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Effects of enforcement on illegal markets: Evidence from migrant smuggling along the southwestern border

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ABSTRACT

The paper analyzes the effects of tighter border control on the illegal crossing market between Mexico and the United States. Combining panel data on illegal migrants with enforcement statistics, the effects of enforcement are found to be moderate: prices of border smugglers ('coyotes') increased by only 17%, while the demand for smugglers has remained unchanged. Enforcement has however shifted illegal migrants to remote crossing places. Border crossing is now more time-intensive with higher prices for coyotes and risk of death. This geographic substitution raised migration costs by $140, more than twice the effect of enforcement on smuggling prices.

1. Introduction

How to deal with illegal migration has been the subject of an intense public and political debate over the past decades. News from Mexicans dying at the Southwestern border have fueled concerns about current illegal migration policies. Reforming existing policies, however, requires first a thorough understanding of the structure and incentives in this illegal market.

This article analyzes how enforcement has affected the illegal border crossing market between Mexico and the United States. An estimated 600,000 illegal migrants enter the United States each year, the vast majority along the border with Mexico. Efforts to seal the border have increased dramatically over the last two decades. Fig. 1 shows that the budget of the border patrol has increased sevenfold since 1986. This rise made the border patrol the fastest growing federal agency in the 1990s. Much of this growth in enforcement is concentrated along popular crossing routes in California and Texas.

Tighter enforcement increases the probability of apprehension, which raises the costs of illegal migration. One possible response is that illegal migrants stop migrating. Yet, several studies provide evidence that the deterrence effect of the border build-up appears to be small.[2] Illegal migrants can however adjust their behavior along at least two other margins: they can lower their apprehension probability by hiring a smuggler. Smugglers, known as 'coyotes', are experts and have better information about how

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[2] See Donato, Durand and Massey (1992), Espenshade (1994, 1995), Hanson and Spilimbergo (1999), Kossoudji (1992), Massey and Singer (1995), Massey et al. (2002), Reyes et al. (2002), Singer and Massey (1998). Hanson (2006) provides a comprehensive survey.

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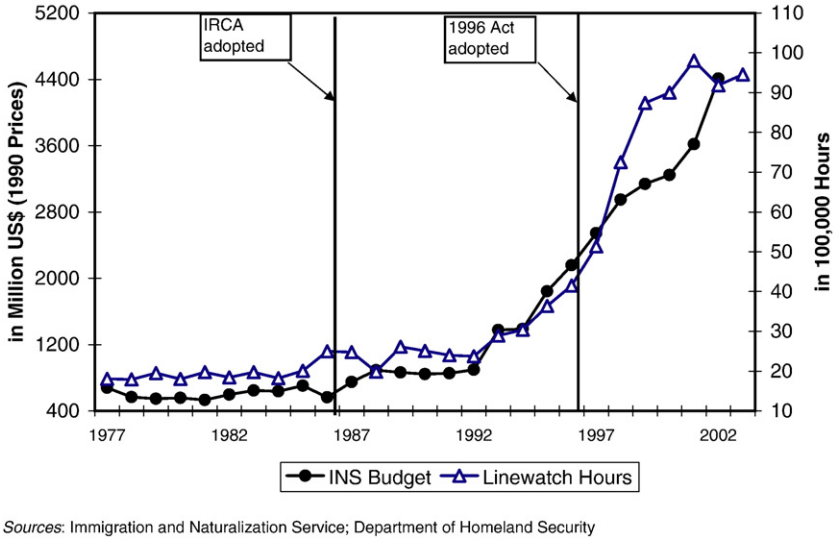


Fig. 1. The rise of border patrol resources.

to cross the border without getting detected by the border patrol. Alternatively, migrants can try to avoid the border patrol by crossing in areas with traditionally low enforcement. Knowledge about responses along these margins is much more limited (Massey et al., 2002; Orrenius, 2001, 2004; Reyes et al., 2002).

Focusing on the impact of the border build-up on migrant smuggling and the border crossing market has a number of attractive features. First, analyzing the relationship between enforcement and illegal border crossings is of interest in its own right. Little is known about how prices of illegal commodities respond to enforcement. Even less is known about the supply side in illegal markets (but see Lopez Castro, 1998). The theoretical framework developed here shows how one can exploit information on coyote demand and prices to evaluate how the risk of smugglers changes with enforcement.[3]

Second, responses in the border crossing market help to explain why the deterrence effect is small. Deterrence depends on the benefit of illegal migration net of total migration costs. Tighter enforcement in one sector raises smuggler prices and apprehension costs in that sector, which pushes migrants to cross in areas with less enforcement (see also Massey et al., 2002; Orrenius, 2004). While enforcement increases illegal migration costs, switching sectors and using coyotes provide a less costly alternative than deterrence, in which case a migrant foregoes the much higher wages in the United States.

Finally, previous studies rely on time series variation to study border crossings (but see Orrenius, 2004). This approach can be problematic if enforcement differs across sectors or other shocks affect border crossing behavior. The approach taken here exploits variation in enforcement both within and across sectors to estimate the effects of the border build-up on smuggling prices, the demand for smugglers and the choice of border crossing sector.

The empirical analysis uses a rich dataset on undocumented trips across the border from the Mexican Migration Project. The data contain border crossing histories of over 2200 illegal Mexican migrants including information about the crossing place, whether a smuggler is used and how much is paid for the service. To track enforcement efforts along the Southwestern border, the panel is linked to regional enforcement statistics from the Immigration and Naturalization Service and data on punishments for smugglers from the Sentencing Commission.

The findings suggest that smuggling prices respond to the border build-up, but that the elasticity with respect to enforcement is small. The border build-up raises smuggling prices by less than 20% or $110. Interestingly, prices also increase with enforcement in the neighboring sectors, which suggests that switching sectors is important. The demand for smuggling services is in contrast responsive to movements in prices. The estimated price elasticity of demand is with −0.5 surprisingly close to estimates from the illegal drug market. Further analysis shows that many illegal migrants shift to less guarded sectors outside the main border cities to avoid enforcement along the popular crossing routes. Estimates suggest that switching border crossing sectors increase by almost 40% after 1986. As crossing in remote areas requires more time, more money for coyotes, and is more dangerous, illegal migration costs rise by at least $140. This increase is about twice as much as the rise in sector-level smuggling prices.

The structure of the paper is as follows. The next section outlines a model of the illegal border crossing market and derives its empirical implications. Section 3 provides institutional background about illegal border crossing and enforcement along the Southwestern border. Section 4 introduces the data and studies the deterrence effect of enforcement. A detailed analysis of the border crossing market is presented in Section 5. Section 6 concludes.

[3] A related paper on smuggler demand is by Singer and Massey (1998). This line of work is extended here to study the implications for the supply side and account for endogeneity in the estimation.

2. Theoretical framework

2.1. Supply of smuggling services

The decision to provide smuggling services is similar to the supply decision of a criminal (Becker, 1968). Potential coyotes evaluate the tradeoff between expected revenues and costs from alternative opportunities and punishment if apprehended. The marginal cost of an illegal trip can be written as

$$MC_s(L_s) = \text{time}_s * w^{alt} + \text{prob}^E(L_s)F_s^E \tag{1}$$

where time_s is the time to smuggle migrants across the border in sector s and w^{alt} the market wage earned in an alternative legal job. F_s^E denotes the punishment for the coyote in sector s while prob_s^E is the probability of getting apprehended in sector s. The latter is increasing in enforcement L_s, but at a decreasing rate: thus, $\text{prob}_L^E > 0$ *and* $prob_{LL}^E < 0, \forall s$.

Since little is known about the supply of smugglers, two extreme cases are considered: perfect competition and collusive monopoly. Since there is a large pool of potential smugglers, mostly illegal migrants with a lot of border crossing experience, the market might be quite competitive. However, the fact that the smuggling business is illegal, and relies primarily on personal contacts, facilitates collusive agreements.[4]

Under perfect competition, prices equals marginal costs: $P_s^{PC} = time_s * w^{alt} + prob^E(L_s)F_s^E, \forall s$. Coyotes have to be paid their best outside alternative (first term) and compensated for the risk of being detected and punished (second term). If instead coyotes collude and act as a monopoly, prices P_s^M include an addition term: $P_s^M = P_s^{PC} - \frac{E(p_s^M)}{\partial E/\partial P_s}$, where $E(P_s)$ is the downward sloping demand curve facing coyotes with $E'(P_s) \leq 0$. The price now includes in addition a markup which is larger the more inelastic the demand curve $\left(\text{the smaller} \left| \frac{\partial E(P_s)}{\partial P_s} \right| \right)$.

2.2. Decision problem of illegal migrants

A potential migrant has to decide whether to migrate illegally or stay in Mexico, and how to cross the border (Ethier, 1986). Assuming that migrants maximize expected income, migration decisions depend on the present value of migrating net of total migration costs. The benefit from migration is the real earnings differential between a job in the United States and Mexico ($\Delta w = w^{US} - w^{MX}$). Costs of migrating consist of travel and crossing time plus delays due to apprehension and punishment. Since travel costs are comparatively small, migration costs are largely determined by the time needed to cross the border and costs of apprehension. Costs are then: $\text{time}_s w^{US} + \text{prob}(L_s)F$, where w^{US} denotes the wage earned in the United States, F the cost of apprehension and $\text{prob}(L_s)$ the migrant's probability of apprehension in s. This probability is increasing in enforcement but at a decreasing rate ($\text{prob}_{sL} > 0$ and $\text{prob}_{sLL} < 0, \forall s$) Finally, time_s denotes the time it takes to cross the border, which differs across border sectors as natural conditions make crossing in some sectors easier than others.

The unique feature in this market is that migrants can lower their risk of apprehension by hiring an expert. By paying the coyote price P, the migrant purchases the smuggler's probability of apprehension, $\text{prob}^E(L)$. Since coyotes have better information about smuggling routes, easier access to false documents and other border crossing technology, their probability of apprehension is lower than for migrants crossing by themselves ($\text{prob}^E(L_s) \leq \text{prob}(L_s), \forall s$). For a given sector s, an illegal migrant hires a coyote as long as the cost from doing so is lower than crossing by himself. Thus,

$$P(L_s) \leq \left(\text{prob}(L_s) - \text{prob}^E(L_s)\right)F \qquad \forall s \tag{2}$$

The right-hand side is the expected benefit from hiring an expert, whereas the left-hand side measures the cost. The demand for coyotes within a sector is decreasing in the smuggling price and increasing in expected punishment costs (F) as well as in the effectiveness of coyotes relative to self crossers ($\text{prob}(L_s) - \text{prob}^E(L_s)$).[5] Define an indicator $D_s^E = 1$ if a migrant would hire a smuggler in sector s and zero otherwise. Given his smuggler choice, the migrant chooses the crossing sector that minimizes the total costs of migration

$$\min_s C_s^M(L_s) = \text{time}_s w^{US} + \text{prob}(L_s)F - D_s^E\left[\left(\text{prob}(L_s) - \text{prob}^E(L_s)\right)F - P(L_s)\right] \tag{3}$$

where optimality requires that the term in square brackets is nonnegative for coyote users. The choice of sector involves a tradeoff between the time costs of crossing (first term) and the expected costs of apprehension (second and third term). In San Diego, for example, time costs are low, while the probability of apprehension is high. The opposite is true in Arizona. If all sectors have positive demand in equilibrium, Eq. (3) is equalized across border sectors.

[4] This setup is a simplification of a more complex model, in which the market structure is derived endogenously from the location decision of each coyote. It requires that there is at least one (monopoly case) or two (perfect competition) coyotes in each sector; formally, for all s and at least one supplier $D^E(P_s^E) * [P_s^E - MC_s(L_s)] - FC^E(L_s) > 0$ where FC^E denotes fixed costs like investment in vans as well as any 'distaste for crime'.

[5] $(\text{prob}(L) - \text{prob}^E(L))$ is assumed to be nonnegative. If the difference is small, expert and migrant are close substitutes. If there is no or prohibitive enforcement, the term, like the value of smugglers, goes to zero.

Finally, the decision to migrate illegally is determined by comparing the net benefit of migration to the outside option of remaining in Mexico. Defining the indicator $D_s=1$ if a migrant would cross in sector s and zero otherwise, the decision rule is to migrate if

$$\Delta w - \sum_{s=1}^{S} D_s\left(C_s^M(L_s) - D_s^E(L_s)\left[\left(\text{prob}(L_s) - \text{prob}^E(L_s)\right)F - P(L_s)\right]\right) \geq 0 \tag{4}$$

Eq. (4) shows that the decision to migrate depends on the choice of coyotes and crossing sector in addition to the effectiveness of coyotes ($\text{prob}-\text{prob}^E$) and punishment costs F.

Eq. (4) together with Eqs. (2) and (3) determine the total migrant flow in sector s. In the case of two sectors s and s', this is $M_s=M_s(C_s^M(L_s),C_{s'}^M(L_{s'}), \Delta w)$ where the demand is decreasing in illegal migration costs of the same sector, increasing in migration costs of other sectors and the benefit of migration. The sector demand for smugglers is then defined by Eq. (2) and the number of people crossing in a sector M_s:$E_s=E_s(P_s, F, \text{prob}(L_s)-\text{prob}^E(L_s), M_s)$. Finally, the total number of illegal migrants entering the United States is $M=\sum_{s=1}^{S} M_s$.

2.3. Optimal choice of border enforcement

The choice of border enforcement involves a tradeoff between higher border patrol resources and the actual or perceived net costs of illegal migration. In the absence of capital expenditures, the costs of having more officers patrolling the border are simply $C^{BP}=w^{BP}*\sum_{s=1}^{S} L_s$ where w^{BP} is the wage of a border patrol agent and L_s denotes hours of enforcement in sector s.

Illegal migration imposes a cost on society denoted by $C(M)$ where $M=\sum_{s=1}^{S} M_s$ is the total number of migrants crossing the border each year and $C_M>0$ and $C_{MM}\geq 0$. Thus, marginal costs from illegal migrants increase either because benefits from illegal migrants go down or marginal costs go up. More enforcement decreases the number of illegal entries in that sector either because of deterrence or apprehension effects, but at a decreasing rate: $M_{sL}<0$ and $M_{sLL}\geq 0$ for all s. A social planner chooses enforcement levels L_s to minimize the sum of costs to society and enforcement. The first-order condition for this problem is

$$-\frac{\partial M_s(L_s)}{\partial L_s} = \frac{w^{BP}}{C'(M)} \qquad \forall s. \tag{5}$$

Overall enforcement is more intense the higher the perceived marginal costs of illegal migrants ($C'(M)$) or the lower border patrol wages (w^{BP})[6] Optimal enforcement L_s^* will also be higher in sectors where migrant flows are more responsive to enforcement $\left(\frac{\partial M_s(L_s)}{\partial L_s}\right)$. Eq. (5) and the second-order condition $-C''(N)\frac{\partial M_s}{\partial L_s} - C'(M)\frac{\partial^2 M_s}{\partial L_s^2} > 0 \forall s$ define the optimal enforcement level in each sector L_s^* and total enforcement along the border $L^*=\sum_{s=1}^{S} L_s^*$, which in turn determine the distribution of illegal crossings among sectors $M_s(L_s^*)$ as well as the total number of tolerated illegal entries M^*.

2.4. The effects of stricter enforcement

Suppose the perceived costs of illegal migration $C(M)$ rise. From Eq. (5), enforcement will rise and more so in sectors where migrant flows are responsive to enforcement. Higher L_s increases the probability of apprehension for both smugglers and migrants. Since coyotes' marginal costs increase, coyote prices have to rise to compensate for the higher risk of smuggling. Under monopoly, the more price-elastic the demand for coyotes, the closer observed price changes will mirror changes in coyotes' marginal costs.

Higher smuggling prices also increase the cost of hiring a coyote, which in turn decreases the demand for coyotes. Since enforcement increases the probability of apprehension for all border crossers, the value of hiring a coyote might go up or down. If coyotes can better adapt to tighter enforcement, $\frac{\partial \text{prob}^E}{\partial L_s} < \frac{\partial \text{prob}_s}{\partial L_s}$ and coyote services become more valuable. The net effect of enforcement on smuggler demand E_s is then ambiguous.

Differential changes in sectoral enforcement also affect migration patterns. Suppose enforcement is only tightened in sector s, but remains constant in all others. This raises migration costs C_s^M and hence decreases border crossings in s. Since migration costs are equalized for all sectors with positive demand in equilibrium and $C_{s'}^M$ for $s\neq s'$ remains unchanged, migrants prefer to switch to another sector (substitution) rather than stop migrating (deterrence).

3. Institutional background

3.1. Characteristics of the border crossing market

Illegal migration from Mexico to the United States has a long tradition driven by geographic proximity, large differences in wealth and limited legal entry.[7] Estimates from census data suggest that 250 to 350 thousand permanent migrants from Mexico enter the United States illegally each year (Warren, 2000). An even larger number cross the border as temporary illegal migrants.

[6] The setup can be extended to consider effects of enforcement in s on neighboring sectors s'. Now, migrant flows are $M_s(L_s,L_{s'})$with $M_{sL'}\geq 0$. The first-order condition then becomes $-C'(M)\left[\frac{\partial M_s(L_s,L_{s'})}{\partial L_s} + \frac{\partial M_{s'}(L_s,L_{s'})}{\partial L_s}\right] = w^{BP}$ for all s, s'. The benefit of enforcement in sector $s\left(\frac{\partial M_s(L_s,L_{s'})}{\partial L_s}\right)$ is now reduced by the effect of increased migration in the neighboring sector $s'\left(\frac{\partial M_{s'}(L_s,L_{s'})}{\partial L_s}\right)$. If migrants are perfectly mobile, enforcement only has an effect if raised in all border sectors.

[7] With the *Immigration and Nationality Act Amendment* in 1965, immigration policy favored relatives of U.S. citizens or permanent residents and those with special occupational skills at the expense of low-skilled migrants from Mexico.

Apprehension data suggest that around 1.3 million illegal border crossings occur each year in the 1980s (Espenshade, 1995; Massey et al., 2002).

On average three out of four illegal migrants rely on coyotes to help them enter the United States, which are usually hired in Mexican border towns (Conover, 1987). Coyotes contact illegal migrants at major bus and train stations or in hotels popular with illegal migrants. There, or at a later meeting, the parties agree on the price and desired destination in the United States. At night, the coyote meets a group of migrants on the Mexican side and takes them across the border.[8] The smuggling price depends on whether the migrant is brought only across the border or to his final destination in the United States and how difficult the border crossing is. More walking or swimming means a lower price. Migrants typically pay half the price up front and the rest upon safe arrival. Before border enforcement tightened, the average fee of a smuggler was around $400 in 1990 dollars, roughly three weeks of paid work as an illegal migrant.

The 1989 mi Southwestern border with Mexico is the main point of entry for illegal migrants into the United States and accounts for 97% (1998) of all apprehensions, of which 96% are Mexicans. Illegal border crossings are traditionally concentrated in a few urban areas. Before enforcement tightened, the most popular entry route was the city borderline between Tijuana and San Diego. Of all illegal migrants apprehended, 45% were arrested in this sector, followed by 21% in the El Paso sector, in particular between the border cities Ciudad Juarez and El Paso.[9]

The detection and apprehension of illegal migrants is the primary task of the border patrol. While immigration inspectors handle the border traffic at legal points of entry, the majority of the border patrol's resources (63% in 1994) are devoted to searching the border for illegal migrants. These “linewatch hours”, the hours agents spend watching the border, are used as measure of enforcement in the empirical analysis below. Most migrants captured (98% of the 1.2 million Mexicans apprehended in 1994) enter the country without proper documentation, i.e. with no legal or false documents. Those apprehended usually spend little time in custody. The vast majority agrees to be deported voluntarily and are simply returned to Mexico (95.3% in 1994). The rest face a formal deportation hearing and are later deported or prosecuted in court. Prison sentences or fines however remain the exception.

3.2. Changes in immigration and enforcement policy

The *Immigration and Control Act* (IRCA) of 1986 marked a major shift in how the U.S. government regulated illegal migration. First, it included an amnesty program in which almost 3 million undocumented residents became legalized.[10] The second important provision was that the resources spent on border enforcement, especially along the Southwestern border, were increased substantially. The border patrol budget more than doubled between 1986 and 1992. The main expansion began in 1993, when several regional initiatives were launched to seal popular illegal crossing routes. In 1993, *Operation Hold-the-Line* in the El Paso sector focused its efforts on a 20-mile stretch of the border in the El Paso metropolitan area. The second big initiative, *Operation Gatekeeper,* started in San Diego in October 1994. Within four years, enforcement staff in San Diego increased by 150%. Initially, the additional resources were deployed along a 14 mile from the Pacific Ocean eastward into San Diego. Big fences were constructed that covered 42.2 mi in 1998 compared to only 19 mi in 1994.[11]

The *Illegal Immigration Reform and Immigrant Responsibility Act* of 1996 further increased resources for border enforcement. While one border patrol officer covered 1.1 mi in 1975, there was one for every 1000 ft or 0.2 mi in 2004. Automated control systems were installed to facilitate detection of migrant smugglers. The 1996 Act also encouraged for the first time the criminal prosecution and increased the punishments of illegal migrants and coyotes. The caseload of immigration violations rose by 50% from 13,068 in 1994 to 22,071 in 2000, of which 80% were convicted. The median prison term of those convicted increased from 2 months in 1992 to 15 months in 2000.

Fig. 1 shows the increase in enforcement along the Southwestern border since 1977. The budget of the Immigration and Naturalization Service (now part of the Department of Homeland Security) increased sevenfold between 1986 and 2003. A similar picture emerges for the evolution of linewatch hours, a more direct measure of border enforcement, which increased by almost 400%.

4. Data and descriptive evidence

4.1. Data sources

To analyze the effects of the dramatic border build-up on the border crossing market, data from the Mexican Migration Project are used. This survey has interviewed a random sample of 200 households in two to five Mexican communities each year since 1982. The 107 communities represent a wide range of regions, ethnic compositions and economic conditions. All have a long

[8] Most coyotes cross outside the legal crossing points. In some cases, they cross at legal points of entry with false documents or guide people directly from their home town in Mexico across the border (Lopez Castro, 1998).

[9] Apprehensions are however a noisy measure of illegal border crossings. Most illegal migrants are never caught or cross at some later point if apprehended. As such, apprehensions underestimate border crossings in the former case and overestimate them in the latter.

[10] Illegal migrants, who had lived in the United States since January 1, 1982, were given permanent resident status. 1.8 million undocumented workers qualified for legalization and 1.6 million (of which 71% were from Mexico) obtained the residence permit. Temporary agricultural workers were granted permanent residence, if they had worked for at least 90 days in the agricultural sector in 1984, 1985 and 1986. 1.3 million farm workers were legalized through this Special Agricultural Workers (SAW) program, of which 81% were Mexicans.

[11] Other operations included *Operation Safeguard* in Arizona (1995, extended 1999) and *Operation Rio Grande* in the southern Rio Grande Valley (1997).

Table 1
Summary statistics of illegal migration data

	Self crosser		Using a coyote	
	Mean	S.D.	Mean	S.D.
Age	37.66	8.14	36.98	7.79
Education (in years)	5.28	3.32	5.01	3.16
Wage in Mexico (in US$)	1.03	1.54	1.16	1.75
First Trip to US?	0.30	0.46	0.36	0.48
Total Number of Trips to US	7.40	6.26	6.24	5.78
Duration of US Trip (in months)	19.83	42.10	17.15	24.39
Total US Experience (in months)	43.04	45.14	34.09	36.15
Domestic Migrations?	0.49	0.50	0.41	0.49
Crossing Alone	0.47	0.50	0.37	0.48
Crossing With Family	0.17	0.38	0.18	0.38
Deported at Least Once	0.21	0.41	0.24	0.42
Working in Agriculture	0.57	0.50	0.43	0.49
Working in Manufacturing	0.33	0.47	0.38	0.49
Wage Earned in the United States	3.93	0.93	3.91	0.89
Observations	1012		3927	

Notes: The table compares the characteristics of undocumented migrants that use or do not use a coyote to cross the border. The unit of observation is person-year. An individual can therefore be in both subgroups if he uses a coyote in one year but crosses by himself in another. The fraction of people working in agriculture or manufacturing in the migrant's community of origin are interpolations between decennial observations from the Mexican Census.

tradition of sending migrants to the United States.[12] Interviews are conducted in the Mexican communities in December and January. This survey design includes only households with at least one member remaining in Mexico, and oversamples temporary migrants, which are more likely to return to their families in the winter months.

The survey contains demographic and economic characteristics of all household members and a detailed life history of work, migration and marriage for household heads. Based on the life history, a yearly border crossing history is constructed resulting in a panel of undocumented trips to the United States. The sample is restricted to male household heads between the age of 16 and 55, who report a positive wage in Mexico and, if they are migrants, a positive wage in the United States. To avoid recall bias, all observations more than fifteen years before the survey date are deleted from the sample.

The survey data is matched to enforcement records from the Immigration and Naturalization Service/Department of Homeland Security (U.S. Department of Homeland Security, various years) and punishment records from the United States Sentencing Commission (Federal Judicial Center, several years). Intensity of border enforcement is captured by the hours border patrol agents spend patrolling the border per border mile ('linewatch hours') for each of the nine border crossing sectors from 1976 to 2004. The average prison term for migrant smuggling in each year and each of the five district courts at the Southwestern border is used as measure of punishment.

The unit of observation in the analysis is an undocumented trip. Of the 12,258 household heads in the sample, around two-thirds have never made a trip to the United States. 4582 household heads had some migration experience, of which 78% entered illegally at least once. The median number of illegal trips is 4 and its median duration 12 months. On average, 77% of all undocumented trips across the border are taken with a coyote.

Table 1 compares the characteristics of self crossers with those using a coyote from 1972 to 2003. Self crossers are somewhat older, slightly more educated than coyote users and have accumulated more border crossing expertise. Coyotes are more often used on the first illegal trip, in smaller communities and where a larger fraction of males has prior migration experience. Self crossers in contrast live in households with more prior migration experience, are more likely to cross the border alone and have more family members in the United States.[13]

4.2. The deterrence effect revisited

The explicit goal of the massive expansion of border patrol resources is to deter illegal migrants from entering the United States. To assess the effectiveness of this policy, the following model is estimated

$$\Pr\left(D_{it}^{M}=1\right)=\alpha_M+\beta_M L_t+\gamma_M' X_{it}+u_{it}^{M}$$

[12] See the website of the Mexican Migration Project (2005) for a map of the areas included in the survey (http://mmp.opr.princeton.edu/research/maps-en.aspx). While the sample is not strictly representative of Mexican migrants, Massey and Zenteno (2000) show that the characteristics of the MMP sample are very similar to those of migrants in nationally representative surveys. See the data Appendix A for more detail on the construction of the data set.

[13] Self crossers report less deportations for possibly two reasons: if a migrant reports several attempts to cross the border, it is not known whether he used a smuggler each time but only whether he employed one in any attempt. This will overestimate the probability of apprehension by expert users if low-ability migrants first try to cross the border alone and then switch to experts after they are caught. Also, since smugglers cross with larger groups, their risk of detection is possibly higher.

Table 2
Deterrence of Illegal Migrants

	1st stage (1)	Probit (2)	Probit-IV (3)
Log Border Enforcement		−0.004	−0.1004
		(0.003)	(0.1619)
Log DEA Budget (in million $)	−0.1491		
	(0.0036)**		
Age	0.0001	0.0009	−0.0008
	(0.0001)	(0.00005)**	(0.00009)**
Married	−0.0019	0.0020	0.0050
	(0.0015)	(0.000)***	(0.0029)
Some Primary School	−0.0007	0.0070	0.0122
	(0.0020)	(0.001)***	(0.00422)**
Finished Primary School	0.0000	0.0130	0.0201
	(0.0022)	(0.002)***	(0.00705)**
More than Primary Education	0.0032	0.0180	0.0354
	(0.0024)	(0.003)***	(0.01081)**
Family in the United States	0.0018	0.0010	0.0016
	(0.0014)	(0.000)***	(0.0030)
US Experience Household Members	0.0001	0.0030	0.0328
	(0.0002)	(0.000)***	(0.00113)**
Number Domestic Migrations	0.0000	0.0000	0.0001
	(0.0002)	(0.000)**	(0.0004)
Business Owned in Mexico	−0.0029	−0.0030	−0.0167
	(0.0016)	(0.001)***	(0.00258)**
Hectar of Land Owned in Mexico	0.0000	0.0000	−0.0002
	(0.0000)	(0.000)***	(0.00003)**
Potential U.S. Wage	−0.0502	−0.0620	0.1256
	(0.003)**	(0.008)***	(0.02207)**
Potential Wage in Mexico	0.0199	0.0030	−0.0166
	(0.0006)**	(0.001)***	(0.0211)
Other Individual Characteristics	Yes	Yes	Yes
Community Characteristics	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes
Linear Time Trend	Yes	Yes	Yes
Observations	114,919	114,919	114,919
R-squared	0.73		
Log-likelihood		−11,543.0	17,380.4
Elasticity of Deterrence		−0.09	−2.23

Notes: The table shows marginal effects from a probit model, where the dependent variable is one if a person migrated illegally in a given year and zero otherwise. The first-stage result is shown in column (1), where the dependent variable is the log linewatch hours and the instrument is the log budget of the Drug Enforcement Agency. The omitted education category is no formal education. Columns (2) and (3) report least squares and the second-stage respectively. All specifications include migrant's age, education, marital status, children, domestic migrations, family in the US, total migration experience, business ownership and hectares owned in Mexico, wages in Mexico and the US, community characteristics and community fixed effects, a time trend and aggregate controls (U.S. average and minimum wages and unemployment rate, Mexicans legalized and naturalized, Mexico's Gross Domestic Product and population). Coefficients with * are significant at the 10% level, those with ** and *** at the 5 and 1% level respectively. Standard errors are corrected for clustering by year. Elasticities are evaluated at the mean.

where the dependent variable is the propensity that individual i is on an illegal trip to the United States in year t. L_t denotes the number of linewatch hours the border patrol spends patrolling the border and X_{it} are control variables that affect the illegal migration decision. Since border enforcement, especially the border build-up after 1986, responds to illegal migration flows at the Southwestern border, β_M will be biased toward zero. Reverse causality is one possible explanation for why the deterrence effects reported in the literature are so small.

To explore the merit of this explanation, the above equation is estimated by two-stage least squares. The instrument for enforcement proposed here is the budget of the Drug Enforcement Agency (DEA). According to DEA estimates, a large fraction of drugs smuggled into the United States enter along the Southwestern border. With the *Anti-Drug Abuse Act* of 1988, substantial efforts were undertaken to coordinate and strengthen local, state, and federal law enforcement in the border states, now designated as High Intensity Drug Trafficking Areas. Hence, a larger DEA budget increases border patrol resources, which might intensify or divert the border patrol's efforts to apprehend illegal migrants.

The identifying assumption is that the DEA budget has no effect on illegal migration propensities other than through border patrol enforcement. While ultimately untestable, the assumption is subjected to a series of plausibility checks (reported in Panel Table A1 in the Appendix A). First, the DEA budget does not respond to illegal migration, as the tasks of the DEA are spread over many activities and areas other than the Southwestern border. Regression estimates reveal that the DEA budget, unlike border enforcement, is uncorrelated with current and lagged illegal flows. Reverse causality of the instrument is therefore not a concern.

Further, other factors might affect both illegal migration decisions and the allocation of resources to the Drug Enforcement Agency. Most importantly, one might expect higher wages in the United States to increase both illegal migration and government resources, though the latter is likely to occur with some time lag. Regressions of the DEA budget on observable factors determining

migration, such as average and minimum wages, unemployment and legalization of Mexicans do not exhibit any systematic relationship. In addition to controlling for these observable shifts, the regressions reported below also include a parametric time trend, which absorbs any unobservable shocks that affect migration propensities linearly.

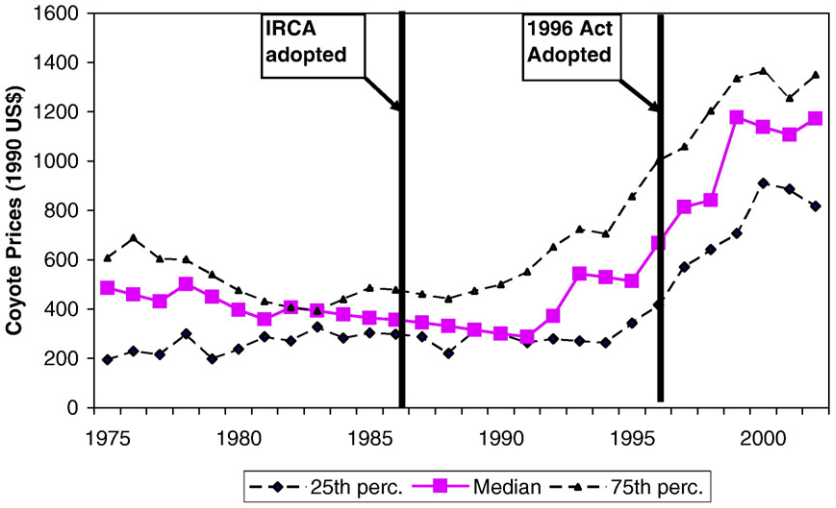
Finally, one might argue that the DEA budget is an omitted regressor in the migration equation rather than a valid instrument. This would be the case if illegal migrants are actively involved in the drug smuggling business, in which case resources to fight drug smuggling would affect the decision to migrate illegally *in addition* to border enforcement. The available anecdotal evidence however refutes this. Accounts from apprehended coyotes and interviews with border patrol personnel suggest that drug smuggling and coyotes are separate businesses. The reason is that information about successful drug routes would otherwise spread quickly, which increases the risk of losing the highly profitable drug business. The first-stage results reported in column (1) of Table 2 corroborates this anecdotal evidence. It shows that a faster growing DEA budget divert time and resources away from illegal migration toward fighting drug trafficking (see Singer and Massey, 1998 for a similar result). This suggests that measures to avoid drug smuggling and illegal migration are substitutes rather than complementary activities.

Columns (2) and (3) in Table 2 report the maximum likelihood and instrumental variable estimates respectively. The effect of enforcement on migration propensities is not statistically significant from zero for any specification. Other variables have the expected sign. Higher earnings prospects in the United States have a large positive, while potential earnings in Mexico a negative effect on the propensity to migrate. Older and more educated individuals are less likely, while family in the United States and prior migration experience encourage illegal migration. From Table 2, one cannot reject the hypothesis that the massive border build-up

Table 3
The price elasticity of coyote demand

	Probit model			Probit-IV	
	Baseline (1)	Add L (2)	1st stage (3)	Probit (4)	Probit-IV (5)
Log Coyote Price (in US$)	−0.002	−0.008		−0.045	−0.38
	(0.030)	(0.031)		(0.035)	(0.167)**
Log Border Enforcement (in 1000 h)		−0.058	−0.126	−0.122	−0.167
		(0.048)	(0.087)	(0.061)**	(0.048)***
Punishment for coyotes (in days)			0.0004		
			(0.0000)**		
Age	−0.003	−0.003	−0.004	−0.016	−0.004
	(0.001)***	(0.001)***	(0.001)***	(0.003)***	(0.001)***
Married	0.017	0.011	0.016	0.077	0.019
	(0.018)	(0.018)	(0.018)	(0.072)	(0.018)
Some primary education	−0.044	−0.051	−0.053	−0.214	−0.053
	(0.015)***	(0.016)***	(0.016)***	(0.065)***	(0.016)***
Primary education	−0.061	−0.069	−0.075	−0.298	−0.078
	(0.022)***	(0.023)***	(0.024)***	(0.087)***	(0.023)***
More than primary education	−0.096	−0.106	−0.113	−0.407	−0.112
	(0.036)***	(0.037)***	(0.040)***	(0.134)***	(0.04)***
Family in the US	−0.011	−0.016	−0.014	−0.069	−0.017
	(0.011)	(0.0100)	(0.010)	(0.042)	(0.011)
US experience of household (in Months)	−0.009	−0.009	−0.009	−0.036	−0.009
	(0.001)***	(0.001)***	(0.001)***	(0.004)***	(0.001)***
Number of domestic migrations	−0.001	−0.002	−0.002	−0.008	−0.002
	(0.002)	(0.002)	(0.002)	(0.009)	(0.002)
Log wage earned in the US	−0.033	−0.022	−0.013	0.015	0.004
	(0.046)	(0.045)	(0.046)	(0.201)	(0.049)
Log wage earned in Mexico	0.098	0.09	0.085	0.314	0.077
	(0.032)***	(0.033)***	(0.038)**	(0.163)*	(0.039)*
Year dummies	Yes	Yes	Yes	Yes	Yes
Sector/district dummies	Yes	Yes	Yes	Yes	Yes
Community of origin dummies	Yes	Yes	Yes	Yes	Yes
Other community characteristics	Yes	Yes	Yes	Yes	Yes
Observations	4039	3913	4384	3920	3920
Log-likelihood	−1631.4	−1566.8		−1581.7	−316.3
R squared			0.98		
Price Elasticity	−0.002	−0.01		−0.05	−0.45

Notes: The left-hand side reports coefficients from a probit model where the dependent variable is whether a coyote is used to cross in a border sector or not. All specifications include year and sector fixed effects and the following controls: age, education, marital status of the migrant, whether he has family in the United States, total migration experience of the household, domestic migration experience, the fraction of males with migration experience, average education level and the fraction of poor and wealthy households in the community and community fixed effects. Column (2) adds log linewatch hours. The right-hand side of the table reports instrumental variable estimates. All specifications include year and court district dummies and the same controls as before. Column (3) shows the first stage, where the dependent variable is the log coyote price and the instrument is the punishment for coyotes. Columns (4) and (5) report maximum likelihood and instrumental variable estimates respectively. Standard errors are bootstrapped and allow for clustering at the sector and year level. Elasticities are evaluated at the mean.



Source: Mexican Migration Project

Fig. 2. Coyote prices increase over time.

has no effect on migration propensities. This lack of deterrence is perhaps less surprising if one considers that illegal migrants might have alternative means to circumvent enforcement rather than foregoing the large gains from migration altogether. These alternative adjustment margins are the subject of the next section.

5. Empirical results

5.1. Price elasticity of smuggler demand

To determine how the demand for coyotes responds to enforcement and prices, the following model is estimated:

$$\Pr(D^E_{ist}=1)=\alpha_E+\beta_E \log P^E_{st}+\delta'_E X^E_{it}+u^E_{it}$$

where the dependent variable is whether a migrant uses a coyote to cross in sector s and year t. Log P^E_{st} denotes the log of smuggling price in sector s and year t, while X^E_{it} represents other variables affecting smuggler demand. These include a set of year and sector fixed effects to absorb aggregate shocks and time-invariant differences in coyote use across sectors. Hence, the estimates are identified from within-sector variation in coyote prices and demand for coyote services. Also included are community fixed effects to account for differences in transportation costs, controls for the wealth and migration experience in the Mexican community and a rich set of migrant characteristics. The parameter of interest is the price elasticity of the demand for coyotes calculated from β_E which is expected to be negative.

Marginal effects from probit model are reported on the left-hand side of Table 3. All standard errors are bootstrapped and allow for clustering by sector and year. The baseline estimates show that coyote prices decrease the demand for smuggling, but the correlation is small and not statistically significant. If enforcement affects the relative benefits of crossing with or without a coyote, border enforcement also has a direct impact on coyote demand even conditional on smuggling prices. If, for example, enforcement is targeted towards coyotes, the risk of apprehension would increase more for smugglers than for self crossers thus reducing coyote demand. Column (2) therefore includes annual linewatch hours as a measure of border enforcement. While the correlation between enforcement and coyote demand is indeed negative, it is also not statistically significant.

The control variables have the expected sign. More educated migrants have a lower propensity to use a coyote. Older migrants with on average more border crossing experience are less likely to use a coyote as are migrants from households or communities with a lot of US migration experience or family in the United States. Wages earned in Mexico in contrast increase the propensity to use a coyote, which suggests that smuggling services are a normal good.

If smuggling prices responds to demand side changes, probit estimates are biased toward zero. Similarly, if coyotes can price discriminate between migrants based on characteristics unobservable to the econometrician, the price elasticity is understated. To address endogeneity and omitted variable concerns, the right-hand side of Table 3 reports instrumental variables estimates. A valid instrument shifts the supply of smuggler services, but has otherwise no direct effect on demand. One candidate suggested by economic theory (see Eq. (1)) is the punishment facing coyotes in case of apprehension measured as the mean prison term in each of the five court districts along the border. As punishment for experts rises, marginal costs of smuggling increases and the supply of

Table 4
Enforcement by Border Sector and Smuggling Prices

	(1)	(2)	(3)	(4)
Log Border Enforcement (in 1000 h)	0.038	0.173	0.27	0.25
	(0.032)	(0.077)**	(0.096)***	(0.097)**
Log enforcement neighboring sectors			0.222	0.241
			(0.102)**	(0.105)**
Age		−0.003	−0.003	−0.004
		(0.002)	(0.002)	(0.003)*
Married		0.024	0.020	−0.005
		(0.039)	(0.038)	(0.039)
Some primary school		−0.038	−0.043	−0.076
		(0.070)	(0.070)	(0.070)
Finished primary school		−0.093	−0.097	−0.156
		(0.071)	(0.071)	(0.074)**
More than primary education		−0.179	−0.175	−0.262
		(0.079)**	(0.080)**	(0.090)***
Indicator whether family in the US		−0.034	−0.034	−0.046
		(0.030)	(0.030)	(0.030)
US experience household members		0.008	0.008	0.006
		(0.003)***	(0.003)***	(0.003)**
Log wage earned in the United States				0.306
				(0.104)***
Log wage earned in Mexico				0.096
				(0.092)
Year dummies	No	Yes	Yes	Yes
Sector dummies	No	Yes	Yes	Yes
Community dummies	No	Yes	Yes	Yes
Community characteristics	No	Yes	Yes	Yes
Observations	2468	2373	2370	2286
R-squared	0.0	0.4	0.4	0.41

Notes: The table reports least squares results where the dependent variable is the log price for smuggling services paid by illegal migrants in a given year. The measure of enforcement is the log number of linewatch hours (in 1000 h) of the border sector, in which the individual crossed the border. Column (2) adds sector of crossing, year dummies and individual characteristics of the migrant (see notes to previous tables for list of variables included). Community fixed effects, the fraction of males with migrant experience, the fraction of poor and richer households as well as the average education level of the community of origin are also added. Column (3) adds the average enforcement of the two neighboring sectors to the specification. Finally, column (4) adds the wage an undocumented migrant would earn in the United States and the wage he could earn in Mexico. Standard errors are bootstrapped and corrected for clustering at the sector and year level.

coyotes decreases because of deterrence and incapacitation effects. The punishment for smugglers however has no direct influence on the demand for smugglers conditional on the other controls.[14]

Column (3) reports the first-stage of the instrumental variable estimates where the dependent variable is the log coyote price in a given court district and year. As expected, tougher punishment for smugglers increases coyote prices. The estimate implies that an increase in punishment by one standard deviation or 162 days is associated with an increase in smuggling prices by 0.065 log points. Columns (4) and (5) show the probit and probit instrumental variable estimates respectively. The instrumental variable estimates of the price effect are negative and larger in absolute value than least squares as expected.[15] Tighter enforcement is associated with lower coyote demand within a sector controlling for prices, which suggests a decrease in the net benefit of using coyotes compared to crossing alone.[16]

The last row reports the price elasticity of coyote demand, which is around −0.5. This is remarkably similar to estimates for illegal drugs ranging from −0.3 to −0.9 (Saffer and Chaloupka, 1995; Van Ours, 1995). Since monopolies always operate in the elastic part of the demand curve ($|\eta_{EP}|>1$), the estimate suggests that coyotes do not act as a collusive monopoly. However, the price elasticity also implies that coyotes can charge a substantial markup if they exert market power.

5.2. The response of coyote prices to the border-buildup

Fig. 2 plots the median, 25th and 75th percentiles over the sample period as reported in the Mexican Migration Project. Coyote prices have tripled from $400 to almost $1200 between 1986 and 2003. Most of the increase is concentrated after 1993, when the

[14] If district courts adjust their sentencing practice to changes in migration flows or a third factor affects both enforcement and sentencing, the instrument is not valid. The instrumental variable estimate is then a lower bound and the true price effect lies between probit and instrumental variable estimates.

[15] The least squares estimates in column (4) differ from those in column (2) as the smuggling price in (4) varies by court district and year, not by border sector and year as in column (2).

[16] This estimate is likely to be understated if enforcement increases in response to a higher demand for coyotes. To avoid this simultaneity bias, one would require an instrument that affects enforcement but not coyote demand directly. Using the Drug Enforcement Agency's budget as an instrument for enforcement, instrumental variable estimates were never statistically significant from zero.

Table 5
Apprehension data and shifts in border crossings

	1992		1998		2004	
	Apprehensions	%	Apprehensions	%	Apprehensions	%
San Diego, CA	565,581	49	248,092	16	126,913	11
El Paso, TX	248,642	22	125,035	7	104,399	9
McAllen, TX	85,889	7	204,257	11	134,185	11
Tucson, AZ	71,036	6	388,612	31	491,771	43
Laredo, TX	72,449	6	103,433	7	75,330	6
Del Rio, TX	33,414	3	131,058	10	68,512	6
El Centro, CA	29,852	3	226,695	15	74,467	7
Yuma, AZ	24,892	2	76,195	6	98,060	9
Marfa, TX	13,819	1	14,509	1	10,538	1
Total	1,145,574		1,643,679		952,863	

Notes: The table reports the number and fraction of apprehended illegal migrants in a border sector per year. Percentages might not add to 100 due to rounding.
Source: Immigration and Naturalization Service; Department of Homeland Security.

border patrol began to seal popular crossing routes. To control for other observable characteristics affecting smuggling prices, the following regression is estimated

$$\log\ P_{ist} = \alpha_p + \beta_p\ \log\ L_{st} + \gamma_p X_{it} + u^P_{ist}$$

where the dependent variable log P_{it} is the log smuggling price reported by migrant i using a coyote in sector s and year t. Log L_{st} denotes log border enforcement in sector s and year t and X_{it} other variables affecting smuggling prices. The coefficient on border enforcement, β_p, measures the elasticity of coyote prices with respect to border enforcement.

The first column of Table 4 shows the raw correlation between border enforcement and coyote prices. Changes in border enforcement are positively correlated with changes in prices, but the correlation is weak and not statistically significant. The second specification adds year, sector and community fixed effects as well as the same controls as in the last section. The correlation between prices and enforcement is now statistically significant, but still small. If migrants are geographically mobile, an increase in enforcement in one sector will however understate the price effect in that sector as migrants switch to less guarded sectors in order to avoid enforcement.

To test the importance of border switching for smuggling prices, column (3) includes the log of mean linewatch hours in the two neighboring sectors. The coefficient on enforcement is now substantially higher and statistically significant. Also, the elasticity of prices with respect to enforcement in neighboring sector is with 0.22 almost as large as the direct effect of enforcement in the same sector (0.27). This provides some evidence that border switching is indeed important. A comparison of changes in raw price within and across sectors confirms this. For example, coyote prices in San Diego increased by 26% (from $388 to $522 after 1986), which is much less than the 35% increase in average prices (from $398 to $610).

Potential earnings in the United States or actual earnings in Mexico can influence coyote prices through an income effect. Column (4) thus adds the log wage earned in the last job in Mexico and the potential wage in the United States to the specification. Both coefficients are positive implying that migrants with more income pay higher smuggling prices. Other variables have largely the expected sign. Migrants with family ties in the United States pay less, while a household's migration experience is surprisingly associated with higher prices. The fact that more highly educated individuals pay less suggests that they might be better able to cross by themselves. Finally, age and marital status have no effect on coyote prices.

The estimates in column (4) imply that the increase in enforcement in each sector by on average 66% or 4100 h/mi since 1986 raise smuggling prices by 16.5% or $68. The increase in enforcement in the neighboring sectors by almost 170% or 5556 h since 1986 raises smuggling prices by an additional $40. Smuggling prices are thus much more responsive to enforcement compared to the illegal drug market (see for example, Miron, 2003; Kuziemko and Levitt, 2004). If the allocation of border patrol officers responds to shifts in the border crossing market and illegal migration flows, the estimate of the price response is a lower bound of the true price effect.[17]

The theoretical framework shows that changes in smuggling prices reflect shifts in marginal costs of coyotes and possibly changes in the markup. If the smuggling market is perfectly competitive, price changes are related to the risk of apprehension by the simple relationship $\Delta P^E = \Delta \text{prob}^E * F$. The median prison term F for smugglers after 1986 was 450 days. Using the mean wage of an illegal migrant in the United States of $4.7, this translates into lost earnings of $11,840. The estimated price change of $108 then suggests that the probability of apprehension for coyotes has changed by only 1%.[18]

[17] In an earlier version (Gathmann, 2006), the Drug Enforcement Agency's budget was used as an instrument for enforcement. The results were very close to the least squares estimates.

[18] This calculation should be considered an upper bound since it abstracts (1) from changes in the markup if coyotes have market power; and (2) from longer prison terms in the late 1990s. One explanation for the small change in risk is that smuggling methods have also become more sophisticated.

5.3. Switching to more remote border sectors

Before enforcement tightened, two-thirds of illegal migrants in the dataset entered the United States along the San Diego or El Paso sector, in particular in the cities of Tijuana and Nuevo Laredo. Between 1986 and 2003, the fraction of migrants entering through sectors other than California increased from 30% to 46%. Migrants also substituted within each sector from crossing in cities to more rural areas. While 93% of migrants crossing in the San Diego sector did so in Tijuana prior to 1993, this fraction declines to 70% after 2000.

Aggregate apprehensions support this pattern: Table 5 shows that apprehensions in the most popular crossing sectors, San Diego and El Paso, have declined dramatically both in absolute numbers and as a fraction of total apprehensions. Whereas in 1992, 71% of apprehensions occurred in San Diego and El Paso, by 2004 the number had dropped to a mere 20%. In contrast, apprehensions in Arizona, where enforcement has traditionally been low, have jumped from 8% in 1992 to 52% in 2000.

To assess whether these switches are related to enforcement, Table 6 reports marginal effects from a probit model, where the dependent variable is whether the migrant switched border crossing sectors between trips. Since this restricts the sample to repeat migrants, the number of observations is smaller than in previous tables. All specifications include year and sector fixed effects, while columns (2) and (3) add the same community and individual variables as before. Standard errors are bootstrapped and allow for clustering at the sector and year level.

The results demonstrate that enforcement in a sector has a strong influence on a migrant's decision to switch border sectors. The elasticity of geographic substitution reported in the last row implies that increasing enforcement in the sector of the previous trip by 10% raises the likelihood of switching by 5.5%. Hence, the border build-up after 1986 (0.786 log points) is associated with an increase in border switching by 7.9 percentage points or 37% compared to the pre-1986 period.

Reported crossing attempts support the view that migrants switched from high to low enforcement sectors. Tighter enforcement, if effective, should increase the probability of apprehension and therefore the number of border crossing attempts. However, if migrants substitute toward less patrolled areas, this reduces the impact of enforcement. In the data, the overall number of attempts actually decreased from 1.54 before 1986 to 1.35 after 1986 (T-statistic: 4.9), a reduction of 12%. Since border crossing attempts also decrease for the same migrant conditional on individual characteristics and year and sector fixed effects, the observed decrease is not driven by selection along the migration margin.

Table 6
Illegal migration and sectoral switching

	(1)	(2)	(3)
Log Border Enforcement (in 1000 h)	0.086	0.1	0.1
	(0.036)**	(0.035)***	(0.036)***
Age		−0.004	−0.004
		(0.001)***	(0.001)***
Married		0.006	0.005
		(0.016)	(0.018)
Some primary school		−0.045	−0.05
		(0.034)	(0.038)
Finished primary school		−0.055	−0.058
		(0.035)	(0.040)
More than primary education		−0.019	−0.018
		(0.040)	(0.048)
Indicator whether family in the US		0.028	0.025
		(0.018)	(0.018)
US experience household members		−0.02	−0.02
		(0.003)***	(0.003)***
Domestic migrations?		0.001	0.001
		(0.004)	(0.004)
Log Wage Earned in the United States			0.039
			(0.077)
Log Wage Earned in Mexico			−0.028
			(0.054)
Year dummies	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes
Community dummies	No	Yes	Yes
Community characteristics	No	Yes	Yes
Observations	2584	2314	2247
Log-likelihood	−1231.4	−999.1	−968.8
Elasticity of geographic substitution	0.45	0.57	0.57

Notes: The table reports marginal effects from a probit model where the dependent variable is whether a migrant crossed the border in a different sector than on his previous trip. The main independent variable is log enforcement in the sector the migrant crossed on the previous trip. All specifications include year and sector fixed effects. Standard errors are boostrapped and account for clustering at the sector and year level. Column (1) reports the baseline specification without any individual controls. Column (2) adds the migrant's age, marital status, education, whether he has family in the US, the US experience of the household, whether he has any domestic migration experience as well as community dummies and controls for migration experience, education and wealth level in the migrant's community of origin. Column (3) also includes the wage earned in Mexico and the United States. The last row reports the elasticity of substitution evaluated at the mean.

This decline in crossing attempts is a rationale response if the new crossing routes are more dangerous as suggested by the six fold increase in the death toll at the border between 1994 and 2000 (Reyes et al., 2002; Cornelius, 2001). Today, around 500 illegal migrants die each year during their attempt to cross the border, which is equivalent to 1.2 deaths for each 1000 border crossing attempts. These numbers are conservative, as they only include bodies detected by the U.S. border patrol or the Mexican police.[19] A look at the causes of border deaths confirm that the increase is related to changing migration patterns. For example, 67 persons died along the Californian border due to hypothermia or heat stroke in 1998 compared to only two in 1994. In contrast, other causes like accidents or homicides declined or remained constant (Eschbach et al., 2003).

5.4. Robustness checks

A variety of corroborating validity tests bolster this paper's findings (see Gathmann, 2006 for the results). Specifically, the response of coyote demand and prices to enforcement are similar if fixed effect models are estimated to account for unobserved heterogeneity among migrants. Similarly, the enforcement effect on coyote prices remains unchanged if one controls for quality differences in coyote services, by including whether an expert user is apprehended on the current trip.[20]

Since the wave of legalization after 1986 allowed many repeat migrants to become legal residents, the pool of illegal migrants became less experienced over time. The data reveal that first-time migrants are both more likely to use coyotes and less price-sensitive. Since the actual shift in coyote use is small, legalization cannot account for the limited effect on coyote demand reported above. Furthermore, changes in coyote prices for first-time migrants are very similar to those for repeat migrants and can thus not explain the price effect of enforcement. Legalization might also increase or decrease the propensity to migrate independently of enforcement. An analysis of first-time migrants after the legalization wave however shows that coyote demand and prices reveal similar patterns than in the whole sample.

To account for compositional changes along the migration margin more generally, parametric and semi-parametric selection models are estimated. Using a fruit and vegetable price index as exclusion restriction in the migration equation, the estimates for both coyote demand and prices are somewhat smaller in absolute terms. This result suggests that enforcement deters migrants paying low smuggling prices, which is consistent with evidence that observed labor market skills of illegal migrants have increased (Orrenius and Zavodny, 2005).

Finally, some studies suggest that the border build-up encourages illegal migrants to settle permanently in the United States (Massey et al., 2002; Reyes et al., 2002). This affects the border smuggling market if permanent migrants differ from temporary illegal migrants. However, evidence based on the nonrandom sample of permanent migrants interviewed by the Mexican Migration Project in the United States shows that the enforcement effect on prices and price elasticity of demand are similar in magnitude to those reported for temporary migrants. Taken together, this evidence implies that the border build-up was itself responsible for the observed changes in the border crossing market.

6. Conclusion

Enforcement efforts of the border patrol almost quadrupled between 1986 and 2004. Using data on illegal Mexican migrants combined with aggregate enforcement statistics, this article analyzes the effects of this dramatic policy shift on the illegal border crossing market. Like the previous literature, the deterrence effect is found to be small even after accounting for endogeneity in enforcement. The border-buildup after 1986 has however raised smuggling prices by 17%, which in turn has decreased the demand for coyotes. In addition, tighter enforcement pushed migrants to less patrolled sectors where crossing conditions are more difficult and smuggling prices higher. While substitution away from well guarded crossing routes has decreased the migrant's risk of apprehension, it has increased the health risks and time costs of crossing. Both aggregate apprehension data and the Mexican Migration Project reveal that the impact of enforcement on the choice of crossing sector is large.

Anecdotal evidence suggests that crossing the border can now take between 3 to 6 days in remote areas even without apprehension. If crossing the border requires four days instead of one, the additional time cost is $80–90 in foregone earnings. Using a coyote to cross in remote areas is also more expensive. The mean difference between high and low enforcement sectors after 1993 adds another $55. Without considering the costs of increased health risks, substitution to remote sectors increases migration costs by $135–145. This is twice the $68 price increase due to higher enforcement within the same sector.

Overall, these results imply that the deterrence effect of the current policy is low. The large gains from illegal migration, about three times higher wages in the United States, compensate for the additional migration costs, which are roughly equivalent to additional ten working days. More generally, the findings demonstrate that policies that ignore low-cost alternatives to the targeted behavior, here illegal migration, are limited in scope and ultimately without success.

[19] In the words of an illegal migrant: "[..] since you can no longer cross the line in Tijuana, you have to go through the desert, where you have to walk three or four or six days and sometimes even more. And in the desert, you run out of water, of food, of everything, because you can't carry much, because of the distance. The safer routes are longer, you have to walk longer and although it's safer it's uglier, with more desert. And the heat is intense, and the water runs out"(Reyes et al., 2002).

[20] The results (available upon request) are also not sensitive to functional form assumptions: estimates based on linear probability or logit models were very similar to the probit estimates reported here.

Appendix A. Data

The Mexican Migration Project is a repeated cross-sectional survey conducted annually since 1982 (except 1984 to 1986). Fieldwork proceeds on a state-by-state basis starting from the core migrant-sending region in west-central Mexico, later extended to include newer sending regions in the southwestern and northern part of Mexico. The sampled communities cover isolated rural towns and large farming communities as well as big metropolitan areas. The data includes information on migration experience, wages earned in the United States and on the last formal job in Mexico, detailed demographic information and business holdings in Mexico. For household heads, a history of illegal migration to the United States, including the price for a coyote if used, the border crossing sector and number of apprehensions at the border is compiled. Less than 10% of illegal migrants report missing values on coyote use or do not remember where they crossed the border, but almost 30% do not recall the price paid.[21] The sample is restricted to household heads between age 16 and age 55 with valid information on age, education, Mexican wage and workers with positive earnings in the United States if a migrant. Women are excluded from the analysis since few women migrate and their migration decisions are driven by other factors than male migration. The consumer price index with 1990 as the base year is used to deflate wage and price data. Variables denoted in Mexican pesos are adjusted by the exchange rate taken from the International Financial Statistics.

Enforcement is measured as the number of linewatch hours the border patrol spends patrolling in each of the nine border sectors from 1976 to 2004. The punishment data is taken from the Federal Court Cases Data Base (1970–2004). Mean prison terms for immigration violations (illegal entry and reentry) and smuggling aliens in each year and each of the five district courts at the Southwestern border (California South, New Mexico, Arizona, Texas South and Texas West) were constructed and matched to the border patrol sectors.

Wages in Mexico are reported only for the last job held. Therefore, wages earned in previous jobs are predicted from a standard Mincer regression with education, experience, experience squared, dummies for the year and state of residence, marital status and occupational dummies as regressors. The same procedure is used to predict wages in the United States for individuals migrating in that year, since only wages for the first and last trip are observed in the data. A parametric selection model is used to construct potential U.S. wages for those not migrating. The participation equations include the number of members, children and minors in the household and whether the father and mother ever migrated, the migrant's education, age and state of residence as regressors. The existence of family members in the United States, which raises migration propensities, is used as an exclusion restriction.

Table A1
Robustness analysis

Panel A: Coyote Demand	Fixed effects			Selection model		Permanent migrants		
	1st stage (1)	FE (2)	FE-IV (3)	Parametric (4)	Semi-P. (5)	1st stage (6)	OLS (7)	IV (8)
Log Coyote Price (in US$)		−0.026	−0.206	−0.04	0.014		−0.091	−0.446
		(0.022)	(0.105)*	(0.032)	(0.035)		(0.071)	(0.473)
Punishment for Coyotes (in days)	0.203					0.12		
	(0.016)**					(0.033)**		
Observations	4266	4266	4266	104,931	108,098	796	796	796
R-Squared	0.64	0.06	0.27			0.8	0.32	0.3
Price Elasticity		−0.03	−0.26	−0.06	0.02		−0.11	−0.52
Panel B: Smuggling Price	FE	After		Selection Model		Permanent	First-time	Repeat
	Estimates (1)	IRCA (2)	Migration (3)	Parametric (4)	Semi-P. (5)	Migrants (6)	Migrants (7)	Migrants (8)
Log Sectoral Enforcement	0.091	0.071	0.019	0.104	0.113	0.177	0.024	0.063
	(0.076)	(0.242)	(0.095)	(0.105)	(0.093)	(0.325)	(0.158)	(0.052)
Log Enforcement Neighboring Sectors	0.296	−0.13		0.136	0.140	0.299		
	(0.342)	(0.243)		(0.099)	(0.102)	(0.372)		
Observations	2256	298	105,068	105,066	105,066	555	764	1526
R-squared	0.15	0.71				0.4	0.56	0.4

Notes: Panel A reports robustness checks for coyote demand, while Panel B for coyote prices. All specifications include year and community fixed effects as well as the same controls as in previous tables including log wages. The instrumental variable estimates (columns (1), (3), (6) and (8) of Panel A) estimates include court district fixed effects, while all others include border sector fixed effects. Column (1)–(3) of Panel A and column (1) in B show fixed effects estimates. Column (2) in Panel B restricts the sample to first-time migrants after 1989. Columns (3)–(5) in Panel B and (4)–(5) in Panel A show results from a selection models to control for composition changes in the population of illegal migrants. The first specification uses the inverse Mills ratio and the second a polynomial in the propensity score. Columns (6)–(8) in Panel A and column (6) in Panel B report results for the nonrandom sample of permanent migrants in the United States, while the last two columns in Panel B separate results for first and repeat migrants. Standard errors are corrected for clustering.

[21] Data from the *Encuesta sobre Migracion en la Frontera Norte de Mexico* (EMIF) were used to check the consistency of reported coyote prices and illegal border crossings. EMIF is a repeated cross-sectional survey asking migrants about their experience at eight locations along the Southwestern border since 1993. While reported coyote prices were lower than in the Mexican Migration Project, the distribution of prices and migration propensities across border crossing sectors were very similar in the two data sets.

Table A2
Validity tests for border enforcement instrument

	DEA (1)	Linewatch (2)	DEA (3)	Linewatch (4)
Illegal Migration Rate	1.243	18.099		
	(2.011)	(6.115)***		
Illegal migration rate ($t-1$)			3.114	7.117
			4.111	(3.656)**
Illegal migration rate ($t-2$)			−4.03	−5.04
			(4.295)	(3.525)
Linear time trend	Yes	Yes	Yes	Yes
Observations	29	29	27	27
R-squared	0.93	0.86		
Granger causality (p value)			0.632	0.043

	DEA (1)	Linewatch (2)
US average wage	−0.001	0.074
	(0.039)	(0.031)**
US minimum wage	0.138	0.428
	(0.179)	(0.323)
US unemployment	−0.0166	−0.152
	(0.044)	(0.074)**
Mexicans legalized	0.0001	0.0000
	(0.000)	(0.000)
Mexicans naturalized	0.0000	0.0000
	(0.000)	(0.000)
Mexican population	−0.00003	0.0001
	(0.0001)	(0.0001)
Mexicans legalized (IRCA)	−0.00001	0.00000
	(0.0000)	(0.0001)
Linear time trend	Yes	Yes
Observations	28	28
R-squared	0.89	0.69

Notes: The table reports several validity tests for the instrument of border enforcement used to identify the deterrence effect. All specifications use annual observations and include a linear time trend. Columns (1) and (2) show the partial correlation of the log DEA budget and log linewatch hours with the illegal migration rate in the same year respectively. Columns (3) and (4) report the estimates of a VAR model and the p value of the Wald test of Granger-noncausality. Panel B reports estimates of the log of DEA budget (column (1)) and log linewatch hours (column (2)) on observable push and pull factors of illegal migration. Standard errors are reported in parentheses.

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