be displaced it would be picked up in the U.S. CBP's statistics in another border sector. However, most illegal immigrants will be unlikely have the resources to attempt crossing at a different border sectors (i.e. Florida, Canada, or other coastal points) due to the large costs necessary for the attempts.

Lagged values of enforcement hours are included to examine whether the apprehensions made in the previous month have any effect on the number of apprehensions for the next month. If there is such an effect, it implies that the border enforcement is an effective deterrent to illegal immigration. While hours (H) and its lag are anticipated to be collinear, both are still included in the model since economic theory suggests they measure different effects. Economic significance along with statistical significance must be taken into account when selecting the model.

The model uses a relative wage variable (Wage), but the variable is comprised of two other measures. The first is the U.S. wage. The U.S. wage used by Hanson and Spilimbergo (1999) is what a prospective migrant who successfully crosses the U.S.-Mexico border would expect to make. The original model takes a weighted average of seven industries that a successful illegal immigrant is likely to enter. This includes construction, manufacturing, transportation, wholesale trade, retail trade, finance/insurance/real estate, and services. However, for simplicity, manufacturing wages are the only wages used in the replicating study. Second is the Mexican wage for prospective migrants. Hanson and Spilimbergo (1999) make the assumption that manufacturing wages are

the relevant local wage for those who will likely migrate across the border. The Mexican wage is only found in an indexed format with all wages relating to the 2015 wage, which is set as 100. Thus, it will appear that the Mexican wage exceeds the U.S. wage because U.S. wages are in dollars whereas the Mexican wages are an index number centered on 100. Further discussion of the interpretation of the U.S.-Mexico real relative wage relating to apprehensions will be found in the results section of the paper.

In order to compare the wages across time and countries, some adjustments to the wages need to be made. The U.S. wage and the Mexican wage both must be deflated by the U.S. Consumer Price Index (CPI) and the Mexican CPI, respectively. This places the wages in real terms. The real relative wage is then taken from dividing the real U.S. dollar wage by the real index of Mexican wages. The final transformation, to ensure homoscedasticity, is to take the natural log of the real relative wage. In the model, the current real relative wage (W) is included to see if the current month's wages influence the flow of migration. The previous month's real relative wage is also included to determine if the wages in the past influence the current migration decisions.

Hanson and Spilimbergo (1999) also consider the effects of economic volatility in their model. Through examining lagged periods of a peso devaluation, they were able to associate apprehensions with the presence of economic volatility. A positive link between economic volatility and migration is also established by Jerome (1926). The work of Hanson and Spilimbergo (1999) supports Jerome's work and they found that a 6.5% to 8.2% increase in border apprehensions is associated with a devaluation in the peso during the previous month. While their model looked at economic volatility in this way, the replication model used did not include the peso exchange rate being devalued as it is simply another measure of the economy already seen in examining the relative wages.

Lagged apprehensions are included to account for return migration. Since the large cost of migration is sunk and deportation policy is to drop apprehended immigrants off not far from the border, apprehended immigrants are likely to attempt to cross the border illegally again. There is growing theoretical, empirical, and anecdotal evidence suggesting that undocumented migrants who attempt to enter the United States across the U.S.-Mexico border will persevere in their efforts. No matter how many times they are apprehended by the U.S. Border Patrol, they will continue crossing the border until they eventually succeed (Calavita et. al, 1992).

For the same reason, the lagged value of apprehensions at the interior is included in the original model. Illegal immigrants deported from the interior are also likely to attempt to re-enter the United States relatively quickly. The recent interior apprehensions (apprehension of illegal immigrants made within the United States) are unavailable and thus the lagged interior apprehensions will not be included in the model.

One addition to the model is a dummy variable accounting for a United States economic recession. This is included to see if the downturn in the American economy has any statistically significant impact on the flow of migrants to the United States. Hanson and Spilimbergo (1999) did not include this variable. It is expected that the variable would decrease apprehensions as there will be a less promising economic outlook for the immigrants looking to migrate the United States. This would in theory lead to a lower level of apprehensions during a recession. Dummy variables for the month and a time trend are also included, along with a random error term.

Predictions regarding the signs of the coefficients are laid out below in Table A. It is believed that enforcement hours (H) will have a positive coefficient as numerous studies, including Hanson and Spilimbergo (1999), have found a positive marginal product of enforcement. Nothing has changed that would lead one to expect that additional enforcement would reduce the number of apprehensions. However, the lagged enforcement hours are expected to have a negative coefficient due to the presence of a deterrent effect. In addition, the current relative wage (W) and lagged relative wages also would be expected to have a positive coefficient, leading to increased apprehensions. The relative U.S.-Mexico wage could increase due to the U.S. wage increasing, the Mexican wage decreasing, or a combination of the two.

Immigrants who are previously apprehended and deported are very likely to repeat migrate. This would lead to predicting that lagged apprehensions would have a positive coefficient as there would be an increase in the supply of immigrants seeking to migrate. Hanson and Spilimbergo (1999) agree with all of these findings, but further analysis will need to be done to see if this holds true for the updated data, including years since 1999.

TABLE A

Variable	Description	Expected Sign
Apprehensions	SW U.S. Border Apprehensions by U.S. Customs and Border Patrol of individuals attempting to cross the U.S.-Mexico border illegally. (Dependent Variable)	N/A
Enforcement Hours	U.S. Customs and Border Patrol person hours spent enforcing the U.S.-Mexico border	+
Enforcement Hours Lag	U.S. Customs and Border Patrol person hours spent enforcing the U.S.-Mexico border during the previous period.	−
Real Relative Wage	[Real U.S. Dollar Wage in Manufacturing/U.S. CPI] [Real Indexed Mexican Wage in Manufacturing/Mexican CPI]	+
Real Relative Wage Lag	The Real Relative Wage as calculated above from the previous period.	+
Apprehensions Lag	Apprehensions made by U.S. Customs and Border Patrol during the previous month of individuals attempting to cross the U.S.-Mexico border illegally.	+
Recession	Dummy variable to indicate the presence of a recession in the United States economy during a particular month.	−
Trend	The apprehensions display a downward trend over the series, so including a term with a negative expected sign makes sense.	−
Month	Monthly dummy variables are included to account for the seasonal nature of apprehensions. Signs per month are difficult to predict, but in general apprehensions are expected to be higher in summer months when more seasonal jobs are available for immigrants.	Varying

V. Data

The data collected are from multiple sources but are from 1999 through 2017. All values are monthly. The dependent variable is the number of border apprehensions. This is the monthly value of all apprehensions occurring at the U.S.-Mexico border. The source of this data in the original Hanson and Spilimbergo (1999) paper was the Immigration and Naturalization Services; the agency shut down in 2003. The new agency taking many of the Immigration and Naturalization Services' responsibilities is the U.S. Customs and Border Patrol which falls under the Department of Homeland Security. The U.S. Customs and Border

Patrol stores publicly available statistics. The updated apprehension measures for the Southwest sector were found there. Interior apprehensions are also examined in the original study, but not in this replication due to the lack of availability of the interior apprehensions.

The enforcement hours of the agents enforcing the border were also previously gathered from the Immigrations and Naturalization Services, but with its closing, the statistics are no longer available. The U.S. Customs and Border Patrol does not have the monthly totals of enforcement hours at the U.S.-Mexico border. Dr. Gordon H. Hanson, who worked on the original paper, was able to provide updated values of enforcement hours through 2008. This is not as recent as desired, but under some manipulation and set assumptions, the measures can be extrapolated out to 2018. The number of staff members enforcing the border are available for each year. The model assumes that each staff member works the same number of hours and that the number of enforcement hours is non-seasonal; Hanson and Spilimbergo (1999) show that the enforcement hours are not a seasonal variable. Each month's number of enforcement hours is that year's number of border patrol employees multiplied by the standard number of hours for a typical U.S.-Mexico Border Patrol employee.

The relative wage between the United States and Mexico is a created variable. The United States wage in the original study was the weighted average of seven non-agricultural industries given by the *U.S. Bureau of Labor Statistics*. For the current replication study, only manufacturing wages are used for both the U.S. and Mexico. Construction wages were considered for the study, but data was not found in as clean of condition as the manufacturing wages were. Therefore, the best available wage measure was selected. The nominal U.S. manufacturing wages[1] and the nominal indexed Mexican manufacturing wages[2] are found in the Federal Reserve Economic Data (FRED) database. The U.S. CPI[3] and Mexico CPI[4] are used to put these terms into real measures and are also found from FRED.

As previously pointed out, the most glaring limitation to the data is the fact that actual illegal immigration is not measurable. The entire study can only provide a lower bound for illegal immigration. The apprehension function would only predict the total number of illegal immigrations accurately only if there were zero successful illegal immigrant crossings, which is an unreasonable assumption. The error term of how great the under approximation is also unknown due to the

nature of the response variable. Another limitation is the lack of availability of the all desired data. The model could lack some precision due to the simplifying assumptions made because of data limitations. These are necessary due to the unavailability of the data otherwise, and model accuracy should be considered accordingly.

VI. Results

The data from 1999-2017 were used to calculate the regression results for the equation described earlier. All values used in this model were in their log form. A collection of all regression results is included in the following Table B.

The adjusted r-squared correlation coefficient for the model shows that the model accounts for 93.25% of the variation in the data. The first coefficient is the enforcement hours (H). The log of the enforcement hours was found to be strongly significant predictor of the number of apprehensions. The corresponding p-value to the log of enforcement hours is less than 0.001 as seen in Table B. Since the values are in log forms, their interpretation is in percentage increases rather than unit levels. For a 10% increase in enforcement hours, apprehensions would be expected to rise by 33.53%. This is greater than the original study by Hanson and Spilimbergo (1999) which found a 10% increase in enforcement hours to increase apprehensions by 7.57%. Both studies show that increasing enforcement increases apprehensions. Therefore, a positive marginal product of enforcement exists. This is expected because as more resources are devoted to the border, a higher proportion of immigrants will be apprehended. This increase in the coefficient could mean that enforcement has become more efficient. This could be due to better personnel, training, equipment, etc. These findings offer support for current U.S CBP enforcement policies. This would mean more of a focus should be placed on building up the enforcement of the border rather than monitoring the employers where these illegal immigrants may look to find work.

In contrast to the positive marginal product of enforcement hours, the lagged enforcement hours are seen to have a negative effect, as expected. A 10% increase in lagged enforcement hours would lead to a 34.17% decrease in apprehensions. The lagged enforcement hours are very strongly statistically significant as seen in the p-value being less than 0.001. Again, this is of much greater magnitude than the original Hanson and Spilimbergo (1999) study which showed a 3.00% decrease in apprehensions.

TABLE B

Variable	Expected Sign	Actual Sign	Coefficient	Standard Deviation	P-Value	Statistical Significance
Intercept	+	+	1.705	1.149	0.139	
Enforcement Hours	+	+	3.353	0.578	$2.40e^{-8}$	***
Enforcement Hours Lag	–	–	-3.417	0.573	$1.06e^{-8}$	***
Real Relative Wage	+	+	0.217	0.963	0.821	
Real Relative Wage Lag	+	–	-0.310	0.980	0.752	
Apprehensions Lag	+	+	0.875	0.036	$2.0e^{-16}$	***
Recession	–	+	0.061	0.036	0.092	*
Trend	–	–	-.009	0.006	0.093	*
M2	N/A	–	-0.056	0.052	0.258	
M3	N/A	+	0.243	0.052	$5.23e^{-6}$	***
M4	N/A	+	0.217	0.052	$4.04e^{-5}$	***
M5	N/A	+	0.321	0.052	$3.33e^{-9}$	***
M6	N/A	+	0.181	0.053	0.0007	***
M7	N/A	+	0.105	0.053	0.051	*
M8	N/A	+	0.223	0.053	$4.51e^{-5}$	***
M9	N/A	+	0.118	0.054	0.028	*
M10	N/A	+	0.221	0.054	$5.83e^{-5}$	***
M11	N/A	+	0.234	0.056	$3.89e^{-5}$	***
M12	N/A	–	-0.179	0.057	0.002	**

*Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

This large increase provides evidence of a strong deterrent effect associated with enforcement. If there is a greater presence of enforcement at the border, more people may become unwilling to migrate due to the greater likelihood that they would be apprehended while crossing the border.

When describing the model, it was expected that the current and

lagged enforcement hours may be collinear. This thought was confirmed because both have a variance inflation factor (VIF) greater than 10. Any number above this threshold implies that the variable is collinear with another variable or variables. However, due to the differing theoretical measures that they provide, and the strong statistical significance, they are important variables to keep in the model.

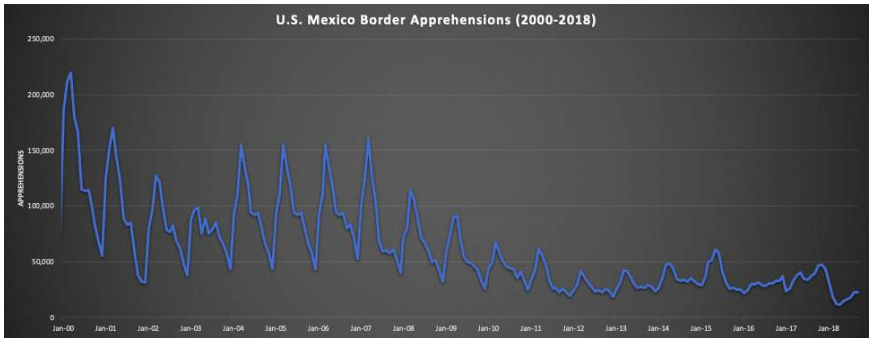
The next results with the model involve the relative wage between the United States and Mexico. The U.S.-Mexico relative wage calculated uses Mexican wages that are based on an index. If the actual Mexican wages were available a much more straightforward interpretation of the relative wage measure would exist. All analysis of the relative wages needs to be in regard to the change in the real U.S. dollar wage divided by the real index of Mexican wages. The real U.S. dollar wage divided by the real index of Mexican wages will be referred to as the "U.S.-Mexico Relative Wage" for the remainder of this paper.

The original Hanson and Spilimbergo (1999) paper has actual wages for the United States and Mexico, thus it makes comparing coefficients between the results for this paper and the original paper impossible. The original paper found that a 10% increase in their wage measure lead to a 5.28% increase in apprehensions. This empirical study showed that a 10% increase in the U.S-Mexico Relative Wage leads to a 2.17% increase in apprehensions. However, this is not a statistically significant coefficient as the p-value is 0.821. This means there is reasonable odds that this coefficient could be found by chance, and thus this variable does not add value to the model statistically speaking. The lag of the U.S.-Mexico Relative Wage is also included in the model to see if economic shocks have a delayed response in the number of apprehensions. This also was not statistically significant with a large p-value of 0.752. If the model were to be based purely on statistical means, the U.S.-Mexico Relative Wage and its lag would be removed from the model. However, due to the economic theory linking wages to migration (Butcher and Card 1991), I kept it in the model.

I also tested to see if the U.S.-Mexico Relative Wage and its lag were collinear, and the empirical results suggest that they are not collinear. They have VIFs that are less than the common threshold of 10. Economic changes can have their effect distributed over a period of time which is why inclusion of the lag could be helpful. Future models could consider including more lags to see if that would yield additional statistical significance.

The next variable in the model was looking at the lag of border apprehensions. The original Hanson and Spilimbergo (1999) study found that a 10% increase in lagged apprehension increases current apprehensions by 5.75%. This paper found that a 10% increase in lagged apprehension leads to an 8.75% increase in current apprehensions. This is a strongly statistically significant result with a p-value of significantly less than 0.001. This shows a potential flaw in the current deportation policy. With apprehended immigrants dropped off not far on the other side of the border, they are very likely to repeat migrate. As the replication study shows, immigrants are more likely to repeat migrate, and thus get apprehended again than they were during the original study. This is an area where changes in policy could really change the amounts of immigrants who repeatedly attempt to migrate with essentially no incentives against doing so.

Figure 3.



U.S. Border Patrol Monthly Apprehensions (FY 2018-2018). U.S. Customs and Border Protection. 2019. https://www.cbp.gov/sites/default/files/assets/documents/2019-Mar/bp-total-monthly-apps-sector-area-fy2018.pdf

In looking at Figure 3, it is clear that there has been a significant change in the overall level of apprehensions, and thus immigration since 1999. To account for the change, a trend term was included in the model and was found to be statistically significant at the 10 percent level. Since the level of apprehensions has decreased, it makes sense that apprehensions are decreasing by 0.009% with the trend.

Since there is this great downward trend in apprehensions (Figure 3), and the U.S.-Mexico Relative Wage measure are insignificant, a break in

the data could be useful in constructing better models. This was not done for this study but is an extension that could be helpful. As a suggestion, it may be helpful to examine the data separately before and after 2010 due to the higher levels and volatility of apprehensions displayed prior to this point.

To attempt to better explain the number of apprehensions of immigrants, an additional dummy was added to the model to indicate a recession. The results show that a recession actually causes apprehensions to increase at the U.S-Mexico border. This is a statistically significant variable with a p-value of 0.092. The positive sign of the coefficient is opposite of what was predicted prior to running this model. However, the positive coefficient could be explained because a recession in the United States could have an even stronger economic impact on adjacent countries such as Mexico. This gives greater incentive to migrate as the economic prospects are potentially more promising in the United States. The statistical significance of recessions also gives support for adding a break in the data as there has not been a recession in the United States since 2009. This is an example of a significant dummy variable, and there are many other dummy variables that could add value to the model that could be added as an extension to the model in another trial. Table B also shows the results for the included trend and monthly dummy variables.

Overall, it is difficult to measure the impact of wages on apprehensions since they are not statistically significant. However, from the given coefficients, it shows that the effect of relative wages on apprehensions are less than they were during the original study. Hanson and Spilimbergo (1999) found that a 10% increase in their real wage led to a 7.5% to 8.8% increase in apprehensions. This paper shows that a 10% increase in the U.S. Mexico Relative Wage leads to approximately a 2.17% increase in apprehensions, so the results show that the effect of wages has decreased since 2000 compared to results presented over the years 1976-1995. The enforcement hours of the U.S.-Mexico border now have a much greater marginal product of enforcement. At the same time, this has also raised the deterrent effect as seen through apprehensions decreasing significantly with the lag of enforcement hours. However, there could be other contributing factors to declining immigration other than the deterrent effect that are not explained by the model. The replication model has a respectable adjusted r-squared of 0.9325, but there are certainly areas to improve the model that could be carried on in

extensions.

VII. Conclusion

Results found in an empirical study published over 20 years ago ought to be reexamined, as this paper does. For the sake of policy decisions, labor markets, and enforcement procedures, it is necessary to know the extent to which relative wages and border enforcement affect the flow of illegal immigration from Mexico to the United States. Over the last 20 years, evidence suggests that the effect of relative wages on illegal immigration has decreased. However, the evidence also points to a greater marginal product of enforcement.

These results can help to predict the flow of illegal immigrants and can be used to determine the marginal product of border enforcement as a policy to control the border. Knowing what aspects of the immigration discussion have statistical significance are important for making decisions that affect the lives of real people. This study demonstrates the value of replicating studies over different periods of time in order to help focus discussions on certain areas with an empirical framework. Empirical analysis such as the Hanson and Spilimbergo (1999) study alongside of this replication study seek to provide means to better understand immigrant flows.

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