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Examining the Labor Market Consequences of Endogenous Low-skill Migration with a
Market-based Immigration Policy

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Abstract

The undocumented migration of Mexican nationals to the U.S. is largely influenced by the availability of labor demand in unskilled sectors in the U.S., making it more efficient than the legal channels of migration available to unskilled Mexican nationals. Labor demand in unskilled industries is larger than the available unskilled labor in the U.S., but Mexican migrants, who constitute the majority share of foreign-born individuals in the U.S., are immigrating at the lowest rates in modern times, with net Mexican migration at approximately zero. This paper simulates a market-based immigration system for Mexican nationals, with a focus on the partial equilibrium effects in long run supply and demand for undocumented Mexican migrant labor in the U.S. agriculture sector. Reducing the additive tax on Mexican wages in the model effectively simulates an immigration policy shift. I estimate the net-of-tax long run labor supply and demand curves for U.S. agriculture, simulating an open-border policy with Mexico. Eliminating the additive tax on Mexican wages (which represents immigration policy reform) increases the quantity of labor used in U.S. agriculture, decreases U.S. agriculture wages for Mexican migrants, and raises Mexican agriculture wages. Since the labor supply curve for Mexican nationals is extremely elastic, the largest benefits of an immigration policy shift go to the U.S. producers, who can use higher labor inputs in production to lower the price of production. The results of the experiments are very similar, even with large differences in the visa pricing scheme chosen; this represents an exciting finding: the demand for access to the U.S. unskilled labor market for Mexican nationals is inelastic, which explains the fact that migrant smuggler costs have increased from approximately \$50 in 1990 to upwards of \$5,000 in the mid-2010s.

Keywords: Immigration, Migrant Labor, Agricultural Migrant Labor, Mexican Immigration, Undocumented Immigration, Immigration Reform, Low Skill Labor.

1. Introduction

The face of unskilled labor in the United States is changing dramatically as the rate of immigration rises steadily over time. In the United States, a majority of the total domestic working population—approximately 66 percent—is educated beyond high school and works in mid- to high-skill industries (BLS, 2015). Many low-skill-intensive sectors, especially the most labor-intensive sectors in agricultural production, are affected by labor shortages. Working conditions are often too physically challenging, and compensation is insufficient to appeal to native workers, whose wage elasticity of labor supply is often too inelastic to employ at competitive prices in unskilled industries (Taylor, 2010). Increasingly, unskilled immigrant populations have become vital for low-skill sectors and all sectors dependent on the productivity of low-skilled sectors (Guan et al., 2015).

A majority of the total foreign-born unskilled population is of Mexican origin (Passel and Cohn, 2015a). According to the National Agricultural Worker Survey, in U.S. agriculture, an estimated 68 percent of the total labor force is Mexican-born (Taylor et al., 2012). Historically, unskilled Mexican migrants have consisted primarily of young, unmarried men seeking temporary employment in agriculture. However, more women and families are migrating to the U.S. seeking permanent residence in urban settings and employment in unskilled sectors outside of agriculture (Hanson, 2006).

Net Mexican migration rates were substantially positive after the implementation of the Immigration Act of 1990, largely due to an influx of illegal immigrants. However, the most recent estimates indicate that net Mexican migration is approximately zero, and has been shrinking since the beginning of the 2010-2020 decade (Gonzalez-Barrera, 2015). Legal unskilled labor migration from Mexico is largely constricted by an inefficient quota-based

immigration policy, leaving undocumented immigration as the only migration channel for most unskilled Mexican nationals. As a result, undocumented Mexican immigration is extremely responsive to the labor market in the U.S. Widespread unemployment in non-agriculture, low-skill industries following the 2008 financial crisis led to a precipitous decline in the rate of Mexico-U.S. migration: from 25 migrants per thousand in 2005 to seven per thousand in 2012 (Villarreal, 2014).

Even among the remaining undocumented immigrants, it is estimated that only five percent seek employment in the U.S. agriculture sector (Passel and Cohn, 2015a). The slowing of unskilled Mexican migration to the U.S., in conjunction with unskilled migrants' employment preferences shifting away from U.S. agriculture, implies that immigration reform may be necessary to satisfy the unskilled labor demand in the United States. This paper models and analyzes the U.S. agriculture labor market impacts of establishing a market-based immigration policy for Mexican nationals.

Understanding the impacts of immigration policy reform requires an examination of undocumented Mexican immigrants. Due to the complicated nature of crossing the highly-monitored U.S.-Mexico border, most illegal immigration occurs with the help of guides, known as "coyotes," "polleros," or "pateros," who smuggle migrants across the border. The migrant-smuggling industry is expensive and highly responsive to increases in the intensity of border enforcement (Roberts et al. 2010). As border security increases, so does the financial cost of illegal migration; demand for smuggling services is relatively inelastic, however, so most Mexican citizens are willing to pay large amounts for border-crossing guides rather than forego the relatively large benefits of living and working in the United States. Since Mexican migrants are already paying a steep fee for an unregulated, dangerous, and illegal service, it is likely they

would be willing to pay even more for a legal, secure manner to access the U.S. unskilled labor market. This is the foundational rationale for creating a price-based immigration system.

This project consists of an analysis of the U.S. labor market response to endogenous unskilled labor movement from Mexico to the U.S. caused by replacing the current quota-based immigration system with a price-based system for Mexican nationals. I use a simple partial equilibrium model, drawing on prior work by Baldos and Hertel (2012) to analyze the US agriculture labor market impacts of implementing such a policy. I focus specifically on undocumented Mexican nationals living in the United States. I introduce an endogenous migration decision and account for the migrant smuggling industry along the U.S.-Mexico border. Migration patterns from Mexico to the U.S. are endogenously determined by the model in response to changes in labor demand; in this context, we can explore the implications of switching to a market-based immigration system.

The price to enter the United States under this new system is determined by an approximation of the willingness to pay of low-skilled Mexican nationals to migrate legally. Thus, this final price incorporates the direct and indirect costs of migrating illegally. The direct costs include smugglers' fees, the opportunity cost of missed employment in Mexico, and a cost of living adjustment. The indirect costs include the opportunity cost of unused land in Mexico, the disutility of being far from home and family, the inherent risks involved in migrating illegally, and the disutility of living and working as an undocumented immigrant in the U.S.

This project will be of interest to researchers in the fields of immigration economics, labor economics, international development economics, and public policy analysis. Although far from politically-feasible in the near term, this analysis will provide a useful platform from which to address many issues missing from the literature on illegal immigration. This project attempts to

understand the economic consequences of implementing a price-based immigration system for Mexican nationals.

2. Background

The modern era of immigration policy in the United States began with the Immigration Act of 1990, under which visa quotas were allocated to all countries based on the total volume of historical immigration to the U.S. This piece of legislation created the system of family-based visa petitions, where visa applications are ranked by the family proximity of the U.S. citizen or legal permanent resident sponsoring the application, with the highest application rank given to spouses and children, and the lowest application rank given to married, adult siblings. This system is still in use today. Although many Mexican nationals qualify for an application, the United States Citizenship and Immigration Services only authorizes the distribution of 340,200 family-petition-based visas per year; Mexico receives only a fraction of this global quota (USCIS, 2016). Mexico's demand for U.S. visas largely outnumbers the quota allocation, which is evident in the Visa Bulletin, which states that in June, 2016, most applications currently being approved were filed by Mexican nationals in the mid-1990s, compared to the global average of mid-to-late-2000s (USCIS, 2016). With such inefficiency in the legal migration system for Mexican nationals, undocumented immigration rates increased dramatically into the 1990s and beyond.

In response to this quick expansion of undocumented Mexican immigration into the U.S., beginning in 1993, the U.S. Border Patrol more than doubled the size of the total number of border enforcement officials by the year 2000, reaching 9,212 agents by that year (Cornelius, 2001). Border enforcement became increasingly militarized, with the implementation of stadium-style lighting, infrared night scopes, motion sensors buried underground with cameras

that automatically follow any recorded movement, and IDENT, a database system for tracking apprehended individuals through photographs and fingerprint records. In addition 10-foot, reinforced steel fences were added to the border along the high-traffic areas (on a total of 76 miles of the border by the year 2001). Border patrol officials were also stationed in more concentrated patterns along high-traffic corridors (mainly around San Diego, Calexico, El Paso, and the southern Texas-Mexico border) to deter illegal immigration in those areas. This border protection plan was implemented in various phases, beginning in the high-intensity locations.

Operation “Hold-the-Line” began on a 20-mile stretch of the U.S.-Mexico Border near El Paso, Texas in September 1993. Operation “Gatekeeper” began along a 14-mile stretch of the border surrounding the San Diego, California area in October 1994. It was employed in three phases, the last of which extended the protected area to Yuma, Arizona. Operation “Safeguard” began in 1994 with the intention of protecting the Arizona border, but was not substantially funded until 1999. As a consequence, most illegal migration was redistributed to the unguarded portions of Arizona. Operation “Rio Grande” began in 1997 along the south Rio Grande Valley in Texas (Cornelius, 2001).

While these border fortification strategies increased the total number of apprehensions in high-traffic corridors, immigrants adjusted to the more difficult conditions by using less-monitored locations and hiring professional smugglers to guide them across the border. In fact, migration scholars claim that approximately 70-80 percent of illegal migrants that attempt crossing are successful, even after the post-1993 border enforcement hike (Cornelius, 2001).

As a response to intensified militarization of the U.S.-Mexico border, fewer migrants came to the U.S. for temporary employment in agriculture (Hanson, 2006). Those Mexican males who did immigrate illegally to work in agriculture began paying higher prices for smugglers, which

have a “strong negative effect on the probability of returning to one’s home country”, according to multivariate analysis by Cornelius (2001). Consequently, more families began crossing illegally into the U.S. to reunite, which fueled a restructuring of the Mexican immigrant smuggling industry (Izcara Palacios, 2012; Lopez Castro, 1998; Gathmann, 2008; Dolfin and Genicot, 2010; Roberts et al., 2010; Hanson and Spilimbergo, 1999). Namely, there is an apparent division of the migrant smuggling sector into two market structures: small-scale, part-time smugglers that mainly transport migrants looking for agricultural employment in the U.S. and operate under perfect competition (hereby referred to as perfectly-competitive smugglers), and large-scale, full-time smugglers that mainly transport migrants looking for non-agricultural employment in the U.S. and operate under a type of monopolistically competitive market structure (hereby referred to as monopolistically-competitive smugglers). In these enterprises, smugglers invest heavily in building their network and contacts and then recoup their costs via a sizable markup over the marginal cost of smuggling any individual migrant across the border (Roberts et al., 2010; Izcara Palacios, 2012).

The increased difficulty in illegal immigration has increased the dependence of illegal migrants on the smuggling industry. Consequently, smuggling prices have skyrocketed--from approximately \$50 in the early 1990s to estimates of \$1,000-5,000 today for guidance across the Rio Grande, depending on the smuggler. Large-scale, monopolistically-competitive smugglers with better reputation are more expensive (Izcara Palacios, 2012).

3. The Model

3.1 Model Assumptions

In this model, we make the following assumptions:

1. Mexican nationals make rational consumer decisions about immigrating illegally into the United States: if the economic benefit of crossing the border illegally to work in an unskilled industry exceeds the direct and indirect costs of doing so, then they will migrate.
2. The benefits (or perceived benefits) of living in the U.S. are many, but for the sake of simplicity, we will assume that the only benefit in the short run is purely economic, i.e., the potential wage increase associated with migration to the U.S.
3. The direct costs are defined as the price paid to smugglers for transport into the U.S., the opportunity cost of lost wages in Mexico, and the cost of living adjustment for living in a relatively more expensive country.
4. The indirect costs are defined as the disutility of crossing the border illegally (which includes the physical risk of dying, being injured, or kidnapped for ransom along the trek and the financial risk of being apprehended by immigration authorities after paying a steep smuggler fee), living away from home, and living as an undocumented immigrant in the U.S.
5. Although Mexican nationals have varying degrees of educational attainment and English language proficiency, we assume that all undocumented Mexican immigrants have a substantially lower degree of educational attainment than their U.S.-born counterparts, and will face a discount on potential U.S. wages as a result. We reflect this discount by using the 25th percentile of wages in U.S. industries as the potential U.S. wage for undocumented Mexican immigrants.

6. Immigrants who are agricultural workers in Mexico will find agricultural labor in the U.S., and workers from all other industries in Mexico will find labor in the service, construction, and manufacturing sectors in the U.S., which employ 33, 15, and 14 percent of all unauthorized immigrants, respectively (Taylor et al., 2012; Passel and Cohn, 2015a).
7. All undocumented immigrants from Mexico use smugglers for guidance across the border. While it is possible that some are better-acquainted with the border terrain and can make the trek without a smuggler, this is less feasible for average Mexican citizens as border security becomes tighter.
8. Undocumented immigrants looking for work in the agriculture sector will use the small-scale, perfectly competitive smugglers, whereas those looking for non-agricultural work will use the large-scale, monopolistically competitive smugglers.
9. All migrants in this model are adults that migrate without their families.
10. The consumption bundle for Mexican immigrants living in the U.S. is equal to the consumption bundle for Mexican nationals, minus expenditures for education, entertainment, and personal use, which are spent on remittances. In other words, undocumented Mexican migrants will not experience “lifestyle inflation” as they move to the United States
11. The data from the Mexican Ethnosurvey of Family, Migration, and Labor, administered by the Mexican Migration Project can be interpreted as being representative of both the migrant population and the Mexican population, according to Ryo (2013) and Massey and Capoferro (2004).

3.2 Data

3.2.1 Wages

U.S. wages come from the Bureau of Labor Statistics Occupational Employment Statistics dataset. I used the Agriculture, Forestry, Fishing and Hunting sector (NAICS sector code 11) to account for the potential U.S. wages faced by undocumented Mexican migrants in agricultural employment, and the average of the Construction, Manufacturing, Accommodation and Food Services, and Other Services sectors (NAICS sector codes 23, 31-33, 72, and 81, respectively) to account for the potential U.S. wages faced by undocumented Mexican migrants in non-agricultural employment. Undocumented immigrants often receive lower wages than their native counterparts as a consequence of legal status, lack of English language abilities, and lower education attainment (Passel and Cohn, 2015a). In order to account for this characteristic of the U.S. labor market faced by undocumented Mexican immigrants, I use the 25th percentile of U.S. wages for my analysis. The 25th percentile of average U.S. agricultural annual income in 2013 is USD \$18,230, and the average of the 25th percentile of average construction, manufacturing, accommodation services, food services, and other services annual incomes in 2013 is USD \$23,803.

Mexican wages come from the Secretaría del Trabajo y Previsión Social. I use the average wage from the agriculture sector to determine the annual income opportunity cost for Mexican nationals considering entering the U.S. agriculture labor market as undocumented immigrants. The average 2013 agricultural wage in Mexico is approximately MXN \$48,736, or USD \$3,820. I use the weighted average of all other sectors' average wages to determine the annual income opportunity cost for Mexican nationals considering entering the U.S. construction, manufacturing, accommodation services, and food services labor markets as

undocumented immigrants. The average 2013 non-agricultural wage in Mexico is approximately MXN \$84,292, or USD \$6,607.

3.2.2 Smuggler Prices

In order to estimate the range of smuggler prices faced by Mexican nationals who attempt to enter the United States illegally, I use data from the Mexican Ethnosurvey of Family, Migration, and Labor from the Mexican Migration Project (MMP). MMP is a project established and overseen by Princeton University and Universidad de Guadalajara; it is the largest, most comprehensive dataset on Mexican migrants and their communities in Mexico and the U.S. As part of the survey, migrants self-identify as documented or undocumented immigrants. Of the 3592 self-reported undocumented migrations observed from 1990 to 2008, there were 2964 immigrants, or 82.5 percent, who used a smuggler to cross the border.¹ Of these, 2190 (or 73 percent of all immigrants using smugglers) reported the cost for the guide service.²

Before the major border militarization strategies began, i.e. between 1990 and 1992, 72.8 percent of all undocumented immigrants in the MMP survey used a smuggler. During the initial phases of Operations “Hold-the-Line”, “Gatekeeper”, “Safeguard”, and “Rio Grande” along the U.S.-Mexico border, i.e. between 1993 and 2000, 84.1 percent of undocumented immigrants used a smuggler. In the post-9/11 era, i.e. between 2001 and 2008, 91.4 percent of undocumented Mexican immigrants reported using a smuggler. Table 1 includes the descriptive statistics from the MMP data on undocumented Mexican immigrants, including a year-by-year

¹ In addition, 459 (or 12.8 percent) reported not using a smuggler, and 169 (or 4.7 percent) did not know or did not report if they used a smuggler.

² Of the 3592 migrants that self-reported as undocumented between 1990 and 2008, 774 reported use of a smuggler but did not know the price paid. This may be an effect of the relatively common practice of network-financed smuggling among those Mexican immigrants with large family or community networks currently in the United States.

breakdown of the smuggler usage rates and average smuggler prices faced. It is clear that smuggler demand is influenced by U.S. border enforcement intensity.

Although there is no differentiation between smuggler types (i.e. between perfectly-competitive and monopolistically-competitive smugglers) in the existing MMP migrant survey, I calculate the approximate division based on the self-reported prices from the survey. First, we make the assumption that the perfectly-competitive smugglers do not change their cost structure between 1990 and 2008. This is mainly due to their operational strategy: guide a handful of young, able-bodied men through border terrain with the lowest concentration of border security, such as mountainous or desert-ridden routes through the Arizona/New Mexico region. I assume that they do not experience fixed costs, and their product and target market has remained the same since 1990. Their customers pay lower amounts of money, but have to walk for much longer distances, so a substantial price increase cannot be justified. If faced with a significant fee increase, these perfectly-competitive smugglers would lose customers to the monopolistically-competitive smugglers whose services offer a shorter walk with high-skill guidance. In contrast, monopolistically-competitive smugglers have dramatically changed their structure to account for the increased difficulty in crossing the border since 1993.

Because of these characteristics, and the fact that the price data from the MMP survey has large variation, I calculate a price ceiling for the perfectly-competitive smugglers and assume that any prices above this threshold are prices paid for high-skill services from monopolistically-competitive smugglers. This price ceiling is calculated as the arithmetic mean plus one standard deviation of the smuggler price data from 1990. The real mean price from 1990 is \$826, and the standard deviation of the 1990 data is 633, so the real price threshold for 1990 is \$1,459. Due to the assumption that the perfectly-competitive smuggler cost structure remains unchanged

between 1990 and 2008, any real smuggler price above \$1,459 is assumed to represent payment to a monopolistically-competitive smuggler. Table 1 lists the average prices below (for perfectly competitive smugglers) and above (for monopolistically-competitive smugglers) this threshold for years 1990-2008. It also lists the market share owned by the monopolistically-competitive smuggling sector, which represents the majority of smuggler service purchases beginning in 1998.

Table 1. Smuggler use and cost among self-reported undocumented Mexican immigrants, 1990-2008. Source: Mexican Ethnosurvey of Family, Migration, and Labor, Mexican Migration Project, author's calculations.

Year	Self-reported undocumented crossings			Average self-reported smuggler prices, inflation-adjusted (2011) USD			
	Total crossings	Percent using smuggler	Percent of smuggler users reporting price	All smugglers	Perfectly competitive	Monop. competitive	Monop. competitive market share (percent)
1990	398	72.1	74.9	826	632	2,071	13.5
1991	287	73.5	73.5	879	623	2,427	14.2
1992	265	73.2	70.1	1,002	639	2,405	20.6
1993	267	79.8	72.8	1,116	710	2,324	25.2
1994	259	78.4	68.5	1,059	733	2,027	25.2
1995	267	78.7	77.6	1,330	774	2,128	41.1
1996	233	88.0	72.7	1,450	953	2,465	32.9
1997	229	86.5	78.3	1,371	945	2,215	33.5
1998	244	87.3	72.8	1,666	1,071	2,156	54.8
1999	203	84.7	72.1	1,815	949	2,228	67.7
2000	243	90.9	74.7	2,040	1,057	2,276	80.6
2001	143	91.6	73.3	1,993	1,028	2,263	78.1
2002	134	91.0	79.5	2,059	959	2,310	81.4
2003	110	90.0	74.7	2,172	1,106	2,339	86.5
2004	84	97.6	84.1	2,270	1,060	2,475	85.5
2005	89	93.3	72.3	2,345	1,238	2,468	90.0
2006	62	88.7	76.4	2,551	1,071*	2,551	100.0
2007	44	86.4	68.4	2,641	904	2,868	88.5
2008	31	87.1	55.6	2,612	988*	2,612	100.0

*Note: the data analysis reflects that 100 percent of smuggler-using undocumented migrants in 2006 and 2008 used monopolistically-competitive smugglers. This is likely due to a data limitation as the total observations drop off after 2003; therefore, the price of the perfectly-competitive smugglers was determined by taking the average of the years before and after.

Although this method is largely simplified and limited by the assumption that perfectly-competitive smugglers are relatively unresponsive to changes in border security and by the dwindling number of undocumented crossing observations after 2005, both the average prices and market shares represent the anecdotal evidence in the literature. In other words, various interviews with smugglers and recent undocumented immigrants in the literature illustrate the same story represented by this partition of the smuggling sector (Lopez Castro, 1998; Cornelius, 2001; Gathmann, 2008; Dolfin and Genicot, 2010; Roberts et al., 2010; Izcarra Palacios, 2012; Garsd, 2016). Figure 1 further illustrates the dramatic shift in smuggling service market share.

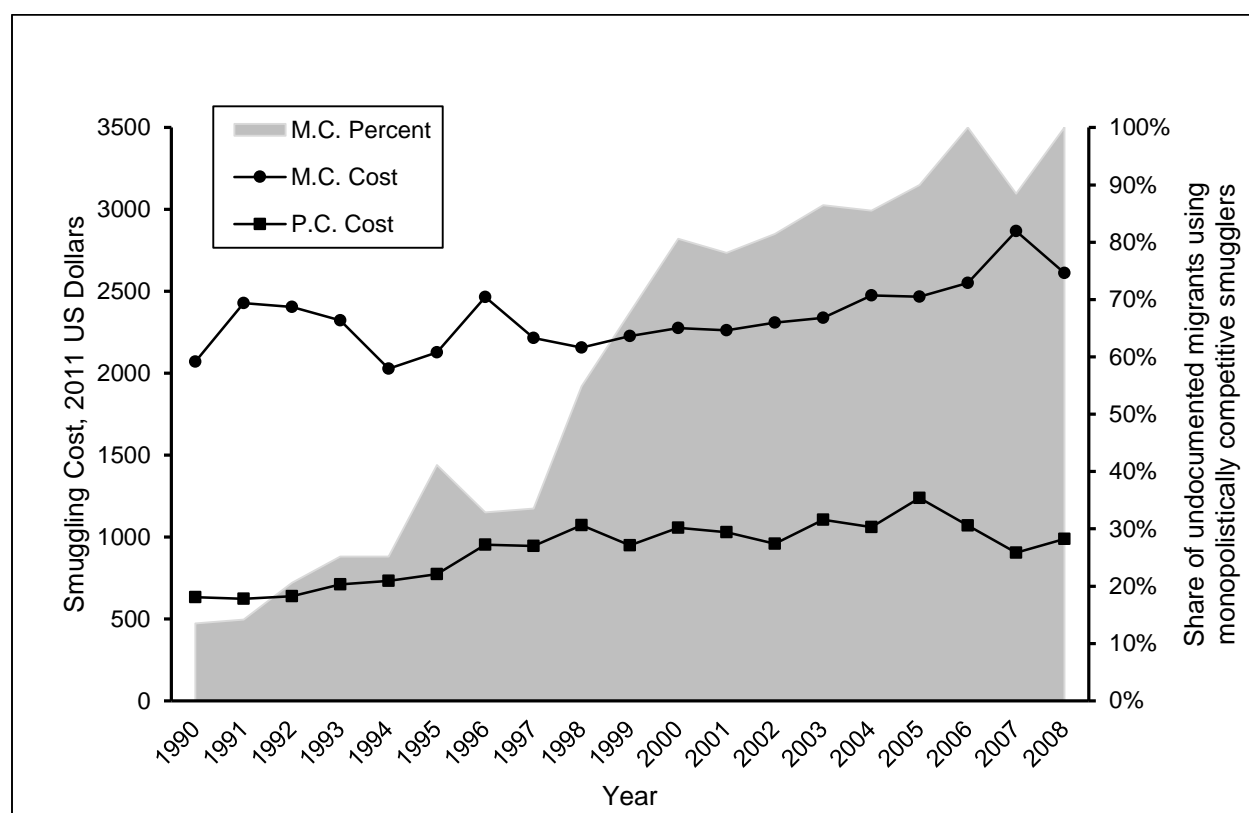


Figure 1. Real Average Smuggling Price for Mexican Nationals: Perfectly-Competitive vs. Monopolistically-Competitive Smugglers from 1990-2008 (adjusted for inflation in terms of 2011 U.S. dollars). Source: Mexican Migration Project, author's calculations.

Figure 1 is the graphical representation of the MMP survey responses described in Table 1. The two lines represent the smuggling prices faced by undocumented Mexican migrants in

inflation-adjusted 2011 U.S. dollars. The price data behave like the literature widely anticipated: the lower prices, which represent the fees charged by low-scale, perfectly-competitive smugglers, remain fairly constant through the near-20-year span, whereas the higher prices, which represent the fees charged by high-scale, monopolistically-competitive smugglers, steadily increase over time, with dramatic spikes over years with particularly high levels of border patrol spending.

The shaded portion of the figure represents the relative share of the migrant smuggling market controlled by monopolistically-competitive smugglers, as defined by the author's calculations. The market share owned by these large-scale smugglers was fairly small in 1990, but following the implementation of the militarized border protection strategies in 1993, the market share began a steady rise. Toward the finalization of the border infrastructure-building era in California and Texas (after 1997), the market share of monopolistically-competitive smugglers skyrocketed. This staggering shift in market share despite the larger prices charged by monopolistically-competitive smugglers illustrates the added difficulty level in crossing the U.S.-Mexico border illegally after the militarization border patrol strategy.

In this model, we assume that only migrants looking for agricultural employment use the small-scale, perfectly-competitive smugglers. Since Mexican undocumented agriculture workers only represent an estimated 3.6 percent of all Mexican undocumented immigrants currently present in the U.S. (Gonzalez-Barrera, 2015; Taylor et al., 2012), then the story told by Figure 1 seems especially accurate.

The MMP migration survey asks immigrants about the duration of their stay in the U.S. From this data, I establish a distinct timeline difference between Mexican immigrants seeking agricultural employment and those seeking non-agricultural employment. Figure 2 displays the

histograms of duration length for Mexican immigrants seeking agricultural and non-agricultural employment, respectively, on their first entry into the U.S.

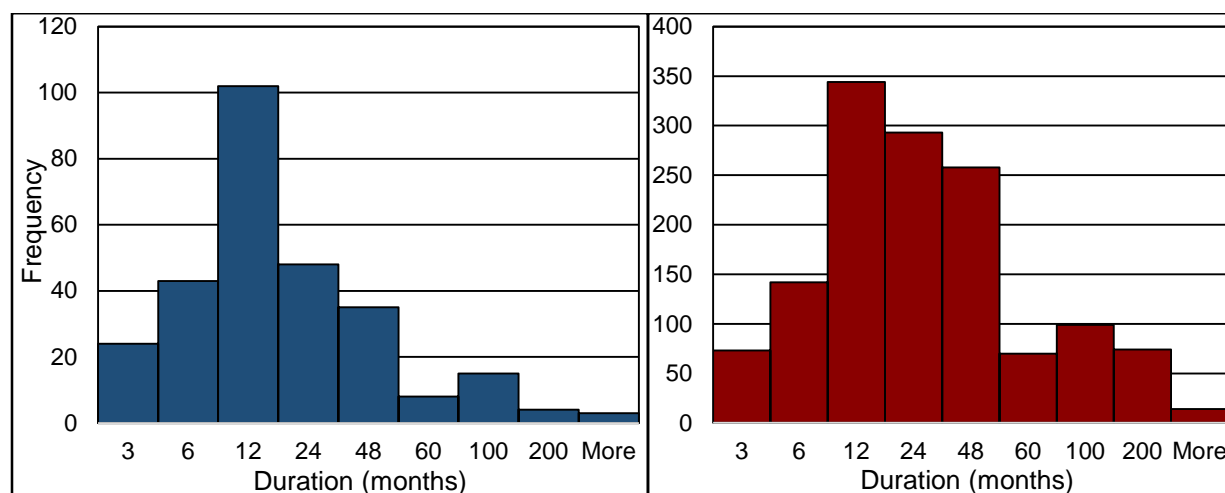


Figure 2. Distribution of length of stay in the United States for first-time, undocumented Mexican immigrants seeking agricultural (left) and non-agricultural (right) employment, 1990-2008. Source: Mexican Migration Project.

The majority of undocumented immigrants working in agriculture are seasonal migrants that remain in the country for a year or less (the median duration is 12 months for agriculture workers), whereas those working in non-agriculture sectors tend to stay for longer periods of time (the median duration is 24 months for non-agriculture workers). On average, undocumented immigrants seeking agricultural employment between 1990 and 2008 stayed in the U.S. for nearly 24 months, or 2 years, while those seeking non-agricultural employment stayed for nearly 34 months, or 2.8 years. This has implications for the relative appeal of different smuggler costs: a higher-cost smuggling service may seem more appealing with the expectation of spending more time in the U.S.

3.2.3 Cost-of-Living Adjustment

The cost-of-living adjustment was calculated by adjusting the average Mexican consumption bundle for necessities to the purchasing power of the U.S. dollar. I used the study of 2013 Mexican household purchases from Pereyra (2015). The study estimates the average Mexican

household's spending distribution as a percentage of total household income, separated into the following variables: housing and utilities, food, clothing, transportation, health, household appliances, education, entertainment, and personal use. This distribution of Mexican household spending is displayed in Figure 3.

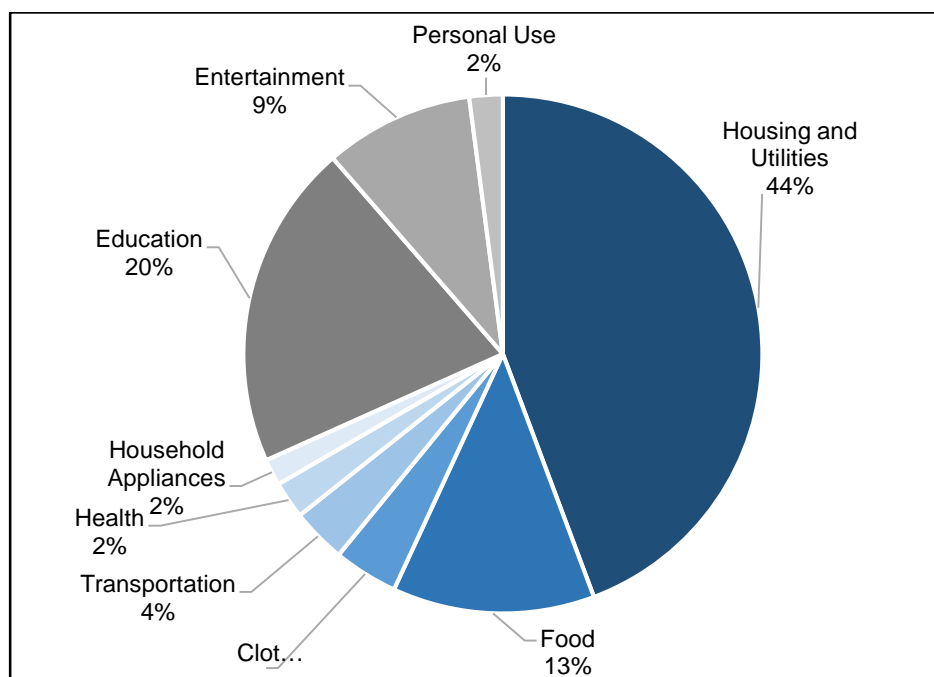


Figure 3. Average Mexican expenses as a proportion of household income, 2013. Source: Pereyra (2015).

Note that approximately 68 percent of the average Mexican household's income is used for basic necessities including housing, utilities, food, clothing, transportation, health, and household appliances. We assume that Mexican immigrants will not change their lifestyle, and will limit their spending to basic necessities while in the U.S.; the remaining 32 percent of their U.S. income is assumed to comprise the amount available for remittances. These consumption distributions remain constant for all households in Mexico; agricultural and non-agricultural households spend their incomes in these same proportions.

For Mexican agricultural households, the 2013 average annual income is approximately MXN \$48,736 (or USD \$3,820). We assume these households will spend 68.28 percent on basic

necessities, or approximately MXN \$33,277 (or USD \$2,608) per year. Given the USD-MXN Purchasing Power Parity (PPP) of 193 (OECD, 2016), this bundle of goods is worth approximately MXN \$64,224, or USD \$5,034 if purchased in the United States. The cost-of-living adjustment is the difference between the cost of living in the U.S. and Mexico, or approximately an additional USD \$2,426 for agricultural Mexican immigrants.

For Mexican non-agricultural households, the 2013 average annual income is approximately MXN \$84,292 (or USD \$6,607). In Mexico, the average non-agricultural household spends approximately MXN \$57,555 (or USD \$4,511) on basic necessities, which has a value of approximately MXN \$111,080, or USD \$8,707 in the U.S. The cost-of-living adjustment is approximately an additional \$4,195 for non-agricultural Mexican immigrants.

3.2.4 Labor Shares in Agricultural and Non-agricultural Sectors

Data on the agricultural and non-agricultural labor markets in Mexico come from the Instituto Nacional de Estadística y Geografía (INEGI), Mexico's main statistical agency. In Quarter IV of 2013, approximately 52.3 million individuals were part of the economically-active Mexican population. Approximately 6.9 million, or 13.17 percent, were employed in the agriculture sector, and 45.5 million were employed in all other sectors in Mexico.

In the U.S., estimates of the total number of undocumented immigrants come from various demographers in the Pew Hispanic Research Center. Passel and Cohn (2015b) estimate that in 2014, approximately 11.3 million undocumented individuals lived in the U.S. Gonzalez-Barrera (2015) estimates that 49.6 percent, or 5.6 million are Mexican. In 2013, total U.S. agricultural employment was 435,250 workers, according to the Bureau of Labor Statistics. At the mean U.S. annual wage for agriculture employment, the total value of U.S. agricultural labor is approximately \$10.59 billion. Hertel et al. (2012) estimate the production cost share of

agricultural labor is 0.38, and the National Agricultural Worker Survey estimates that 68 percent of this total is Mexican-born, and 68 percent of the Mexican-born agricultural labor force is undocumented (Taylor et al., 2012). Therefore, we can estimate that approximately 201,260 undocumented Mexican immigrants currently work in the U.S. agriculture sector. Thus, the remaining 5.4 million undocumented Mexican immigrants are assumed to work in the U.S. non-agriculture sectors.

3.3 Conceptual Model

3.3.1 Household migration decision

A Mexican national makes a rational migration decision in the following manner:

$$W_s^{US} - (W_s^{Mex} + P_s^{Smug} + C_s^{LivingAdj} + I) := \begin{cases} \geq 0 \Rightarrow \text{migrate}; \\ < 0 \Rightarrow \text{do not migrate}; \end{cases} \quad (1)$$

for $s \in \{\text{Ag}, \text{Non-ag}\}$,

where W_s^{US} is the potential annual income earned by undocumented immigrants in the United States for sector s (i.e. Ag or Non-ag), W_s^{Mex} is the annual income currently earned by Mexican nationals in sector s , P_s^{Smug} is the price paid to smugglers for transportation across the U.S.-Mexico border in sector s (agricultural workers in Mexico will use perfectly-competitive smugglers, and non-agricultural workers in Mexico will use monopolistically-competitive smugglers), $C_s^{LivingAdj}$ is the cost of living adjustment for sector s (agricultural and non-agricultural workers will keep the same respective consumption bundle they held in Mexico, adjusted for U.S. prices), and I is an indirect cost function that accounts for the remaining income gap at equilibrium. This indirect cost function, following Hertel and Zhai (2006), is in the following constant elasticity functional form:

$$I = \gamma \left(\frac{L_s^{Mig}}{L_s^{Mex}} \right)^\delta \quad \text{for } s \in \{\text{Ag}, \text{Non-ag}\}, \quad (2)$$

where γ is a shift parameter, δ is the elasticity of perceived indirect costs with respect to total undocumented Mexican population in the United States, L_s^{Mig} is the total number of undocumented Mexican immigrants working in sector s in the United States, and L_s^{Mex} is the total number of Mexican nationals working in sector s in Mexico. When $L_{Ag}^{Mig} / L_{Ag}^{Mex}$ is equal to the share of Mexican agricultural workers currently living illegally in the U.S.—approximately 2.93 percent—then equation (1) will equal zero for the agriculture sector. Likewise, when $L_{Non-ag}^{Mig} / L_{Non-ag}^{Mex}$ is equal to the share of Mexican non-agricultural workers currently living illegally in the U.S.—approximately 11.87 percent—then equation (1) will equal zero for the non-agriculture sector.

3.4 Empirical Model: SIMPLE-MIG

We implement the conceptual model of the undocumented Mexican migrant labor market in US agriculture in partial equilibrium to closely examine the wage and employment impacts of an immigration policy shift. This model, which draws some elements from the Simplified International Model of agricultural Prices, Land use and the Environment, or SIMPLE (Baldos and Hertel, 2012), simulates the effects of an endogenous migration movement on the U.S. agriculture sector. We fix total agricultural production to quantify the shift in undocumented, agriculture labor supply given an immigration policy change, *ceteris paribus*.

In the spirit of SIMPLE, we modified the agriculture production function to use two inputs, namely undocumented Mexican migrant labor ($Q_{MXLABOR}$) and other inputs (Q_{OTHER}), in a constant elasticity of substitution (CES) framework. The elasticity of substitution (σ_{CROP}) allows for the substitution of these two inputs in total agricultural production (Q_{CROP}). The supply of undocumented Mexican labor is determined endogenously by an equation that links the

wages for agricultural labor in the U.S. and Mexico. Mexican agricultural labor is discounted with a tax (τ_{LABMEX}), which represents the income gap between the two countries.

SIMPLE-MIG makes use of exogenous agricultural production, so there is no need for consumer demand equations. The model can be represented in six equations, which determine the agricultural production system in log-linearized (i.e., percentage change) terms, which are denoted with a tilde above the term. The model consists of the following system of equations:

Long run supply for undocumented Mexican migrant labor inputs in U.S. agriculture:

$$Q_{MXLABOR} \widetilde{} = \varepsilon_{LABMEX} * P_{LABMEX} \widetilde{}, \quad (3)$$

where ε_{LABMEX} is the wage elasticity of labor supply for Mexican nationals in U.S. agriculture, and P_{LABMEX} is the wage faced by Mexican nationals in Mexican agriculture;

Long run supply for other inputs in U.S. agriculture:

$$Q_{OTHER} \widetilde{} = \varepsilon_{OTHER} * P_{OTHER} \widetilde{}, \quad (4)$$

where ε_{OTHER} is the price elasticity of supply of other inputs in agriculture and P_{OTHER} is the average price paid for other inputs;

Long run derived demand for undocumented Mexican migrant labor inputs in U.S. agriculture:

$$Q_{MXLABOR} \widetilde{} + \psi_{MXLABOR} \widetilde{} = \widetilde{Q}_{CROP} - \widetilde{\psi}_{CROP} - \sigma_{CROP} * (P_{MXLABOR} \widetilde{} - \psi_{MXLABOR} \widetilde{} - \widetilde{P}_{CROP} - \widetilde{\psi}_{CROP}), \quad (5)$$

where $\psi_{MXLABOR}$ is the labor-biased efficiency index for undocumented Mexican migrants in agricultural production, and ψ_{CROP} is the Hicks-neutral efficiency index for agricultural production;

Long run derived demand for other inputs in U.S. agriculture:

$$Q_{OTHER} \widetilde{} + \psi_{OTHER} \widetilde{} = \widetilde{Q}_{CROP} - \widetilde{\psi}_{CROP} - \sigma_{CROP} * (P_{OTHER} \widetilde{} - \psi_{OTHER} \widetilde{} - \widetilde{P}_{CROP} - \widetilde{\psi}_{CROP}), \quad (6)$$

where ψ_{OTHER} is the other-input-biased efficiency index in agricultural production;

Unit cost condition for U.S. agriculture producers:

$$\begin{aligned} \widetilde{P}_{CROP} + \widetilde{\psi}_{CROP} = & \theta_{MXLABOR} * (\widetilde{P}_{MXLABOR} - \widetilde{\psi}_{MXLABOR}) \\ & + \theta_{OTHER} * (\widetilde{P}_{OTHER} - \widetilde{\psi}_{OTHER}), \end{aligned} \quad (7)$$

where $\theta_{MXLABOR}$ is the cost share of undocumented Mexican migrant labor in U.S. agricultural production, and θ_{OTHER} is the cost share of other inputs in U.S. agricultural production;

U.S.-Mexico agricultural labor price linkage (a levels equation):

$$\tau_{LABMEX} = P_{MXLABOR} - P_{LABMEX}, \quad (8)$$

where τ_{LABMEX} is the additive tax, which represents the income gap between agricultural employment in the two countries.

In this model, the key driver of endogenous labor migration from Mexican agriculture to U.S. agriculture is the exogenous, additive tax placed on the value of Mexican agriculture wages. Based on the income gap between undocumented Mexican migrants earning the 25th percentile of U.S. agriculture wages (USD \$18,230 annually) and Mexican nationals earning the average Mexican agriculture wages (USD \$3,820 annually), the pre-reform additive tax on Mexican agricultural wages is 0.79, from equation (8). With an open-border immigration policy, this tax rate would converge toward zero in equilibrium. The current quota-based immigration policy severely restricts natural labor movement between the two countries; thus, a shift to a market-based immigration policy can be simulated in this partial equilibrium model by reducing the additive tax on Mexican agricultural wages.

The model is calibrated to reflect the current employment of undocumented Mexican migrants in agriculture (201,260 workers) whose wage rates are reflected as a price index

($P_{MXLABOR}=1$) at equilibrium. Figure 4 depicts the estimated long run supply and demand for undocumented Mexican migrant labor in U.S. agriculture at the pre-reform additive tax level.

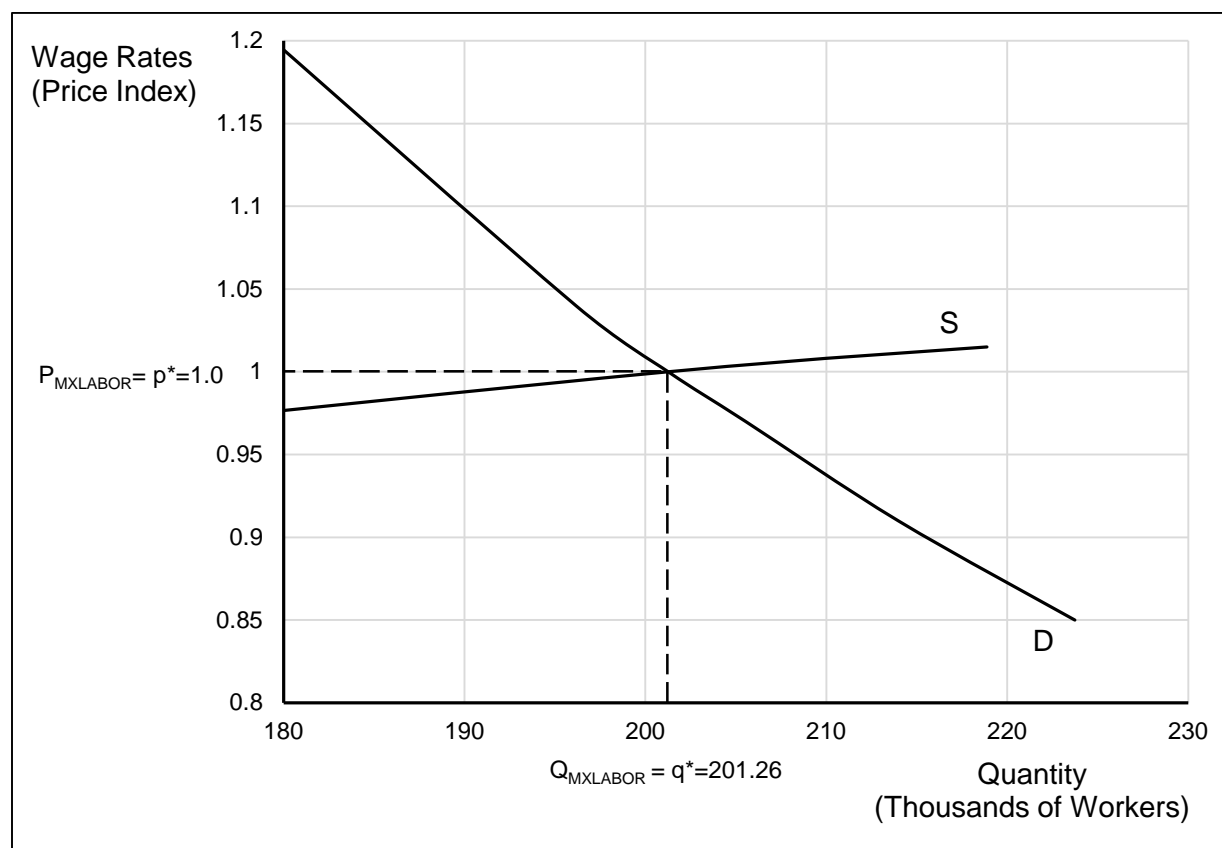


Figure 4. Estimated long run supply and demand of undocumented Mexican migrant labor used as an input in US agriculture with the additive tax on Mexican agricultural wages at the pre-reform level, estimated at 2013 prices using the SIMPLE-MIG model.

Note that the undocumented Mexican labor supply is extremely elastic ($\epsilon_{LABMEX} = 5$), indicating that even a relatively large influx of undocumented Mexican laborers or a relatively large increase in labor demand would not affect wages dramatically (Buccola et al., 2011; Espey and Thilmany, 2000). At this equilibrium, the price of undocumented Mexican labor in the U.S. agriculture sector equals 1.0 (as a price index), whereas the price of Mexican labor in the Mexican agriculture sector equals 0.21 (as a price index). Thus, at pre-reform equilibrium, the value of the additive tax on Mexican agriculture wages equals 0.79 from equation (8).

Eliminating this additive tax on Mexican agriculture wages completely leads to a substantial outward shift in total labor supply in the U.S. agriculture sector, as shown in Figure 5.

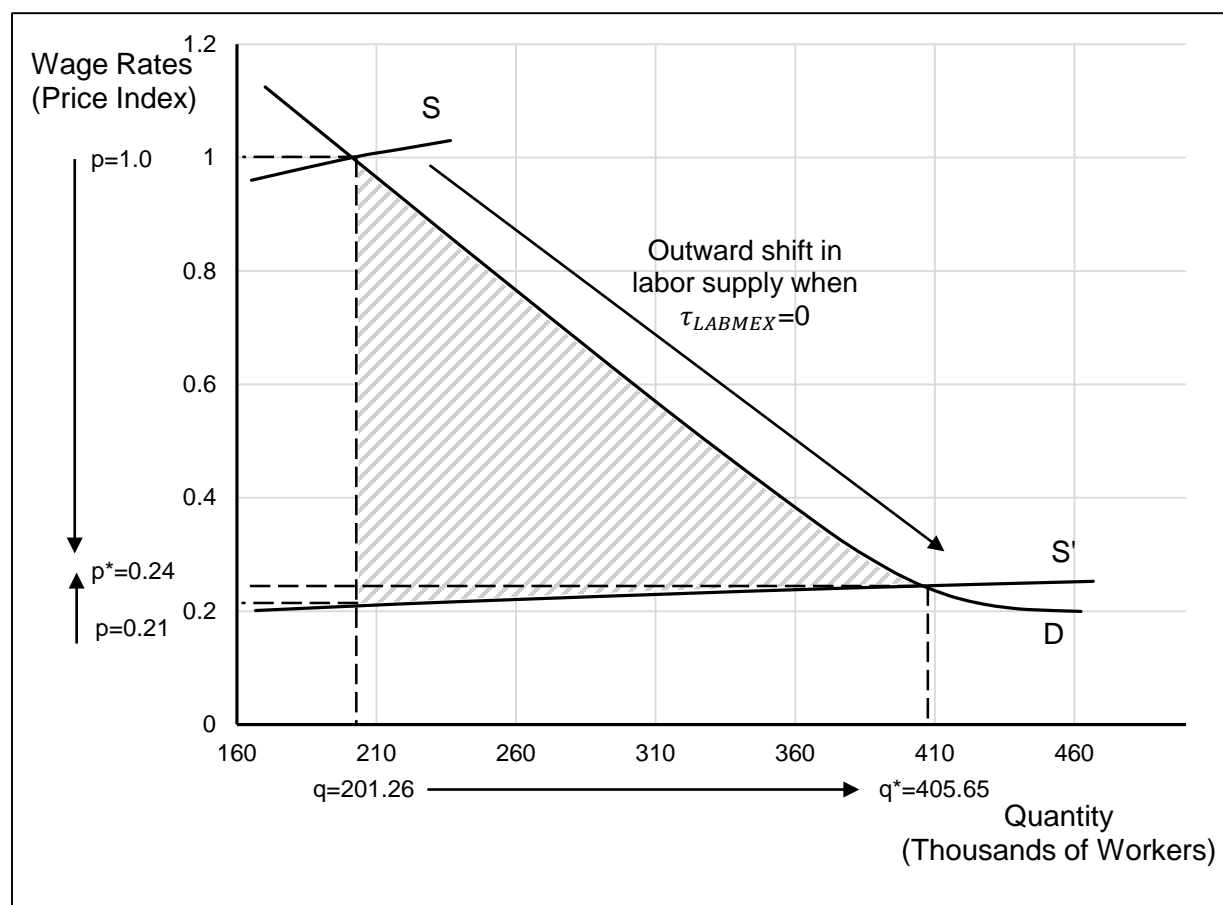


Figure 5. Estimated long run supply and demand for undocumented Mexican migrant labor used as an input in U.S. agriculture when the additive tax on Mexican agriculture wages is eliminated, estimated at 2013 prices using SIMPLE-MIG model.

This shift in the supply schedule occurs during this “full reform” scenario, where the complete elimination of the additive tax on Mexican agriculture wages simulates an open border policy between Mexico and the United States. The post-reform agricultural wages for Mexican workers in both countries are equal at 0.24 (as a price index). As depicted in Figure 5, the price of labor for undocumented Mexican migrants in U.S. agriculture falls precipitously by 75.5 percent, while the price of labor for Mexican nationals in Mexican agriculture rises incrementally by roughly 17 percent.

A reduction of the additive tax on Mexican agriculture wages benefits the most inelastic side of the market. Here, the most benefit from a free-entry immigration policy goes to the agricultural producers in the U.S., who see a massive reduction in labor costs and increase their total use of Mexican labor by 101.6 percent (from 201.26 thousand workers to 405.65 thousand) under a fixed agricultural production assumption.

Removing restrictions on the movement of international low-skill labor also has welfare implications: the shaded area in Figure 5 represents the deadweight loss of the pre-reform additive tax on Mexican agricultural wages. This deadweight loss is reflective of the labor force allocative inefficiency created by the tax on Mexican agricultural wages. We can simulate the labor market effects in the agriculture sector of a market-based immigration policy by reducing the additive tax on Mexican agricultural wages to a value between 0.79 (its pre-reform value) and zero (simulating an open border). Since the value of the tax reduction depends on the chosen cost of the visa, it is a useful exercise to experiment with varying cost schemes.

3.5 Experiments

A key part of establishing a market-based immigration policy lies in determining the price to charge Mexican nationals for a visa. We therefore run four experiments in which the additive tax on Mexican agriculture wages is reduced in amounts that reflect different pricing schemes. In these experiments, we attempt to quantify the extent to which a shift in immigration policy can reduce the indirect costs of migration for Mexican nationals. Legal migrants and illegal migrants must both pay for the direct costs of migration, i.e., the transportation cost (including visa fees for legal migrants and smuggler fees for illegal migrants), the opportunity cost of lost Mexican wages, and the cost-of-living adjustment. Therefore, the share of the additive tax on

Mexican wages that can be eliminated with an immigration policy shift is equal to the share comprised of the indirect costs of migration. Because the determinants of this indirect cost curve are near-impossible to quantify and not entirely exclusive to those migrating illegally³, we must make broad assumptions about the share of the indirect cost curve directly attributable to the illegal characteristics of undocumented migration and smuggler use.

In the first experiment, visas are priced at the current cost faced by those working in the agricultural sector (i.e., the smuggling cost charged by small scale, perfectly competitive smugglers). In this case, we assume that the entire indirect cost curve can be reduced with an immigration policy. Thus, we reduce the additive tax on Mexican agricultural wages by 75.6 percent (from additive rate 0.79 to 0.19). The second experiment is the same as the first except for the share of indirect costs that can be reduced with a policy shift. Here, only half of the indirect costs are assumed to be attributed to illegal migration; thus, we reduce the additive tax on Mexican agricultural wages by 37.8 percent (from 0.79 to 0.49).

In the third experiment, the price of visas is USD \$5,000, which is an arbitrary, but more realistic cost. We assume that all indirect costs are attributable to illegal migration, so the policy reform removes them completely. Here, we reduce the additive tax by 61.3 percent (from 0.79 to 0.31). In the fourth experiment, the price of visas is also USD \$5,000 and we assume that half of the indirect costs are attributable to illegal migration. With only half of the indirect costs reduced, the tax on Mexican agricultural wages is reduced by 30.7 percent (from 0.79 to 0.55). It is appropriate that a visa pricing scheme pegged to the smuggler costs faced by Mexican migrants (at \$1,082, a substantially lower price than the alternate \$5,000 scheme) will have

³ For example, the disutility of being away from family and country is experienced by all international migrants to some degree, so we cannot claim that all indirect costs faced by undocumented migrants can be removed by an immigration policy reform.

consistently lower policy-adjusted additive tax levels. A lower visa price will appeal to more Mexicans, and should logically have the lower post-reform tax level. Table 2 below details the calculations for the changes in additive tax on Mexican wages, given a desired policy outcome.

Table 2. Policy Shock Calculations for Additive Tax on Mexican Agriculture Wages

U.S. Agriculture Annual Income (25th percentile)	\$18,230	
Mexico Agriculture Annual Income	\$3,820	
Pre-reform additive tax on Mexican agriculture wages	0.7905	
	Visas priced at smuggler cost	Visas priced at \$5,000
Transportation Cost	\$1,082	\$5,000
Cost of Living Adjustment (rural Mexico to rural U.S.)	\$2,426	\$2,426
Total relocation cost	\$3,508	\$7,426
Direct costs of migration (Mexico income plus relocation costs)	\$7,328	\$11,246
Indirect costs of migration (U.S.-Mex. income gap net direct costs)	\$10,902	\$6,984
Policy-adjusted additive tax on Mexican agriculture wages		
All indirect costs reduced with policy reform	0.1928	0.3058
Half of indirect costs reduced with policy reform	0.4916	0.5481

Note: all prices are in 2013 USD.

4. Results and Discussion

As with the complete reduction of the additive tax on Mexican agriculture wages depicted in Figure 5 above, every experiment resulted in similar changes for the U.S. agriculture labor market. Table 3 lists the changes in undocumented Mexican migrant wages in U.S. agriculture, wages for Mexican nationals in Mexican agriculture, quantity of undocumented Mexican migrants used in the U.S. agriculture labor force, and the agricultural price of production in the U.S., in both percent change terms (relative to the pre-reform equilibrium levels) and post-reform levels.

Table 3. Partial Equilibrium Effects of Reducing Additive Tax on Mexican Agriculture Wages

Variables	Pre-Reform Equil.	Visa Priced at Smuggler Cost				Visa Priced at \$5,000			
		Experiment 1: Reduce all indirect costs	Experiment 2: Reduce half indirect costs	Experiment 3: Reduce all indirect costs	Experiment 4: Reduce half indirect costs	Levels	Percent Change	Levels	Percent Change
τ_{LABMEX}	0.79	-75.63	0.19	-37.85	0.49	-61.34	0.31	-30.70	0.55
$P_{MXLABOR}$	1.00	-57.50	0.42	-28.99	0.71	-46.79	0.53	-23.55	0.76
P_{LABMEX}	0.21	11.09	0.23	4.53	0.22	8.30	0.23	3.55	0.22
$Q_{MXLABOR}$	201.26	63.55	329.17	24.33	250.23	46.44	294.72	18.81	239.12
P_{CROP}	9.79	-12.81	8.54	-5.66	9.24	-9.88	8.82	-4.50	9.35

Levels units: τ_{LABMEX} in additive tax rates, $P_{MXLABOR}$ and P_{LABMEX} in price index terms with U.S. pre-reform labor price = 1, $Q_{MXLABOR}$ in thousands of workers, and P_{CROP} in USD per metric ton.

For a graphical exposition of the effects of each respective shock on the additive tax on Mexican agricultural wages, refer to Figures 6, 7, 8, and 9, which depict Experiments 1, 2, 3, and 4, respectively. As expected, Experiment 1 increases labor migration flows to the U.S. agriculture sector by the most, totaling an influx of 127.91 thousand workers. At a visa price of \$1,082, this population movement adds an immediate \$138.4 million to the U.S. economy, which has welfare implications that fall outside the scope of this partial equilibrium model, but are noteworthy.

This labor population shift causes substantial downward pressure on agricultural labor rates faced by Mexican migrants in the U.S (a reduction of 57.5 percent). Meanwhile, agricultural labor rates faced by Mexican nationals in Mexico only rise by 11 percent. Again, this illustrates that an influx of low-skill labor migration strongly favors the most inelastic side of the market—here, agricultural producers in the U.S. This benefit to U.S. agricultural producers can be seen through the decrease in the average cost of production, P_{CROP} . Experiment 1 also decreases the most labor allocation inefficiency, a deadweight loss which is depicted as the

shaded triangular area under labor demand, above labor supply, and to the right of the labor quantity used. Although the quantity of Mexican labor used in Experiment 1 is 76.5 thousand

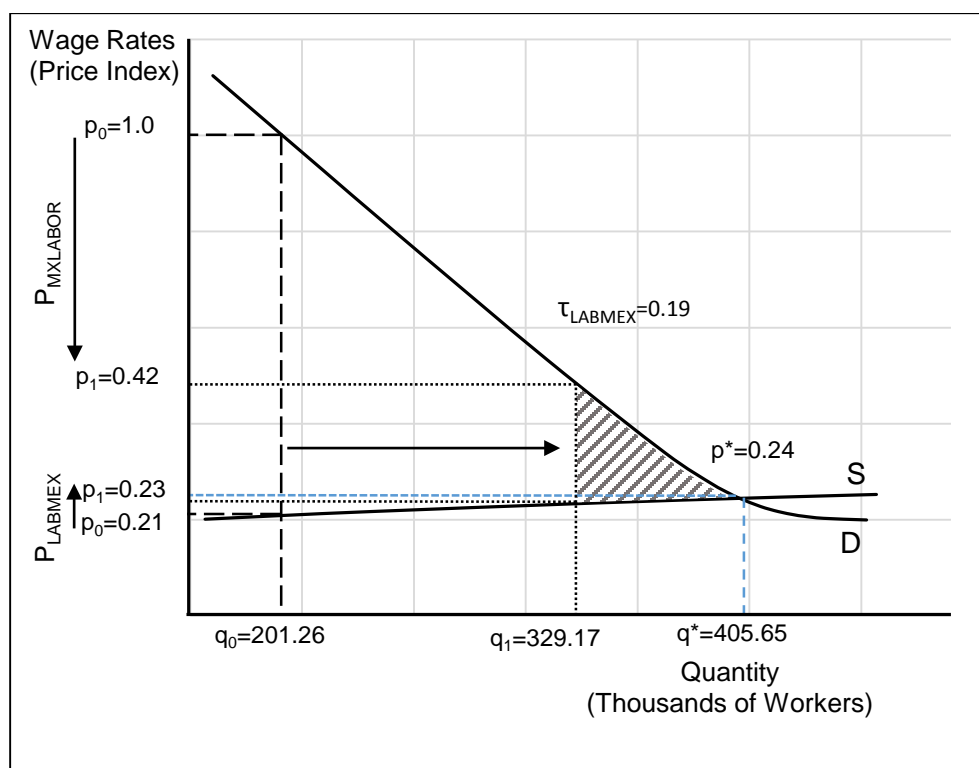


Figure 6. Graphical depiction of Experiment 1: relative changes in labor prices in the U.S. and Mexico agriculture sectors and quantity of labor used in U.S. agriculture from a 75.6% reduction in the additive tax on Mexican wages, plotted on the estimated net-of-tax long run supply and demand for undocumented Mexican migrant labor used as an input in U.S. agriculture.

workers short of the optimal quantity under a zero-additive-tax on Mexican agriculture wages (405.65 thousand), the tax rate used here (0.19) is likely the closest to zero that is politically feasible. Therefore, we should interpret the results from Experiment 1 as an upper bound of the effects on the U.S. agriculture labor market of a market-based immigration policy for Mexican nationals.

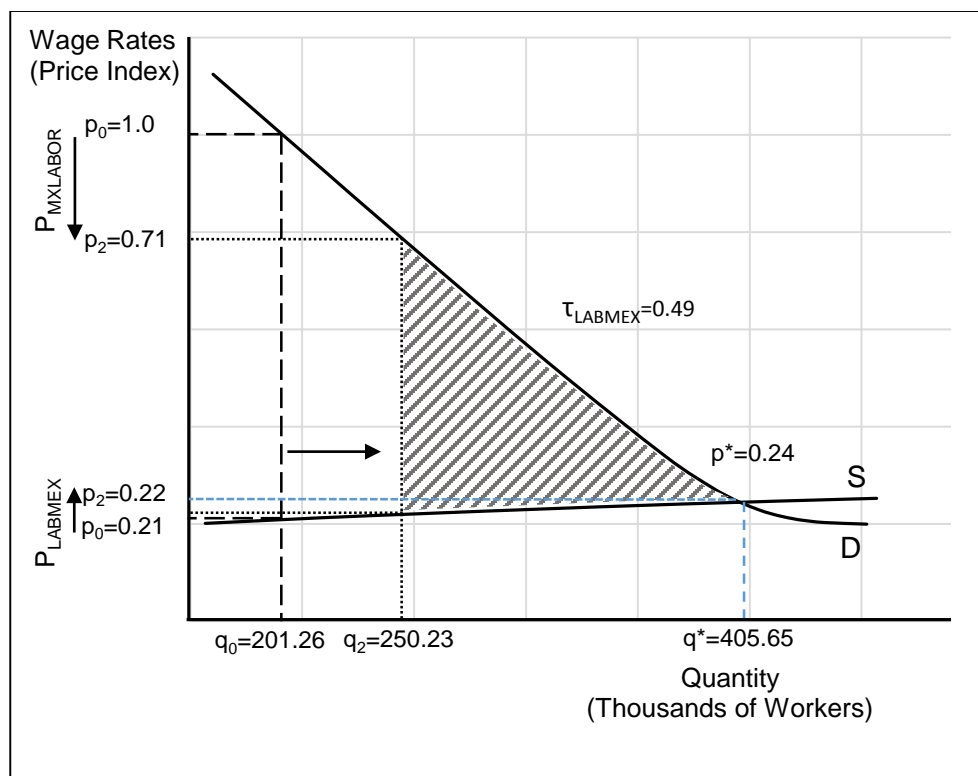


Figure 7. Graphical depiction of Experiment 2: relative changes in labor prices in the U.S. and Mexico agriculture sectors and quantity of labor used in U.S. agriculture from a 37.9% reduction in the additive tax on Mexican wages, plotted on the estimated net-of-tax long run supply and demand for undocumented Mexican migrant labor used as an input in U.S. agriculture.

Experiment 2, which uses the same visa price scheme as Experiment 1, results in drastically different labor market impacts. This is a result of the assumption that only half of the indirect costs of U.S. migration faced by Mexican nationals are attributable to illegal immigration. Intuition about the difficulties of life experienced by undocumented immigrant in the U.S. leads me to strongly believe that *at least* 50 percent of the indirect costs incurred by undocumented immigrants are attributable to illegal immigration (as opposed to disutility from international travel, broadly speaking). Therefore, if a market-based immigration policy were implemented for Mexican nationals, with a visa pricing scheme pegged to the cost of smuggling services, it is likely that the labor market effects of a policy change should lie between the results of Experiment 2 (as a lower bound) and Experiment 1 (as an upper bound).

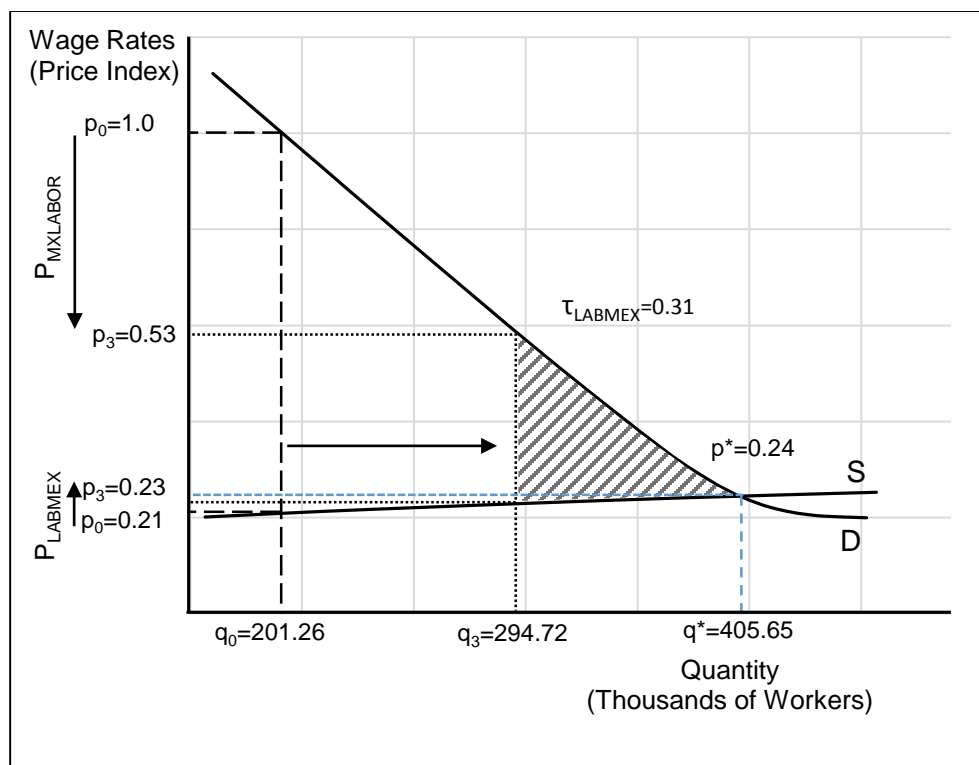


Figure 8. Graphical depiction of Experiment 3: relative changes in labor prices in the U.S. and Mexico agriculture sectors and quantity of labor used in U.S. agriculture from a 61.3% reduction in the additive tax on Mexican wages, plotted on the estimated net-of-tax long run supply and demand for undocumented Mexican migrant labor used as an input in U.S. agriculture.

Experiment 3, which sets the visa price at \$5,000 and assumes that all indirect costs can be eliminated with a market-based immigration policy, results in labor market effects similar to those in Experiment 1. The total quantity of Mexican labor used in the U.S. agriculture sector is 294.72 thousand workers, only 34.45 thousand less than Experiment 1. U.S. agriculture labor prices for Mexican migrants decrease by 46.8 percent, while Experiment 1 results in a decrease of 57.5 percent. Similarly, the increase in agriculture labor prices for Mexican nationals in Mexico rise by 8.3 percent, compared to a rise of 11.1 percent in Experiment 1.

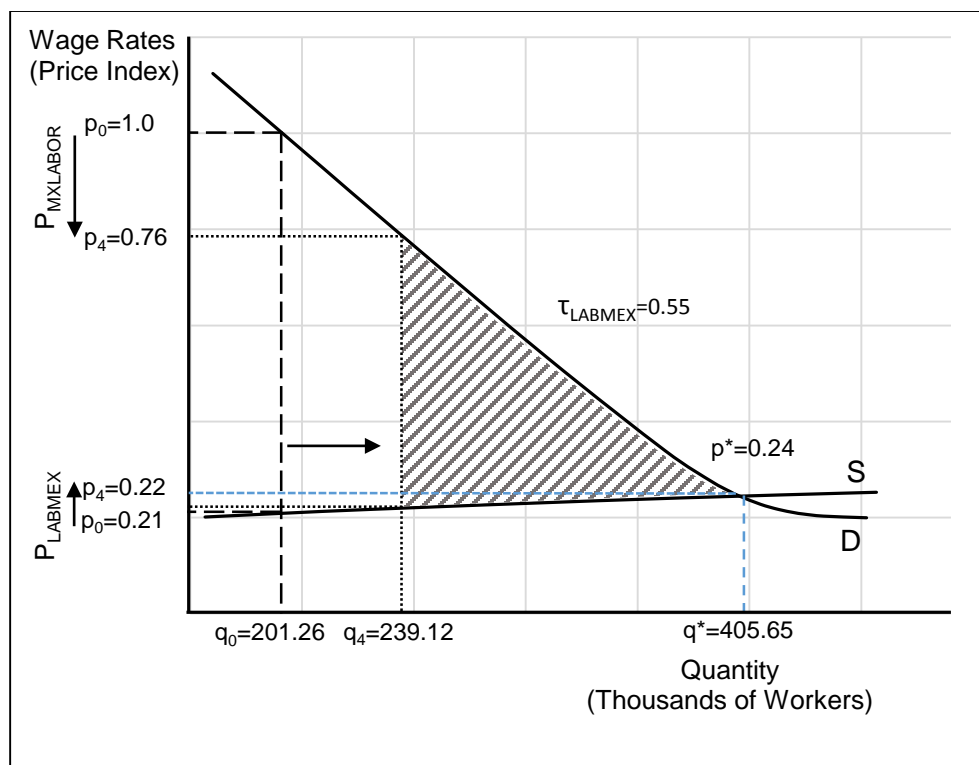


Figure 9. Graphical depiction of Experiment 4: relative changes in labor prices in the U.S. and Mexico agriculture sectors and quantity of labor used in U.S. agriculture from a 30.7% reduction in the additive tax on Mexican wages, plotted on the estimated net-of-tax long run supply and demand for undocumented Mexican migrant labor used as an input in U.S. agriculture.

The similarity of values for these two experiments—despite their visa pricing differences—highlights an important characteristic of market-based immigration policies: namely, the migration response to large changes in visa prices is relatively small. This is an important insight into the Mexican migration decision and underpins the conditions under which relatively large fees are charged to Mexican migrants seeking smuggler services. We can infer from the similarities between Experiments 1 and 3, and the more strikingly-present similarities between the results from Experiments 2 and 4, that the demand for visas (or, similarly, the demand for entry into the U.S. via smugglers) is relatively inelastic for Mexican nationals. This price inelastic demand for entry into the U.S. can help explain the existence of relatively high

fees charged by migrant smugglers—and willingly paid by low-skill Mexican nationals—for entry to the U.S.

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