Spatial Decentralization and Program Evaluation: Theory and an Example

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ICID-SITES-IFAD
Conference on International Development
Rome, October 2018

Motivation

- Governments earmark significant proportions of their budget towards programs that seek to alter behavior of target populations

- Fundamental problems in evaluation
  - Coverage of program initiatives is not random
  - FE works when program placement depends on unmeasured time-persistent characteristics of locations
  - Longitudinal data are not always available or may be too closely spaced

Motivation

- Contribution: an alternative IV method
  - Instruments derived from government decision-making theory
  - Main assumption is that the government's SWF is spatially weakly separable =>
    - independence of MRS
    - generates *spatially decentralized budgeting*
  - Spatial IV model examples is tested with Indonesian census data

Examples

"Finance Minister Malusi Gigaba cracked open a R6bn (477 million US dollars) war chest to assist areas in the country hardest hit by drought, particularly the Western Cape and Cape Town."

Business Day, February 22, 2018

"The Chinese central government has allocated 5.7 billion yuan (about 865.6 million US dollars) in relief funds to help people in disaster-hit regions get through the winter."

Xinhua News Agency, December 12, 2017

Literature

- Program evaluation
  - Pitt *et al*. (1993)
    - Estimate the effect of schools, health, and FP clinics on school enrollment, fertility and cumulative mortality rate of children

- Public Finance
  - Besley and Case (1995)
    - Voters compare across jurisdictions => forces incumbents into a yardstick competition with other incumbents
  - Brueckner (2003)
    - Strategic interaction between decentralized government bodies
    - Political jurisdictions "compete" for resources from the central planner and the district planner

Model for the household

- Model household behavior in the context of a multi-district nation
- Conditional demand for H_{jkl}

$$(1) \quad H_{jkl} = \beta_0 + P_{jkl}\,\beta_1 + (W^h P)\,\beta_2 + \delta r_{kl} + \mu_{kl} + \eta_{jkl}$$

- *Spatial-x* model (Anselin 1988, Baltagi *et al*. 2014)
- W^h is the spatial weight matrix

Model for the social planner

- Most general form of the SWF

$$(2) \quad \mathcal{W}=(H_{111},H_{211},...,H_{n11},H_{121},...,H_{NKL})$$

- Given the cost of acquiring information, write (2) with sub-district level outcomes (sub-district means)

$$(3) \quad \mathcal{W}=\mathcal{W}(w_1[w_{11}(H_{11}), w_{21}(H_{21}),\ldots, w_{K1}(H_{K1})],\ldots, w_L[w_{1L}(H_{1L}), w_{2L}(H_{2L}),\ldots, w_{KL}(H_{KL})]$$

Model for the social planner

- Maximizing (3) subject to *V* yields the reduced-form equation for program intensity

$$(4)\ r_{kl} = r(P_{11},.., P_{KL,}\ \mu_{11},..., \mu_{KL}, V)$$

- Linearizing (4)

$$(5)\ \ r_{k\ell} = P_{k\ell}\,\beta + WP\theta + \varepsilon_{k,\ell}$$

- Differences between W and W^h give rise to the exclusion restrictions

Identification

- Three restrictions on the spatial weight matrix W and on WP:
  - At least one off-diagonal element must be non-zero
  - All of the off-diagonal elements in W cannot have the same value
  - $\theta \neq 0$, that is, the social planner is *spatially informed*
    - Weak separability is sufficient for this

- Given above, there are two cases that generate exclusion restrictions for identification of δ

  - Case I. No network effects ($\beta_2 = 0$) in (1)
  - Case II. There are network effects ($\beta_2 \neq 0$) in (1)

Data and variable construction

- We use data from two sources:
  - The 1980 *Potensi Desa* (Village Potential) survey of Indonesia (*PODES*)
  - The 1980 *Sensus Penduduk* (Population Census) of Indonesia

- The 1980 *PODES* has data at the village level on:
  - Government programs: *PUSKESMAS*, FP clinics, and schools
  - Geographical characteristics: natural disasters
  - Almost all villages in Indonesia covered (about 62,000)

Summary statistics for endogenous variables

Variables	
Outcomes	
Current school enrollment for girls ages	0.593
10-18 years	(0.196)
	N=2921
Current school enrollment for boys ages	0.659
10-18 years	(0.178)
	N=2919
Whether last child's year of birth lies between	0.689
1978-1980 for women ages 21-30 years	(0.163)
	N=2914
Whether any contraceptives are currently being	0.280
used by women ages 21-30 years	(0.244)
	N=3033
Programs	
Proportion of households in villages	
with grade schools	0.774
	(0.279)
	N=2921
with PUSKESMAS clinics	0.245
	(0.196)
	N=2921
with family planning clinics	0.486
	(0.335)
	N=2921
with junior or secondary schools	0.394
	(0.388)
	N=2921

Issues in empirical implementation

- We construct three measures of economic distance
  - one based on spatial proximity (*neighbors*)
  - one based on shared district status (*non-neighbors*)
  - one based on contiguity to a shared district (*distant neighbors*)

- The idea is that competition b/w *neighbors* differs in nature from competition b/w *non-neighbors* and *distant neighbors*

Indonesia

Note:https://www.google.com/search?q=provinces+of+indonesia+map&rlz=1C1GCEA_enUS766US766&tbm=isch&source=iu&ictx=1&fir=NPBtaKWDhf145M%253A%252CeYt1BVVQYHM4rM%252C_&usg=__17LBD_WjwtN3Mdhj02iRePPDXYU%3D&sa=X&ved=0ahUKEwjqwNf58ZDbAhXytlkKHaNZBJMQ9QEIcjAM#imgrc=NPBtaKWDhf145M: (Accessed on May 19, 2018)

West Java

Note: https://www.google.com/search?q=map+of+kecamatan+bandung&tbm=isch&tbs=rimg:CbVtc59J8A3ZIjjcjviSH2X0LSlqN-knEL0SE55hApsGMAe-T8iUfMc5gOr2CLSLg1xK9yDeJBGgvKBKuoY5rjGqgyoSCdyO-JIfZfQtEUjmBDC -4P7qKhIJKWo36ScQvRIRbWcA8uVvtbkqEgkTnmECmwYwBxHnwzEPdPji_1ioSCb5PyJR8xzmAEf9kWK7YHOoWKhIJ6vYItIuDXEoRMK3WmqdXNtsqEgn3IN4kEaC8oBF9NdV5lOxnCCoSCUq6hjmuMaqDEVvKAfVsK9eE&tbo=u&sa=X&ved=2ahUKEwjVpNrs95DbAhXnqFkKHcVLCgkQ9C96BAgBEBg&biw=1084&bih=587&dpr=1#imgrc=BvQk2O4PTraDlM: (Accessed May 19, 2018)

Peta Wilayah Administratif Kabupaten Garut Lengkap

Summary statistics for individual and household controls

Variable	Sub-district Mean (1)	Sub-district SD (2)	*Neighboring* Sub-districts SD (3)	*Non-neighboring* Sub-districts SD (4)
Individual and household attributes				
Dummy for household religion is Islam	0.826	0.325	0.177	0.302
Dummy for household religion is Christianity	0.131	0.288	0.049	0.260
Land owned by household (acres)	0.648	0.718	8.514	5.115
Dummy for household owns its own home	0.921	0.124	0.300	0.184
Dummy for household head's language is Indonesian	0.074	0.193	0.263	0.150
Mother's age (years)	40.308	2.722	8.341	3.398
Household head's age (years)	46.068	3.273	13.191	13.010
Mother's schooling (years)	2.441	1.611	15.651	3.466
Household head's schooling (years)	3.422	1.733	1.158	1.158
Proportion of households in villages with urban status				
interacted with land owned by household	2.680	8.515	4.682	3.612
interacted with dummy for household owns home	0.101	0.194	0.138	0.123
interacted with mother’s schooling	0.538	1.377	1.045	0.998
interacted with household head’s schooling	0.701	1.729	1.331	1.260
interacted with dummy for head’s lang. is Indonesian	0.032	0.130	0.109	0.126
interacted with dummy for religion is Christianity	0.013	0.058	0.039	0.053
interacted with dummy for religion is Islam	0.109	0.221	0.165	0.215
interacted with mother’s age	0.522	1.064	0.801	1.027
interacted with father’s age	0.597	1.210	0.909	1.168
interacted with drought, flood, earthquake or other shocks in the last five years	0.051	0.155	0.109	0.142

Current enrollment for girls ages 10-18

	(1)	(2)	(3)	(4)
Proportion of households in villages				
with grade schools	0.049	0.080	0.103**	0.172***
	(0.041)	(0.049)	(0.044)	(0.055)
with junior or secondary schools	0.328***	0.389***	0.315***	0.247**
	(0.085)	(0.088)	(0.078)	(0.096)
with PUSKESMAS clinics		-0.095	-0.043	-0.069
		(0.074)	(0.063)	(0.083)
with family planning clinics		-0.030	-0.055	-0.037
		(0.042)	(0.037)	(0.045)
Neighboring sub-districts	IV	IV	IV	Ind
Non-neighboring sub-districts	No	No	IV	IV
Distant non-neighbors	No	No	No	No
Hansen's *J*-test χ^2	10.379(10)	10.170(8)	27.683(20)	9.579(8)
	[0.408]	[0.253]	[0.117]	[0.296]
Orthogonality test χ^2			18.372(12)[a]	
			[0.105]	
Redundancy test χ^2			114.544(48)[b]	
			[0.000]	
Spatial network test χ^2				18.860(12)[a]
				[0.092]
Observations (sub-districts)	2,921	2,921	2,921	2,921

Note: "a" denotes neighbors, "b" denotes non-neighbors, and "c" denotes distant neighbors. "Ind" denotes included in the second stage.

Current enrollment for boys ages 10-18

	(5)	(6)	(7)	(8)	(9)
Proportion of households in villages					
with grade schools	0.047	0.083*	0.139***	0.171***	0.089**
	(0.036)	(0.045)	(0.041)	(0.045)	(0.037)
with junior or secondary schools	0.192**	0.259***	0.174**	0.167**	0.241***
	(0.078)	(0.086)	(0.073)	(0.080)	(0.079)
with PUSKESMAS clinics		-0.062	-0.015	-0.029	-0.193***
		(0.069)	(0.060)	(0.071)	(0.068)
with family planning clinics		-0.054	-0.091**	-0.147***	-0.166***
		(0.041)	(0.038)	(0.042)	(0.034)
Neighboring sub-districts	IV	IV	IV	Ind	Ind
Non-neighboring sub-districts	No	No	IV	IV	Ind
Distant non-neighbors	No	No	No	No	IV
Hansen's *J*-test χ^2	12.243(10)	12.138(8)	29.870(20)	12.451(8)	9.319(8)
	[0.269]	[0.145]	[0.072]	[0.132]	[0.316]
Orthogonality test χ^2			19.458(12)[a]		
			[0.078]		
Redundancy test χ^2			107.123(48)[b]		120.600(48)[c]
			[0.000]		[0.000]
Spatial network test χ^2				46.480(12)[a]	40.000(12)[b]
				[0.000]	[0.000]
Observations (sub-districts)	2,919	2,919	2,919	2,919	2,919

Note: "a" denotes neighbors, "b" denotes non-neighbors, and "c" denotes distant neighbors. "Ind" denotes included in the second stage.

Falsification: Impact of programs on other outcomes

	Whether household religion is Islam		Whether gender of the elderly person who died was male	
	(1)	(2)	(3)	(4)
Proportion of households in villages				
with grade schools	-0.125	-0.007	0.137	0.086
	(0.228)	(0.163)	(0.110)	(0.077)
with junior or secondary schools	-0.282	-0.274	0.531**	0.293*
	(0.392)	(0.301)	(0.249)	(0.159)
with PUSKESMAS clinics	-0.365	-0.293	-0.429**	-0.106
	(0.319)	(0.204)	(0.172)	(0.118)
with family planning clinics	0.465**	0.193	0.116	0.033
	(0.237)	(0.150)	(0.097)	(0.065)
Joint test of significance of programs χ^2	6.520(4)	4.780(4)	13.280(4)	8.580(4)
	[0.163]	[0.311]	[0.010]	[0.073]
Neighboring sub-districts	IV	IV	IV	IV
Non-neighboring sub-districts	No	IV	No	IV
Observations (sub-districts)	2921	2921	2921	2921

Selective Migration

	Migration indicator: Duration of residence in current province is < 1 year		Migration indicator: Current province is diff. from province five years ago	
	Girls schooling	Recent fertility	Girls schooling	Recent fertility
Proportion of households in villages				
with grade schools	0.084	-0.080	0.089	-0.104
	(0.071)	(0.110)	(0.072)	(0.120)
with junior or secondary schools	0.336***	-0.081	0.329***	-0.077
	(0.128)	(0.209)	(0.125)	(0.204)
with PUSKESMAS clinics	-0.081	0.465***	-0.052	0.386**
	(0.133)	(0.166)	(0.125)	(0.185)
with family planning clinics	-0.028	-0.388***	-0.036	-0.364***
	(0.067)	(0.111)	(0.078)	(0.114)
Migration indicator	0.791	-2.633	0.510	-1.329
	(2.606)	(3.525)	(1.095)	(1.062)
Interactions of migration indicator				
with grade schools	-2.583	7.470	-0.826	3.203**
	(3.827)	(5.308)	(1.680)	(1.566)
with junior or secondary schools	0.131	-0.809	0.376	-0.316
	(2.347)	(3.275)	(0.932)	(0.986)
with PUSKESMAS clinics	0.068	-10.729	-0.899	-2.775
	(5.787)	(7.163)	(2.028)	(2.152)
with family planning clinics	1.342	3.022	0.360	0.686
	(3.552)	(4.093)	(1.563)	(1.240)
Joint test of significance of migration	0.520(4)	7.350(4)	0.670(4)	7.330(4)
interaction variables χ^2	[0.971]	[0.119]	[0.956]	[0.119]
Observations (sub-districts)	2921	2914	2921	2914

Conclusion

- The assumption of weak separability of a SWF having as arguments the means outcomes of every administrative unit is sufficient to generate a budgeting process that is multi-stage

- Method can accommodate spatial network effects
  - *Requires that the distance over which network effects matter is less than the distance over which attributes matter in allocation decisions*

- Validity of the IVs need to be subjected to empirical tests