Gone with the Wind: International Migration

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Motivation

"*Where shall I go? What shall I do?*"

- European refugee crisis overshadows global trend: *migration*
  - 3.3% of the world's population (250 mio.) are migrants
  - Faster pace of migration
  - South-South migration larger than South-North migration
  - (*Conservative*) Forecast for 2050: 405 million migrants
- Migration matters
  - For destination and origin countries
  - Economic and political factors

Motivation (cont'd)

Contribution

- The paper makes *two* contributions
  - Step 1
    - ★ *Joint* analysis of driving forces of international migration
    - ★ Year-to-year variations *and* long-run effects
    - ★ Build rich panel data set of international migration
  - Step 2
    - ★ *Dynamic* response of migration to shocks
    - ★ Panel VARX model
    - ★ Identification of shocks

Motivation (cont'd)

Driving Forces

- Driving forces are increasingly complex and time-varying
  - Economic
    - ★ Better employment, economic opportunities,...
  - Political
    - ★ Warfare, terrorism,...
    - ★ Political freedom
  - Climatic
    - ★ Disasters, temperature

Motivation (cont'd)

Driving Forces - Climate Change

- Changes to natural systems $\Rightarrow$ severe effects (Dell et al. (2009))
  - Increases temperatures and incidence, likelihood, and frequency of disasters
    - ★ Howe et al. (2012): Inference about climate change
  - Reduce agricultural productivity (Burke et al. (2015))
  - Reduce crop yields (Lesk et al. (2016) $\Rightarrow$ agricultural income risk $\uparrow$
  - Impact on health conditions (WHO (2009))
  - Water scarcity and rivalry over scarce resources
  - Civil unrest and climate-driven conflicts
  - $\Rightarrow$ Will render some areas untenable
- Migration as an adaptation strategy

Motivation (cont'd)

Preview on Key Findings

- Time dimension and year-to-year variations
  - Crucial to understand/identify the effects of climate change
- Climate change
  - Significant adverse real effects
  - At origin: more important than income and policy
- Effects of temperature are non-linear
  - In agricultural land, GDP at origin, and weather-related disasters
- Panel VARX
  - Response of migration different across drivers
  - Temperature: negative on-impact then overshooting
  - Binding liquidity constraints and spatial diversification

Literature Review

- Cai et al. (2016), Cattaneo and Peri (2016)
  - Temperature and precipitation
- Backhaus et al. (2015)
  - Temperature and precipitation (unemployment, GDP, population, trade, EU membership, and demographic pressure)
- Beine and Parsons (2015)
  - Rainfall and temperature (GDP, migration costs, international violence, and natural disasters)
- Gröschl and Steinwachs (2016)
  - Hazard index (lagged stock of migrants, GDP, civil wars, regional trade agreement, migration costs)

Modelling Migration

Theoretical Framework

- Agents make optimal decisions on whether to migrate or to stay
- Maximize utility across multiple destinations, j (and home, i)

$$\begin{aligned} u_{ijt} &= \ln\left(w_{jt}\right) + A_{jt}\left(\cdot\right) - C_{ijt}\left(\cdot\right) + \varepsilon_{jt}, \\ u_{iit} &= \ln\left(w_{it}\right) + A_{it}\left(\cdot\right) + \varepsilon_{it}. \end{aligned}$$

- After some math (McFadden (1984)), the bilateral migration flow is given by

$$\begin{aligned} \ln\left(M_{ijt}\right) = {} & \ln\left(M_{iit}\right) + \ln\left(w_{jt}\right) - \ln\left(w_{it}\right) + A\left(Pol_{jt}, Cli_{jt}, Eco_{jt}\right) \\ & - A\left(Pol_{it}, Cli_{it}, Eco_{it}\right) - C\left(c_{ij}, c_i, c_j, c_{jt}\right) + \varepsilon_{ijt}. \end{aligned}$$

Modelling Migration (cont'd)

Econometric Specification

- Theoretical equation can be written as augmented gravity equation

$$\begin{aligned}\ln\left(M_{ijt}\right) &= \alpha_{it} + \beta_1 \ln\left(w_{jt}\right) - \beta_2 \ln\left(w_{it}\right) + \beta_3 A\left(Pol_{jt}, Cli_{jt}, Eco_{jt}\right) \\ &\quad -\beta_4 A\left(Pol_{it}, Cli_{it}, Eco_{it}\right) - \beta_5 C\left(c_{ij}\right) - \beta_6 C\left(c_{jt}\right) + \varepsilon_{ijt}.\end{aligned}$$

- Origin-by-year fixed effects
  - Controls for all time-varying terms that are constant across destinations but vary across years and country of origin
  - Time-invariant origin-related migration costs $\left(C\left(c_i\right)\right)$ and M_{iit}
  - Unobserved heterogeneity between migrants and non-migrants

Modelling Migration (cont'd)

Econometric Specification (cont'd)

- Econometric issues
  - Log-specification with zeros
    - ★ Transformation $\Rightarrow \ln\left(1 + M_{ijt}\right)$
  - OLS estimation of log-linearized gravity equation with heteroscedasticity $\Rightarrow$ biased estimates
    - ★ Poisson Pseudo-Maximum Likelihood (PPML) estimator (Santos Silva and Tenreyro (2006, 2011))
  - Overdispersion and excess zeros (Burger et al. (2009)) $\Rightarrow$ **Negative binomial regression**

Data

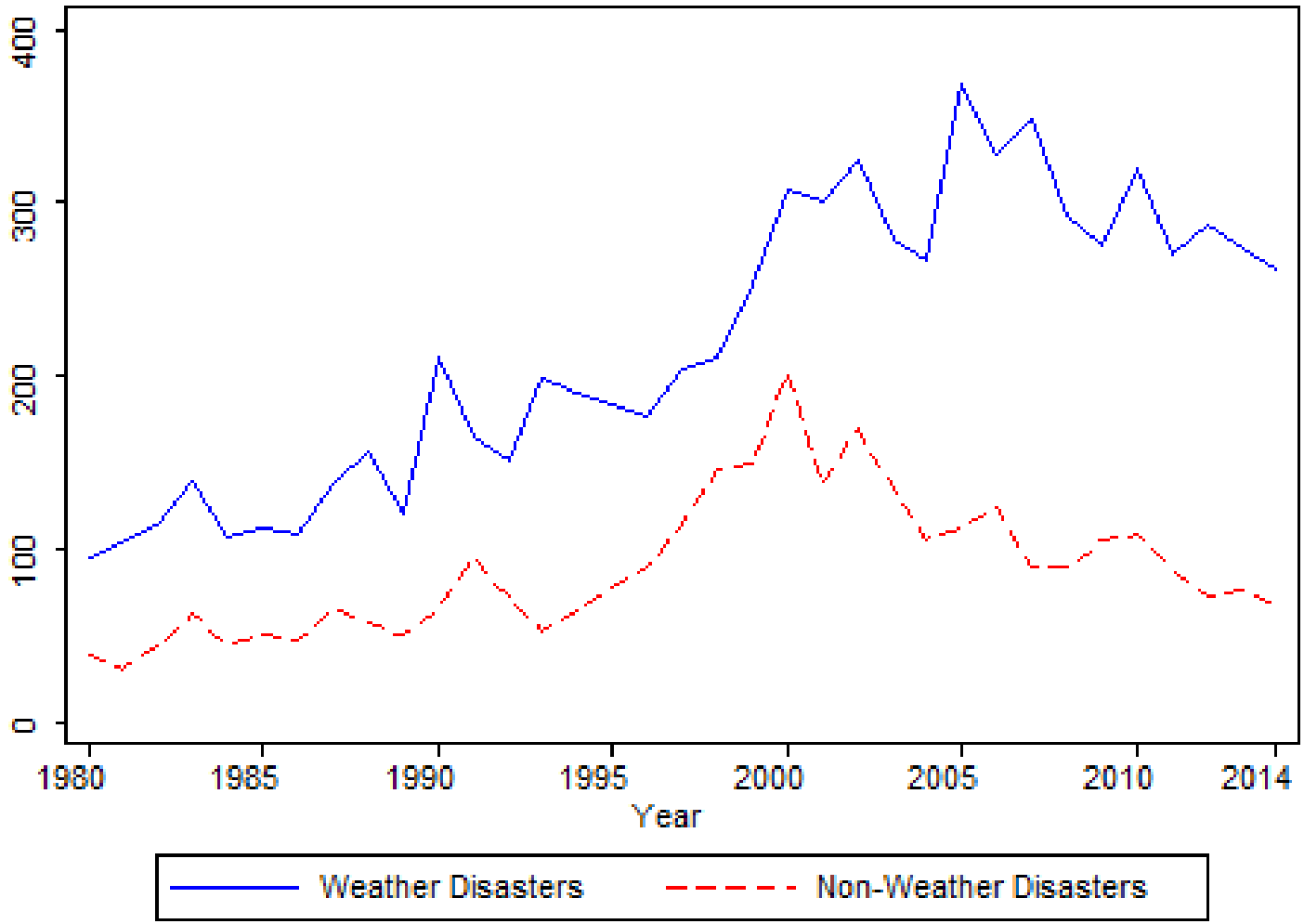
- Bilateral panel data set
  - 16 destination countries and 198 origin countries
  - Period: 1980-2014 (110880 observations)
- Migration
  - **Bilateral flow**: UN Population Division, 2015 Revision merged with OECD and Ortega and Peri (2013)
  - **Large time dimension**: 35 years, Adserà et al. (2016): 30
  - **79856 observations**: 10 $\times$ Mayda (2010), 2 $\times$ Ortega and Peri (2013)
  - **17% zeros**: Gröschl and Steinwachs (2016): 65 percent
  - **Large set of country-pairs**: Mayda (2010): 14/79, Ortega and Peri (2013): 15/120

Data (cont'd)

- Migration costs
  - Distance, dummies for: land borders, common language, colonial ties
- Economic variables
  - GDP, share of young population, bilateral aid, agricultural land (all World Bank)
- Political variables
  - War dummy, **political framework** indicator (polity2, Polity^{TM} IV project by Center for Systemic Peace)
- Climate variables
  - **Temperature** anomalies (Berkeley Earth)
  - **Disasters** (EM-DAT): Weather- and Non-Weather-related
    - ★ $\geq$ 10 killed, $\geq$ 100 affected, state of emergency, or call for international assistance

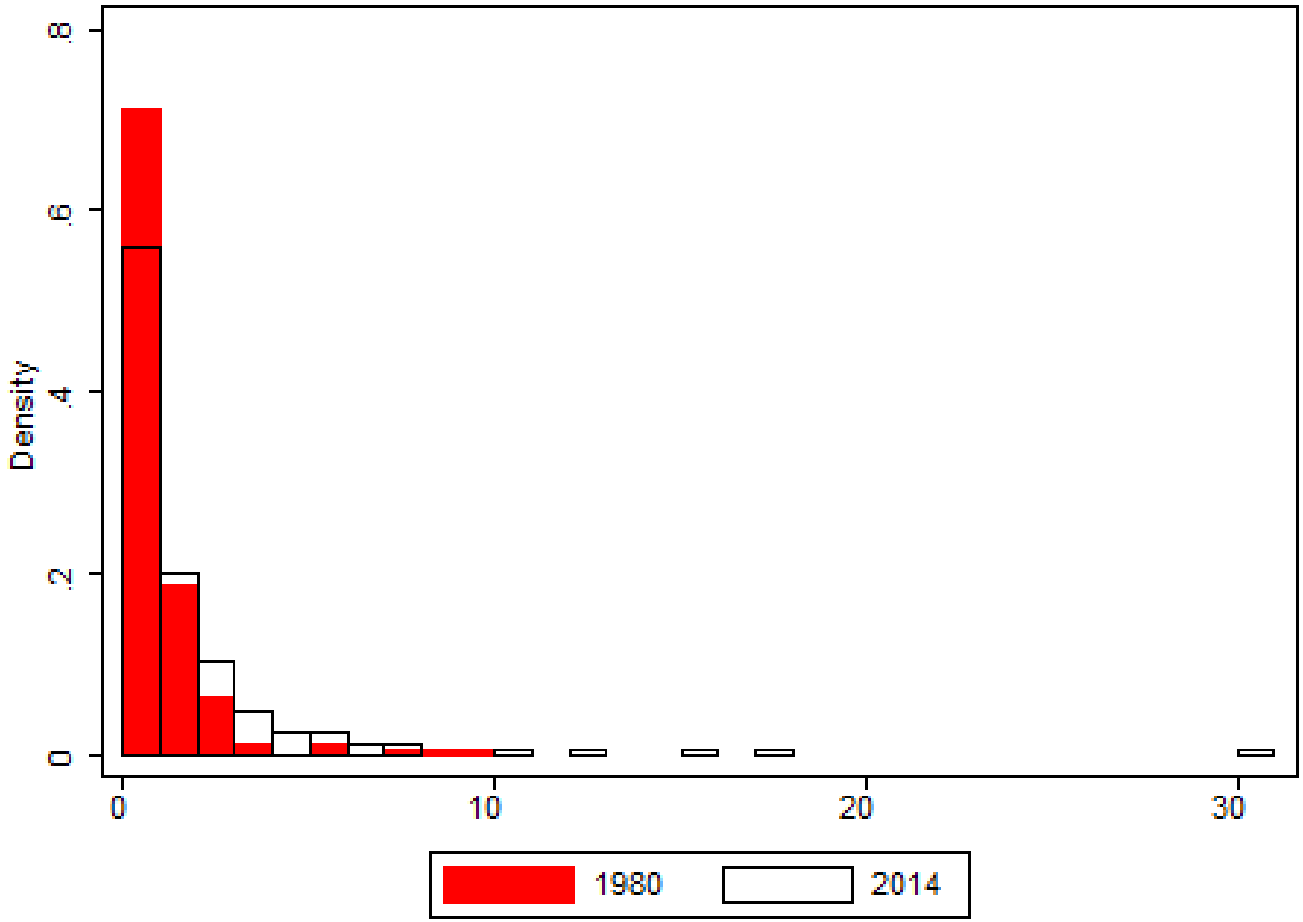
Data (cont'd)

Disasters



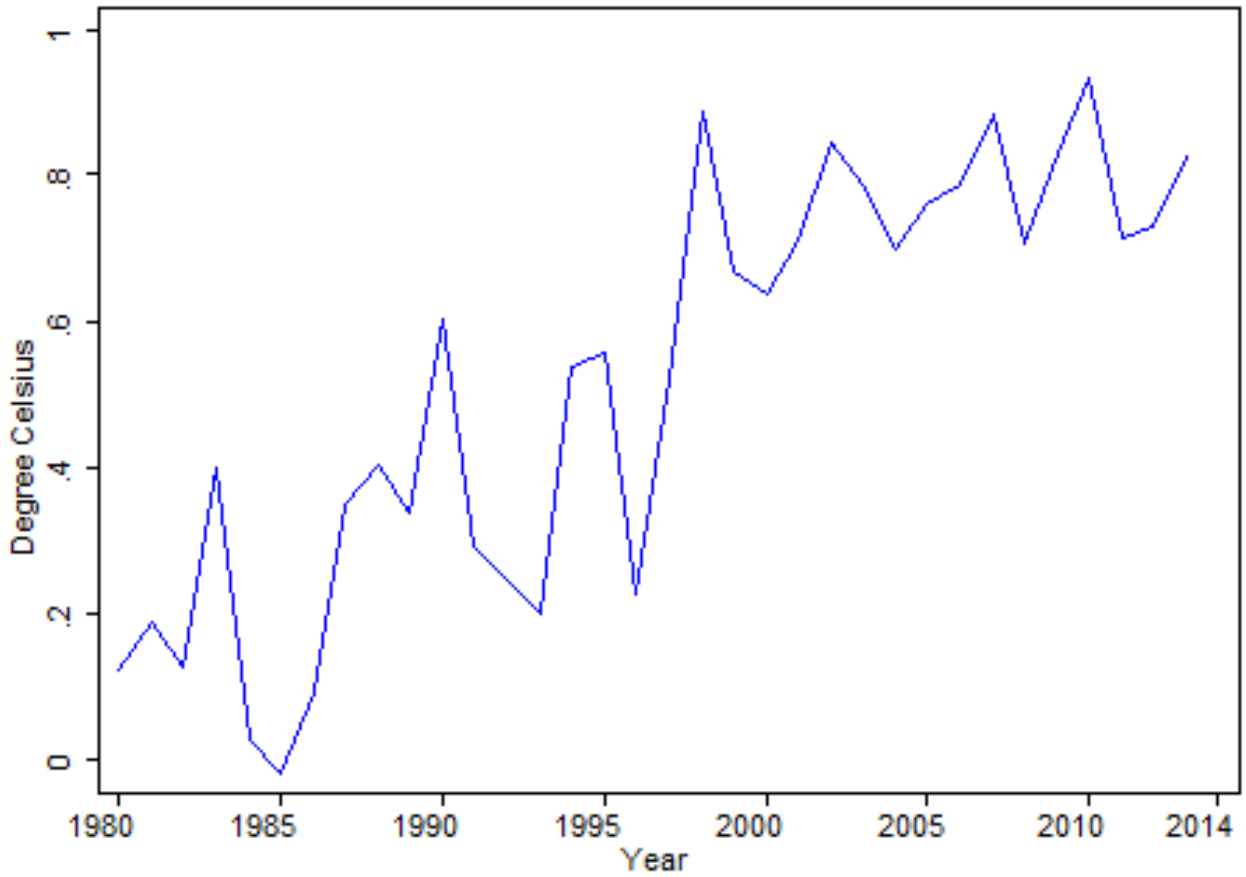
Data (cont'd)

Disasters (cont'd)



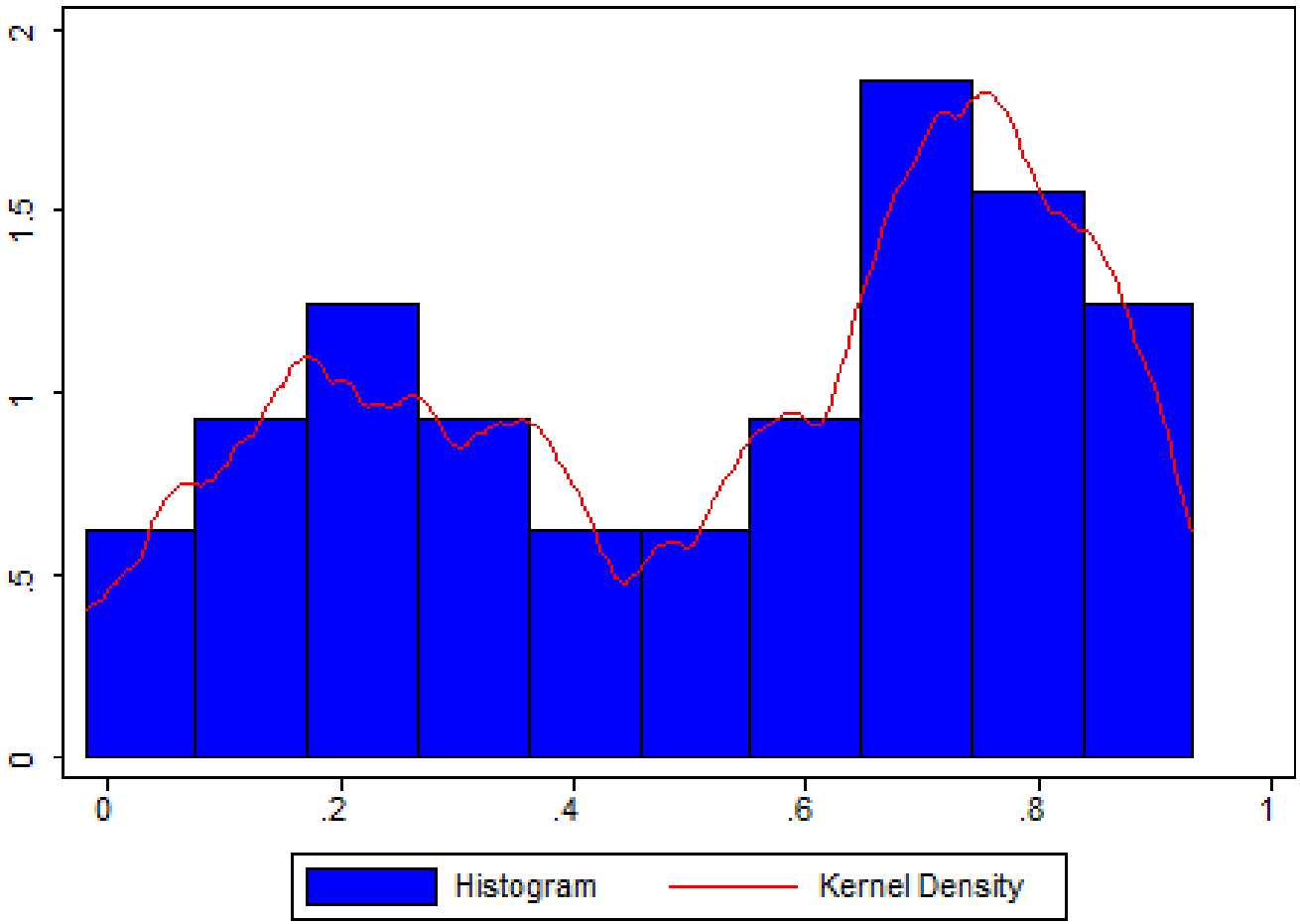
Data (cont'd)

Temperature



Data (cont'd)

Temperature (cont'd)



Results

Basic Model

Variable	1	2	3	4	5	6
ln GDP$_j$	-0.82^{***}	0.64^{**}	0.95^{***}	1.18^{***}	2.71^{***}	1.00^{***}
	(0.15)	(0.27)	(0.23)	(0.06)	(0.82)	(0.21)
ln GDP$_i$	0.26^{***}	0.22^{***}	-0.37^{***}	-0.24^{***}	0.08	
	(0.03)	(0.03)	(0.06)	(0.02)	(0.13)	
ln Distance$_{ij}$	-0.87^{***}	-1.02^{***}	-0.99^{***}	-0.14^{***}	-0.73^{***}	-0.98^{***}
	(0.06)	(0.06)	(0.06)	(0.01)	(0.09)	(0.06)
Border$_{ij}$	0.67^{*}	0.71^{**}	-0.03	-0.11^{**}	0.40	0.002
	(0.36)	(0.29)	(0.21)	(0.05)	(0.26)	(0.22)
Language$_{ij}$	1.33^{***}	0.19	0.71^{***}	0.04^{*}	1.03^{***}	0.69^{***}
	(0.18)	(0.18)	(0.10)	(0.02)	(0.18)	(0.11)
Colony$_{ij}$	-0.16	0.26	0.84^{***}	0.3^{***}	1.43^{***}	0.78^{***}
	(0.24)	(0.23)	(0.14)	(0.03)	(0.21)	(0.15)
Obs.	71826	71826	71826	71596	71826	71826
R^2_{adj}	0.17	0.35	0.75		0.78	0.76
Estimator	OLS	OLS	OLS	NegBin	PPML	OLS
Fixed Effects						
Year	Yes	Yes	Yes	Yes	Yes	Yes
Destination	No	Yes	Yes	Yes	Yes	Yes
Origin	No	No	Yes	Yes	Yes	Yes
Origin-Year	No	No	No	No	No	Yes

Results (cont'd)

Joint

Variable	3	7	8	9	10	11	12
ln GDP$_j$	0.95***	0.95***	0.89***	0.85***	0.84***	1.38***	1.36***
	(0.23)	(0.23)	(0.24)	(0.25)	(0.25)	(0.29)	(0.07)
ln GDP$_i$	−0.37***	−0.37***	−0.22***	−0.23***	−0.24***	−0.18***	−0.11***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.02)
ln Distance$_{ij}$	−0.99***	−0.99***	−0.91***	−0.91***	−0.91***	−0.91***	−0.06***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.01)
Border$_{ij}$	−0.03	−0.03	−0.01	0.0009	0.0001	0.003	0.01
	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)	(0.05)
Language$_{ij}$	0.71***	0.71***	0.72***	0.71***	0.72***	0.72***	0.08***
	(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	(0.11)	(0.03)
Colony$_{ij}$	0.84***	0.84***	1.00***	1.01***	1.01***	1.01***	0.22***
	(0.14)	(0.14)	(0.15)	(0.15)	(0.15)	(0.15)	(0.03)
War$_i$		0.04	0.04	0.04	0.04	0.04	0.02
		(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.02)
War$_{ij}$		−0.21	0.30	0.29	0.30	0.33	0.2
		(0.25)	(0.23)	(0.23)	(0.23)	(0.23)	(0.14)
Policy$_j$			−0.004	0.001	0.001	−0.03	0.03***
			(0.05)	(0.05)	(0.05)	(0.05)	(0.01)
Policy$_i$			0.01***	0.01***	0.01***	0.01**	0.01***
			(0.004)	(0.004)	(0.004)	(0.004)	(0.001)
Temperature$_j$				−0.05***	−0.05***	−0.05***	−0.02***
				(0.01)	(0.01)	(0.01)	(0.005)
Temperature$_i$				0.02*	0.03*	0.02*	0.01*
				(0.01)	(0.01)	(0.01)	(0.005)
W-Disaster$_j$					0.002	−0.002	−0.004***
					(0.003)	(0.003)	(0.001)
W-Disaster$_i$					0.02***	0.02***	0.008***
					(0.004)	(0.004)	(0.001)
Y Population$_j$						−5.41***	−1.36***
						(1.02)	(0.28)
Y Population$_i$						4.01***	3.2***
						(0.68)	(0.16)

Results (cont'd)

Robustness

- Bilateral migration rate
- Lagged values (GDP)
- Lagged dependent variable (Network/Diaspora effects)
- Non-linear effects (squared)
- Different measures (GDP, distance)
- Change in temperature
- Methods (MR, IV-GMM and robust, bootstrapped, and jackknifed SE)
- Other variables
  - Trade, inflation, pop. density, immigration laws, EU, religion

Non-Linear Effects of Climate Change

Variable	10	15	16	17	18	19
ln GDP$_j$	0.84***	0.83***	0.84***	1.04***	0.85***	0.83***
	(0.25)	(0.25)	(0.23)	(0.26)	(0.25)	(0.25)
ln GDP$_i$	−0.24***	−0.24***		−0.18***	−0.25***	−0.24***
	(0.06)	(0.06)		(0.06)	(0.06)	(0.06)
Temperature$_j$	−0.05***	−0.05***	−0.05***	−0.1***	−0.05***	−0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Temperature$_i$	0.03*	0.03*		0.02	0.1***	0.03*
	(0.01)	(0.01)		(0.01)	(0.02)	(0.01)
W-Disaster$_j$	0.002	0.003	−0.002	0.0001	0.0003	0.0003
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
W-Disaster$_i$	0.02***	0.02***		0.02***	0.02***	0.02***
	(0.004)	(0.004)		(0.004)	(0.004)	(0.004)
NW-Disaster$_j$		0.02***	0.02**	0.02***	0.02***	0.02***
		(0.01)	(0.01)	(0.006)	(0.006)	(0.006)
NW-Disaster$_i$		0.02***		0.02***	0.01**	0.02***
		(0.01)		(0.006)	(0.006)	(0.006)
Agriculture$_j$				−0.02***		
				(0.005)		
Agriculture$_i$				0.006		
				(0.004)		
Temp$_j$ × Agr$_j$				−0.003***		
				(0.0004)		
Temp$_i$ × Agr$_i$				0.005***		
				(0.001)		
GDP$_i$ × Temp$_i$					−0.1***	
					(0.01)	
W-Dis$_i$ × Temp$_i$						0.01**
						(0.005)

Dynamic Effects

Panel VAR

- Dynamic effects of shocks to drivers of migration
- We consider *four* shocks
  - Income at destination
  - Wars
  - Temperature $\Rightarrow$ long-run climate change
  - Disasters $\Rightarrow$ short-run climate change
- Estimation of PVARX
  - One lag
  - GMM with robust standard errors

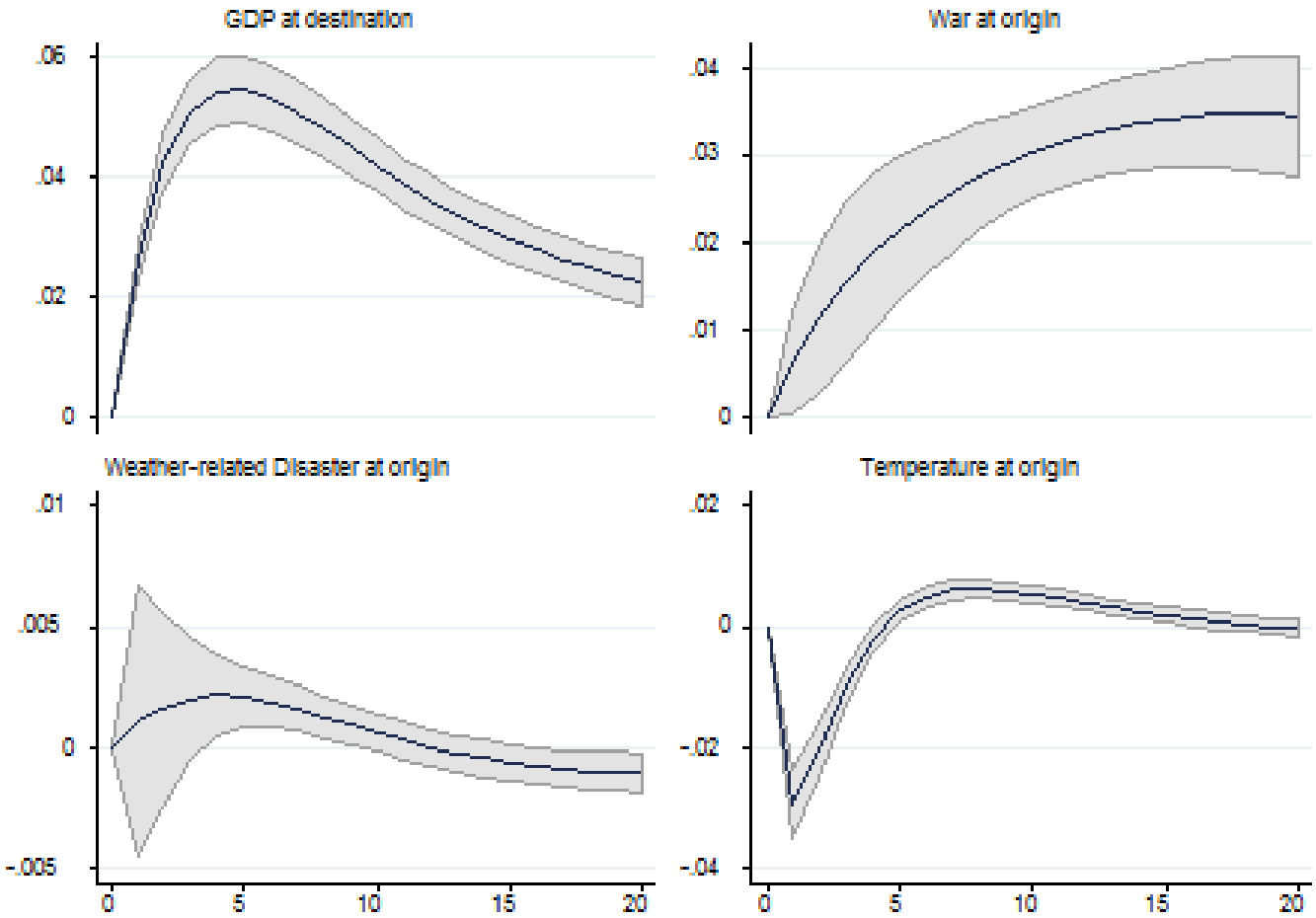
Dynamic Effects (cont'd)

Panel VAR - Identification

- Identification assumptions
  - Unemployment $\longrightarrow$ GDP
  - Epidemic $\longrightarrow$ War
    - ★ Governments blamed for not protecting citizens
  - Volcanic activity $\longrightarrow$ Temperature
    - ★ SO_2 vs. CO_2
    - ★ Stordal et al. (2017): global temperature $\uparrow$ by $7^{\circ}C$ over short-run
  - Agricultural land $\longrightarrow$ Weather-disaster
    - ★ Increased fertilizer usage (green house gases), larger changes in land use (vulnerability and intensity of disasters)

Dynamic Effects (cont'd)

Impulse Response Functions



Dynamic Effects (cont'd)

Results

- Temperature shocks
  - Halliday (2006), Piguet et al. (2011), Cattaneo and Peri (2016)
    - ★ Binding liquidity constraints
  - Dillon et al. (2011)
    - ★ Asset depletion to smooth consumption during transitory shock ⇒ migration costs
    - ★ Insurance against income risk via spatial diversification ⇒ less efficient with rising temperatures

Conclusion

- We add to the literature on driving forces of migration
  - Joint analysis of migration motives
  - Year-to-year variations and long-run effects
  - Dynamic effects of shocks to migration
- Key findings
  - Complex mix of economic, political, and climatic factors
  - Climate change is an important driving factor
  - Shocks have long-lasting effects, different across factors

Conclusion (cont'd)

Policy Implications

- Implications for national and international policies
  - Study *dynamic* response of migration
  - *Speed* of policy response matters
- Short-run policies
  - Flexibility, international collaboration
- Long-run policies
  - Structural adaptation mechanisms (IPCC (2012))
- "*Frankly, my dear, we should give a damn.*"