Internal Migration and Drug Violence in Mexico

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Banco de México, August 2019

Mexico and the International Drug Trade

- Mexico's illegal drug trade is economically large and has externalities through violence
- US illegal drug market estimated at 67bn USD in 2005, $\approx 5\%$ of Mexico's GDP (RAND Corp, 2009)
- Compare auto manufactures: 3% of GDP today
- How large are the externalities?

Research question

- How does drug violence affect the spatial distribution of people in Mexico?
- How costly is violence for workers in violent places?
- Are there spillovers to nonviolent places?

This talk

- Reduced Form: Migration and Violence
- Structural Model and Estimation
  - Labor supply to municipalities
  - Local labor demand
  - Local housing supply

Contribution

- Use a spatial equilibrium model to study the effects of increased violence in Mexico
- Identify preference parameters and estimate welfare changes using individual migration choices
- Instrument for violence using cartel conflict over time

Data

Municipality level data, whole country:

1. Individual level from from Census, $t = 2000, 2010, 2015$
   - Municipality of residence in $t - 5$
   - Education level
   - Homeownership Status
   - Wage and employment by occupation
2. Municipality level homicide rate from National Statistics Office (INEGI), 1998-2015
3. Drug traffic locations from DEA National Drug Threat Assessment maps
4. Municipality level employment shares by sector, from Intercensal Survey (Conteos) $t = 1995$ and Economic Census, $2004, 2009$,

Rent and home characteristics from ENIGH, 2010 (not for all municipalities)

Homicide rate increased after 2007

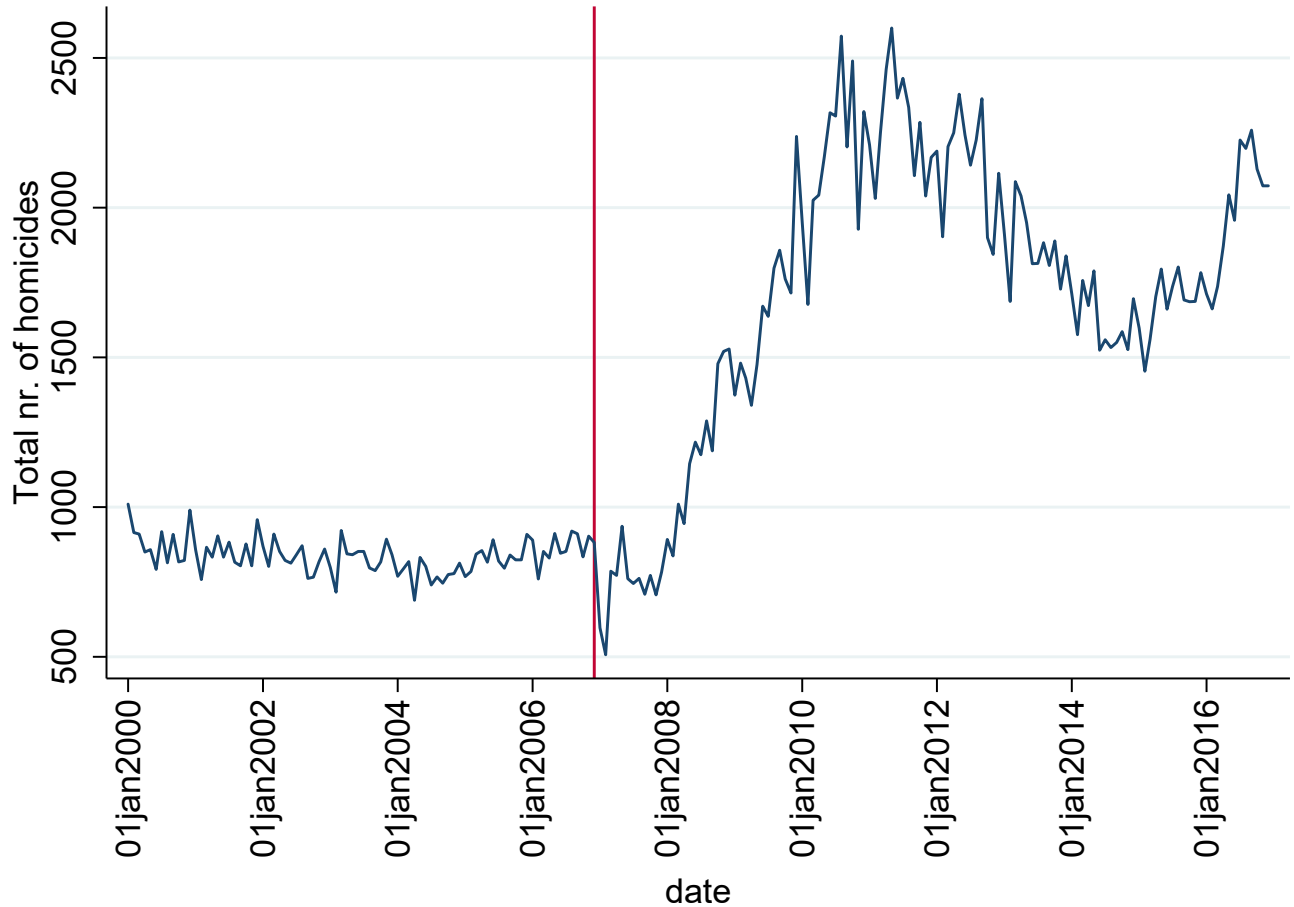


Figure: Monthly homicides in Mexico, 2000-2016

Spatial concentration of homicides

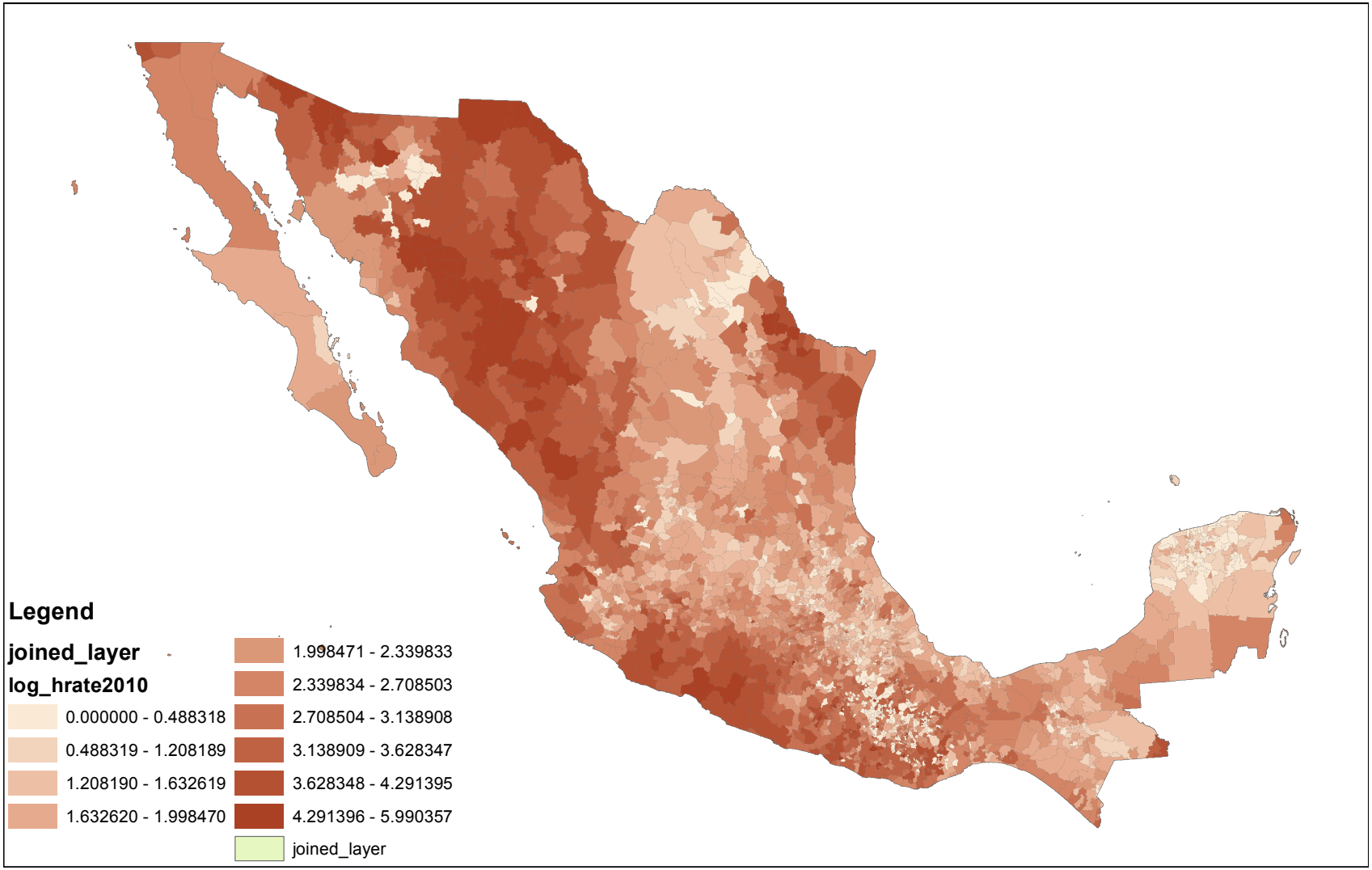


Figure: Log homicide rates per 100 thousand, 2010

Drug murders

- Drug related homicides increase fear and sense of insecurity, and hinder daily activities (Gutierrez Romero, 2016, Flores & Atuesta, 2018, Villareal, 2017)
- Migration lets individuals decrease their exposure to violence

Summary stats

	(1) 1995 to 2000 mean/sd	(2) 2005 to 2010 mean/sd	(3) 2010 to 2015 mean/sd
Homicide rate	12.55	13.95	20.50
	19.33	24.21	35.57
Total homicides	10859.28	14315.22	23881.15
	38349.05	87685.10	112930.58
Internal migrants, thousands	5644.82	6659.55	6390.56
	22469.91	22332.92	20710.80
Observations	2468	2468	2468

Table: Summary statistics, violence and internal migration

Estimation equation

- Let j index municipalities and t census waves
- Let $Y_{jt} \in \log(\text{inflows})_{jt}, \log(\text{outflows})_{jt}$
- Want to estimate

$$Y_{jt} = \alpha_t + \gamma_j + \delta X_{jt} + \beta \log(\text{homicide rate})_{jt} + \xi_{jt}$$

- Plot residuals to relate $\log(\text{homicide rate})_{jt}$ and

Homicide rate and inflows

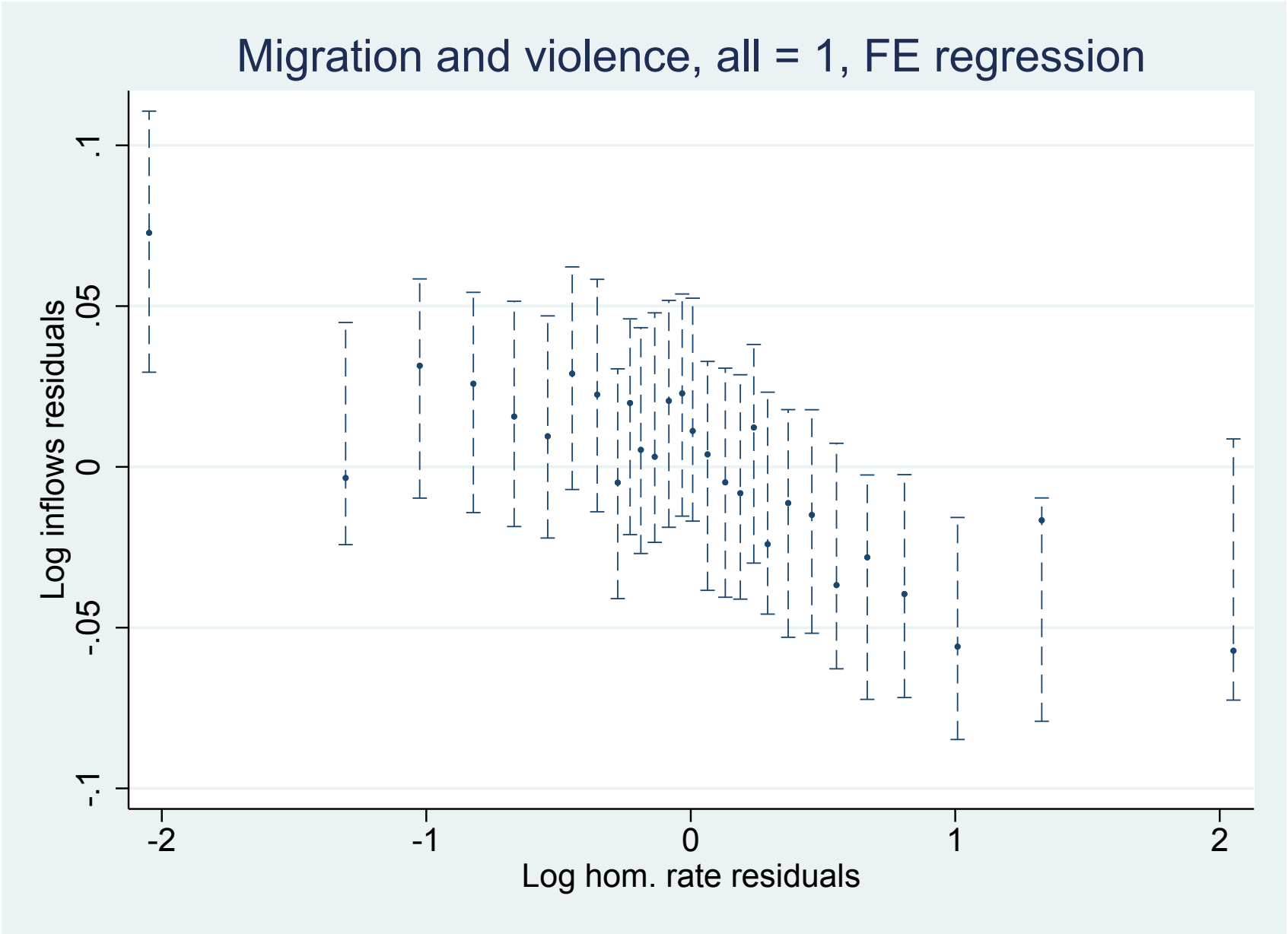


Figure: Binscatter: Log inflows and log homicide rate

Homicide rate and outflows

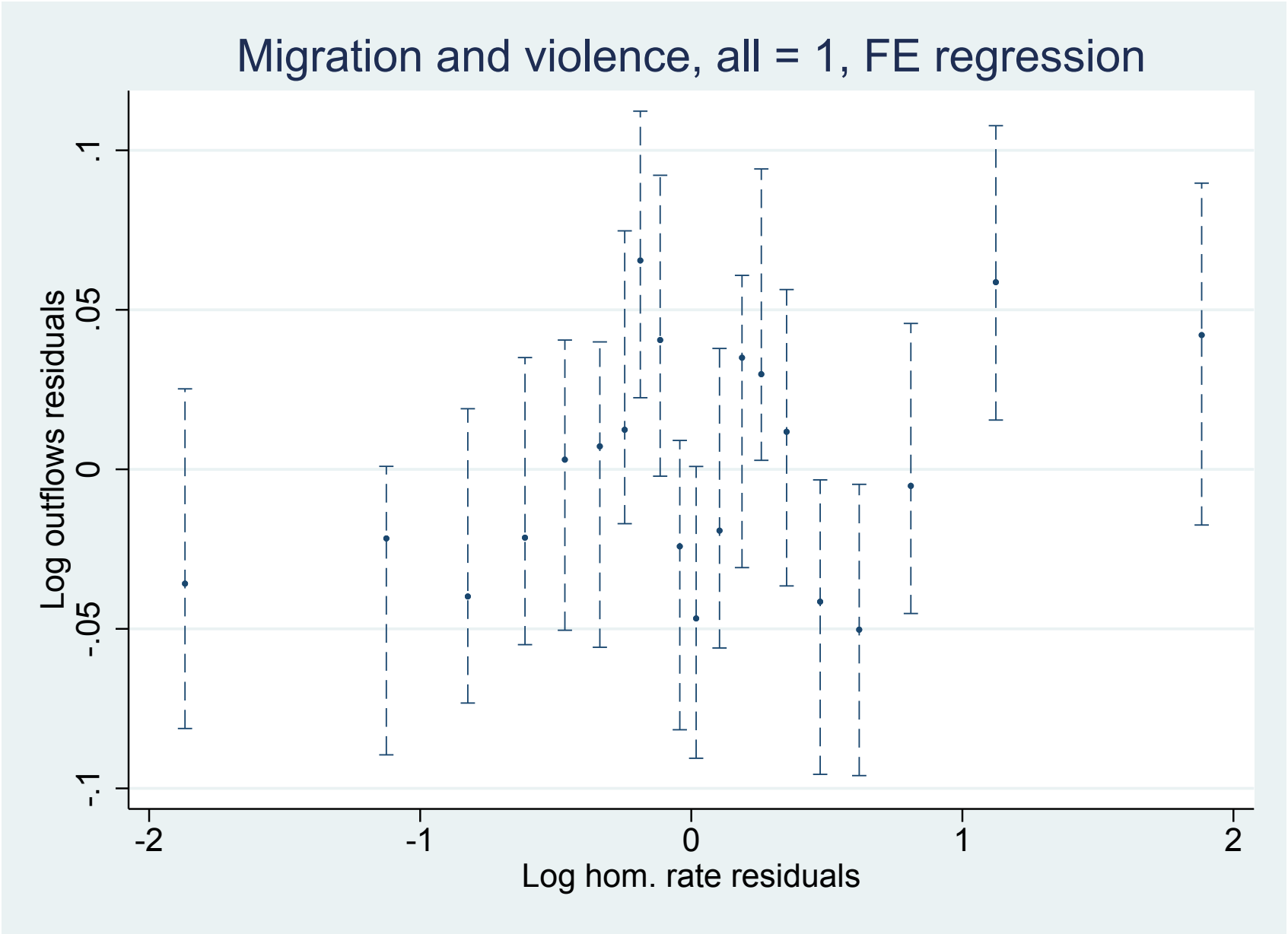


Figure: Binscatter: Log outflows and log homicide rate

Instrumenting Violence

- Violence is not exogenous in the migration equation
- Migration also responds to local labor markets
- Local unobserved institutions also likely to affect both violence and migration
- We need instrumental variables

Contested drug routes

- Violence is larger on contested traffic routes
- Traffic routes are mostly static, but the conflicts change over time
- A municipality finds itself on a contested route when it is between drug origins and destinations of fighting cartels - plausibly independent of local characteristics
- We construct an instrument that captures these changes in the geographic pattern of violence over time

Route conflict

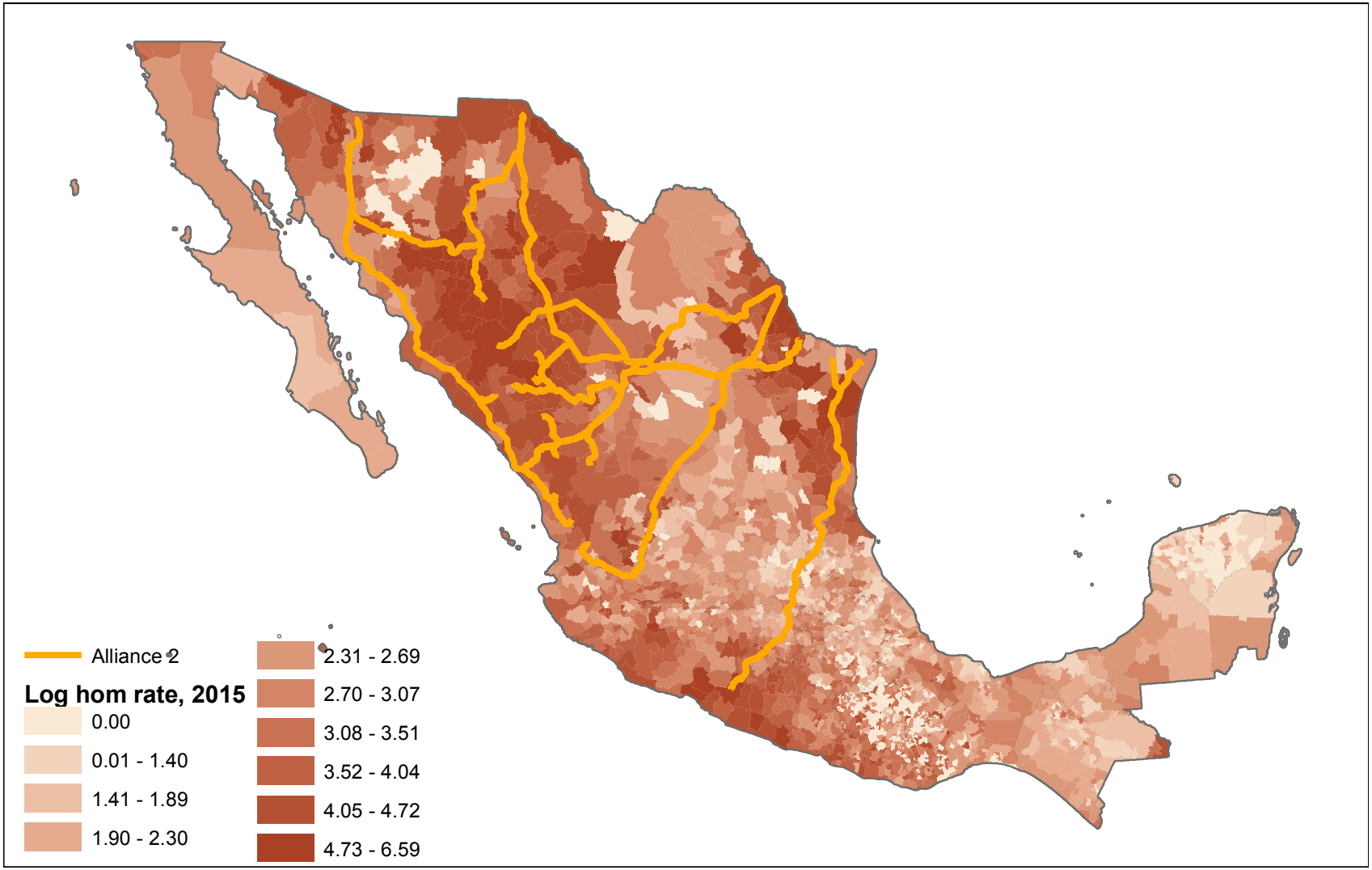


Figure: Poppy seed routes in 2015 and the homicide rate, Alliance 1

Route conflict

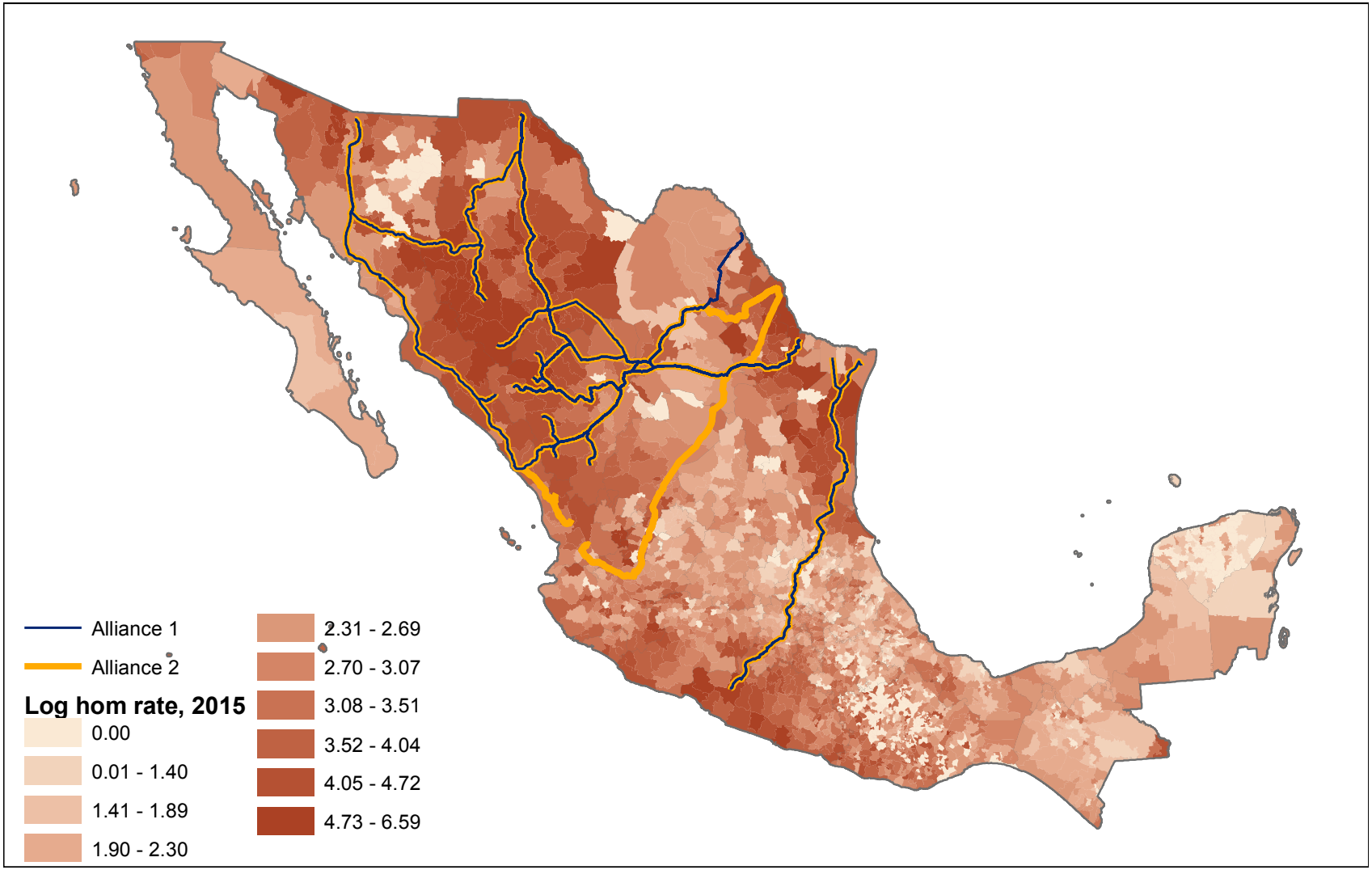


Figure: Poppy seed routes in 2015 and the homicide rate, Alliance 1 and 2

Drug Routes

- Let
  - $a_t \in \{1, 2, 3, 4\}$ index cartel alliances at time t
  - d index drugs: marihuana, poppy, cocaine
- Let $O_{a_t,d}$ the set of municipalities that produce or import drug d and where a_t has presence.
- Presence data from DEA's National Drug Threat Assessment maps
- Identify producing municipalities using
  - Field destruction as measured by SEDENA, for marihuana and poppy seed
  - Ports with significant cartel presence, for cocaine
- Let D_{at} be the set of points of entry into the US where a_t has presence

Drug routes

- We model drug routes r_{at}^{d} as the path over federal highways between each of a_t's drug d origin locations and the closest destination where a_t is present
- Let j index municipalities, and t time
- We define our instruments Z_{jt}^{d} as follows

$$Z_{jt}^{d} = \sum_{\tau=t-5}^{t} \sum_{a} \mathbb{1}(\text{j is 40 km or less from } r_{a\tau}^{d})$$

- We exclude origins and destinations from the analysis

Identification

- In a panel with outcome $Y_{jt} \in \{\log(\text{inflows})_{jt}, \log(\text{outflows})_{jt}\}$, we want to estimate

$$Y_{jt} = \alpha_t + \gamma_j + \delta X_{jt} + \beta \text{violence}_{jt} + \xi_{jt}$$

- If Z_{jt}^d is a valid instrument then $E(\xi_{jt} Z_{jt}^d) = 0$
- Identification condition is that route and non route municipalities would have similar migration patterns keeping violence constant

Migration Subgroups

- We study migration behavior separately for :
- Homeowners
  - Expect owning a home increases the opportunity cost of moving
  - Large share of homeowners : 67% (INEGI, 2015)
- Skilled workers
  - More mobile on average
  - Productive spillovers

Descriptive Panel Regressions

Log Outflows

	All	Unskilled	Skilled	Non homeowners	Homeowners
OLS: Log homicide rate	0.0148	0.0264*	-0.0167	0.00515	0.0165
	(0.0129)	(0.0124)	(0.0149)	(0.0165)	(0.0139)
IV: Log homicide rate	-0.0715	-0.0299	0.252***	-0.106	-0.179***
	(0.0462)	(0.0456)	(0.0646)	(0.0553)	(0.0536)
Observations	7049	7049	7049	7049	7049

Log Inflows

	All	Unskilled	Skilled	Non homeowners	Homeowners
OLS: Log homicide rate	-0.0299***	-0.0413***	-0.0235	-0.0438***	-0.0300***
	(0.00733)	(0.0112)	(0.0137)	(0.0101)	(0.00791)
IV: Log homicide rate	-0.193***	-0.313***	0.171**	-0.285***	-0.271***
	(0.0360)	(0.0470)	(0.0663)	(0.0457)	(0.0460)
Observations	7049	7049	7049	7049	7049

Municipality year level regression. Includes municipality and year fixed effects. Standard errors in parentheses, clustered at the municipality level. Homicide rate measured as homicides per hundred thousand, averaged over previous five years

IV Results

- No effects on outflows , except for skilled
- Increase of 1% in mean homicide rate decreases inflows by .19%
- Again points to violence as disamenity , but not larger than moving costs - except for skilled
- IV effects larger than OLS - randomly assigned violence has larger effects than equilibrium assignment
- Suggests previous sorting of population by sensitivity to violence

Identification Checks

- Route and non route municipalities should have similar migration patterns keeping violence constant
- We can check whether this holds in 2000, before violence increased

Identification Checks

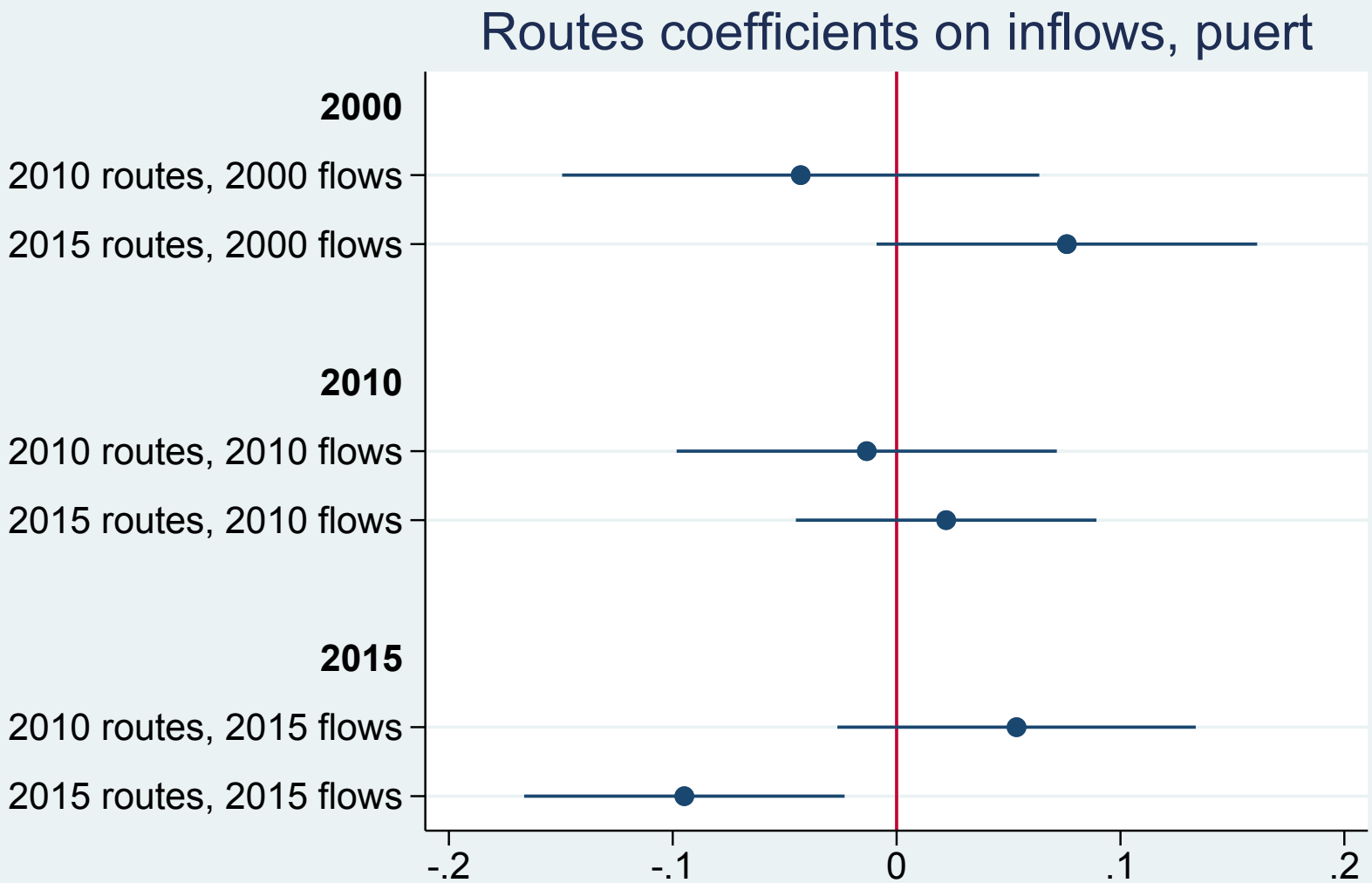
- Define, for each d, and $t = 2010, 2015$

$$\overline{route}^{d}_{jt} = \mathbb{1}(Z_{jt} \text{ above median within year t})$$

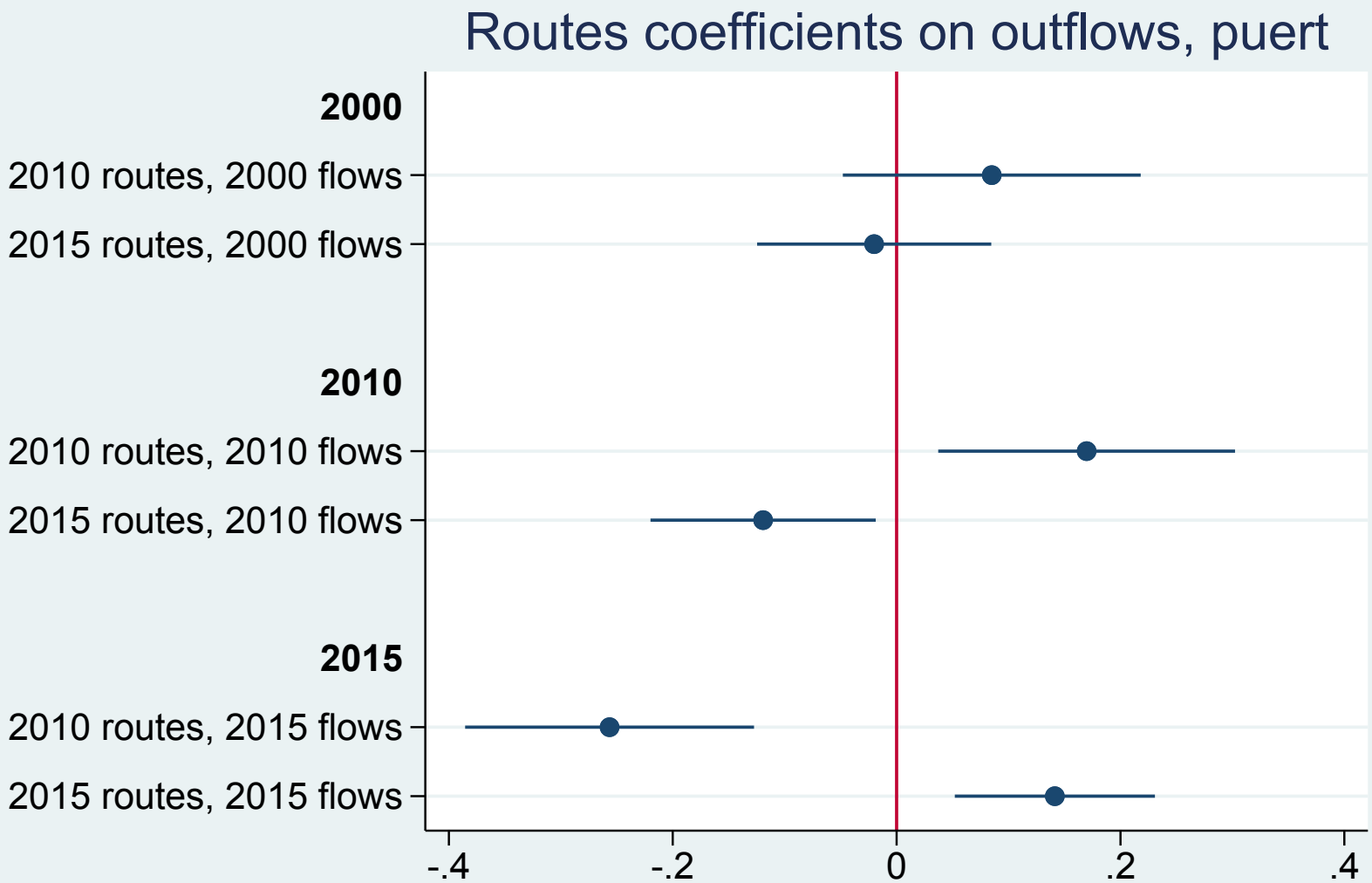
$$\begin{aligned} Y_{jt} = {} & \alpha_t + \gamma_j + \delta X_{jt} \\ & + \beta_1 \mathbb{1}(t = 2000)\ \overline{route}^{d}_{j,2010} + \beta_2 \mathbb{1}(t = 2000)\ \overline{route}^{d}_{j,2015} \\ & + \beta_3 \mathbb{1}(t = 2010)\ \overline{route}^{d}_{j,2010} + \beta_4 \mathbb{1}(t = 2010)\ \overline{route}^{d}_{j,2015} \\ & + \beta_5 \mathbb{1}(t = 2015)\ \overline{route}^{d}_{j,2010} + \beta_6 \mathbb{1}(t = 2015)\ \overline{route}^{d}_{j,2015} + \xi_{jt} \end{aligned}$$

- If route locations were similar in the pre-violence period, $\beta_1, \beta_2 = 0$
- If routes generated out migration, $\beta_3, \beta_6 \neq 0$

Identification Checks



Identification Checks



Why we need a model

- Reduced form misses key features of migration choice:
  - System of cities: migration flows depend on relative characteristics and not absolute characteristics
- A structural spatial equilibrium model solves both problems, and lets us make welfare statements
- Canonical Rosen Roback welfare accounting method in urban economics would look at changes in land rent
- Evidence of moving costs and bad rent data rules this out

How to study a local amenity change?

In spatial equilibrium, following Moretti (2011), a local amenity decrease in municipality j affects:

- Workers in j:
  - Marginal workers move and pay the moving cost
  - Inframarginal workers live with the decreased amenity, higher wages, and lower rents
- Workers in destinations:
  - Live with lower wages and higher rents
- Landowners see rents decrease in j and increase at destinations
- How large is each of these effects?
- This is an empirical question

How we study each mechanism

- Labor supply: estimate discrete choice model

$$\begin{aligned} V_{ijt} &= \delta_{jt} + \beta_c move_{ij} + \epsilon_{ijt} \\ \delta_{jt} &= \beta_v viol_{jt} + \beta_w w_{jt} + \eta_j + \xi_{jt} \end{aligned}$$

- Labor demand: estimate reduced form

$$wage_{jt} = \alpha_t + \gamma_j + \beta_w^d empl_j + X_{jt} + \xi_{jt}^d$$

- Housing supply:

$$rent_j = \alpha^h + \beta^h empl_j + \xi_t^h$$

- $i \sim$ individuals
- $j \sim$ locations
- $t \sim$ years, 2000 and 2010

Labor Supply: Revealed Preference

- Individuals reveal their preference for municipality characteristics when they choose where to live
- Migration choices identify utility parameters associated with violence, wages, rents, cartel presence, and moving
- Migration affects municipality characteristics, and might be correlated with unobservables –we need to instrument for wages and violence (at least)

Labor supply: Model following Diamond (2016)

Individual i, from group g living in municipality j in period t gets utility V_{ijt}^g:

$$\begin{aligned} V_{ijt}^g = \beta_v^g viol_{jt} + \beta_w^g w_{jt}^g \\ + \beta_c^g move_{ij} \\ + \eta_j + \xi_{jt} + \epsilon_{ijt} \end{aligned}$$

where:

- $viol_{jt}$ is log homicide rate in j at t
- w_{jt}^g is mean monthly wage fro group g in j
- $move_{ij}$ indicates whether i needs to move to live in j
- ξ_{jt}, η_j are unobserved
- ϵ_{ijt} is distributed Type I EV for all individuals

Labor supply: Model following Diamond (2016)

- Group all municipality-level variables into a mean utility level δ_{jt}^{g}

$$\delta_{jt}^{g} = \beta_{v}^{g} viol_{jt} + \beta_{w}^{g} w_{jt} + \eta_{j} + \xi_{jt} \tag{1}$$

so that:

$$V_{ijt}^{g} = \delta_{jt}^{g} + \beta_{c}^{g} move_{ij} + \epsilon_{ijt} \tag{2}$$

- Estimate δ_{jt}^{g}, β_{c}^{g} using multinomial logit and individual migration data, separately for each Census year.
- δ_{jt}^{g}, β_{c}^{g} identified from the share of population in each location, and the share of movers

Labor supply: IV estimation

- Estimate eq 1 using IV

$$\delta_{jt} = \beta_v viol_{jt} + \beta_w w_{jt} + \eta_j + \xi_{jt}$$

- We instrument wages using Bartik shocks, following the literature
- Bartik shocks are interactions of sector employment shares at the start of the period and national sector growth rates
- If a municipality has a large share of a sector that will grow, it will receive a positive labor demand shock

Labor supply: Instruments

- Equivalent to using employment shares by sector at the start of the period as instruments (Goldsmith Pinkham et al 2018)
  - Down the road will check which sectors provide identification
- We instrument for violence using contested drug traffic routes, as before

Labor supply: IV results, unskilled

Table: Utility coefficients

	(1) Unskilled
Log homicide rate	-0.0496**
	(0.0201)
Log wage	0.145*
	(0.0809)
Observations	6999

Standard errors in parentheses clustered at the municipality level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Sanderson -Windmeijer F test rejects model is underidentified or weakly identified.
Sargan Hansen J test rejects moment conditions hold or effects are homogeneous

Labor supply: Willingness to Pay

Table: Willingness to pay for violence, moving, in wage percentage

$WTP_{violence}$	WTP_{moving}
-.34	-70.5

- Unskilled workers willing to accept 1% lower wages to live with 3% lower homicide rate
- These are economically important for households
- Mean monthly wage: 3.982 thousand pesos
- Increase in mean homicide rate between 2010 and 2015: 46%

Counterfactual

- With the estimated model, we can ask what a counterfactual world, keeping violence at 2000 levels, is like
- How many less movers?
- How much less moving cost paid?
- How much less cost of exposure to violence?

Labor Supply: Overall costs

Table: Overall costs of violence, keeping everything else fixed

Cost	Estimate	Units
Displaced	97.26	Population (thousands)
Moving cost for displaced	32274.97	2010 pesos (millions)
Cost of exposure to violence	53027.44	2010 pesos (millions)

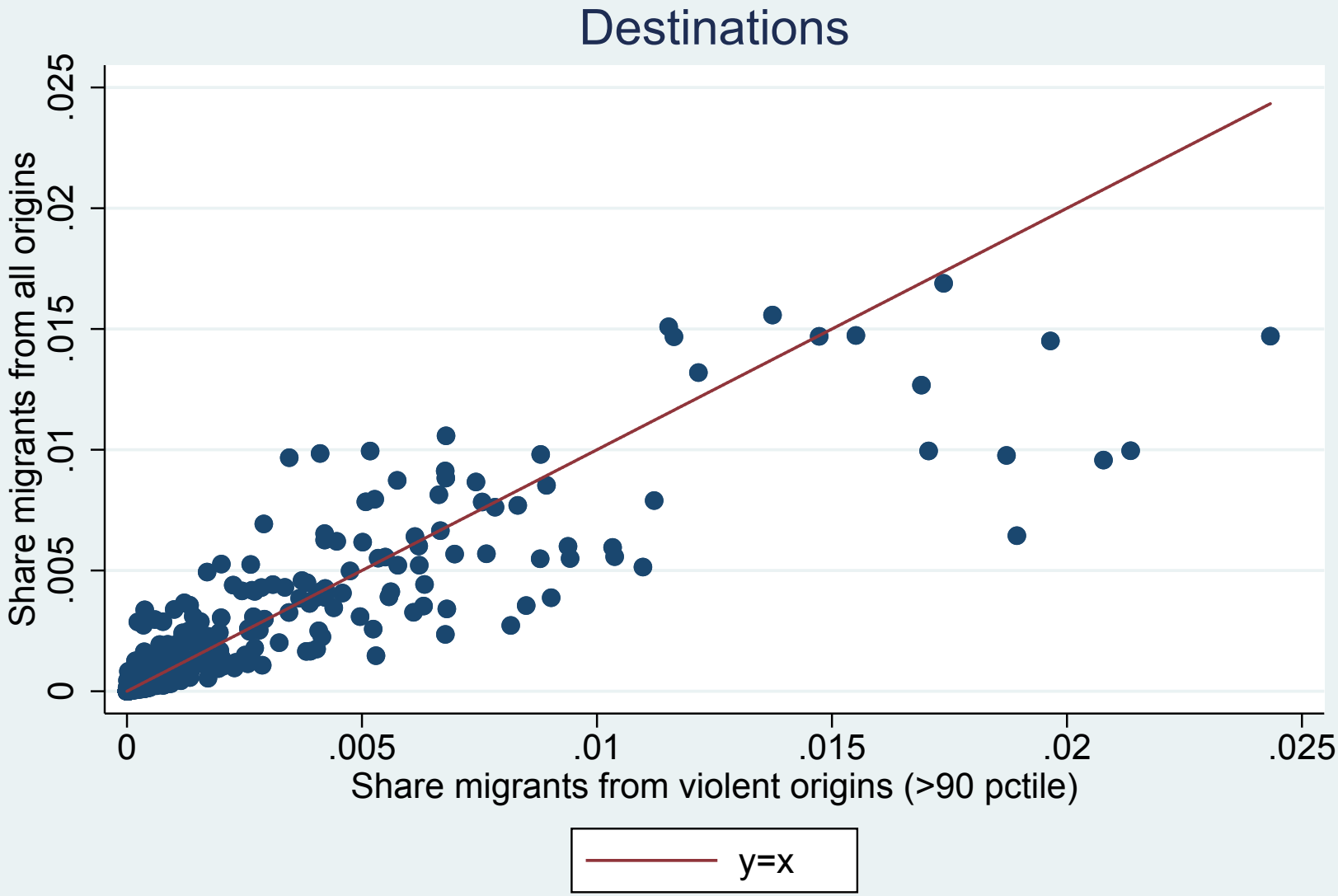
For reference:

- US security aid to Mexico over this period: $\approx 5,000$ million pesos
- Mexico's security budget over this period: $\approx 500,000$ million pesos

Effects of violence at destinations

- If migrants are evenly distributed among all destinations, we can expect small effects on wages and rents at destinations
- If migrants concentrate in a few destinations, these general equilibrium effects may be large
- Next, show distribution of migrants from violent locations

Destinations for migrants from violent places



Labor Demand: Employment Supply Shock

- We need an instrument for migrant inflows into a location
- If two locations are historically linked by migration, violence in one should cause inflows into the other
- Define a labor supply shock at destination municipality j' as follows:

$$B^s_{j'} = \sum_{j \neq j'} F_{jj'} N_j X_j \tag{3}$$

- X_j be a push factor at locality j - we use violence between 2005 and 2010
- $F_{jj'}$ the likelihood that a person will migrate from j to j' conditional on leaving j - we use migration shares from the 2000 Census
- N_j is employment at j in 2000.

Labor Demand: Estimation

- Our instrument predicts the flow of migrants into a location, so we use it to instrument for changes in labor
- We will use it to identify the elasticity of wages and rents

Labor Demand: Estimation

- Write reduced form inverse labor demand as:

$$wage_{jt} = \alpha_t + \gamma_j + \beta_w^d empl_j + X_{jt} + \xi_{jt}^d$$

- Take first differences, between 2010 and 2000

$$\Delta wage_{jt} = \Delta\alpha_t + \beta_w^d \Delta empl_j + \Delta X_{jt} + \Delta\xi_{jt}^d$$

- Estimate this equation using 2SLS with $B_{j'}^s$ as an instrument for $\Delta empl_j$, on the sample of all municipalities
- Notice we have different instruments for different push factors.
- We use homicide rate and log homicide rate.

Labor Demand: Estimates

Table: IV estimates of wage elasticity

	Δ wage	Δ wage
Δ employment	-2.401**	-1.672*
	(0.807)	(0.716)
Δ homicide rate	-0.000895*	
	(0.000375)	
Δ log homicide rate		-0.00217
		(0.00934)
Observations	2438	2438
SWF	8.42	8.66
SWFp	0.00	0.00

Standard errors in parentheses

Municipality level regression

Dependent variable is change in monthly wages from 2000 to 2010

Housing supply: Estimation

- Define reduced form housing supply as follows, assuming each individual consumes the same amount of housing

$$rent_j = \alpha^h + \beta^h empl_j + \xi_t^h$$

We estimate this equation using 2SLS, instrumenting for levels this time with $B_{j'}^s$ on the cross section of municipalities for which we observe rent in the expenditure survey.

Housing supply: Estimates

Table: IV estimates of rent elasticity

Log employment	2.371***	1.386***
	(0.00788)	(0.00490)
Hom. rate 2010 (all)	0.000211***	
	(0.00000495)	
logpob2005	-2.349***	-1.352***
	(0.00833)	(0.00528)
Log mean non-narco homicide rate 100k, 2006-2010		0.0459***
		(0.000157)
Constant	1.936***	0.792***
	(0.0123)	(0.00861)
Observations	29539501	29523047
SWF	1.8e+05	2.1e+05
SWFp	0.00	0.00

Standard errors in parentheses
Dependent variable is log monthly rent, controlling for home characteristics
First model uses hom. rate as push variable to construct the instrument
Second model uses log hom. rate as push variable to construct the instrument
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Scope for Spillovers

- While we estimate relatively few migrants, destination land and labor markets seem elastic
- Then, there is scope for violence to have effects at destinations as well

Limitations/Work ahead

- Ignore dynamics
- More detailed model of migration costs - e.g. consider distance
- Include US as a destination
- No counterfactual distribution of population - no explicit welfare effects for destinations

Conclusions

- Reduced form:
  - Find net migration away from high homicide rate locations, implying homicide rate is a disamenity
  - Effects on inflows and not outflows point to important moving costs
- Structural Labor Supply Model:
  - We estimate worker would be willing to accept a 1% wage reduction to decrease local hom rates by 3%
  - Large moving costs mute the migration response, but welfare costs are large
- Evidence of concentrated migration to some destinations, and elastic land and labor markets - scope for spillover effects