Decomposing Local Fiscal Multipliers: Evidence from Japan

Taisuke Kameda, Ryoichi Namba, and Takayuki Tsuruga

Cabinet Secretariat, CRISER, and Kyoto Univ.

August, 2017

Motivation: Fiscal multipliers

- Growing interest in the interaction btwn gov't spending and the economic activity
- Fiscal multipliers
  - By how many % does output increase when gov't spending increases by 1% of output?
- Two directions in research on fiscal multiplier
  1. Traditional national fiscal multiplier
     - Identified from time-series variations
  2. Local fiscal multiplier (LFM)
     - Identified from the region–time specific variations

Motivation: Local fiscal multipliers

- What is the LFM?
  - Typical estimation eqn.

$$\frac{Y_{r,t} - Y_{r,t-1}}{Y_{r,t-1}} = \beta \frac{G_{r,t} - G_{r,t-1}}{Y_{r,t-1}} + \alpha_r + \delta_t + \varepsilon_{r,t}$$

$Y_{r,t}$: per capita output in region r, $G_{r,t}$: per capita gov't spending in region r, α_r:entity fixed effect, δ_t: time fixed effect

- The LFM differs from the national fiscal multiplier
  - b/c δ_t controls for all common effects of agg. shocks and policy (e.g., common effect of monetary policy)
  - but β fails to capture common effects of fiscal policy

Motivation: Spillover

- Another important difference from the national fiscal multiplier
- An interpretation
  - Fiscal multiplier of gov't spending in an economy in a monetary union (e.g., EU countries)
- Within a single country, ...
  - Strong interdependence without the border effect
  - Gov't spending may easily spill over into other economies

Research questions

1. How large is the LFM in Japan?
    - We provide estimates of LFM, comparable to other countries
2. How large is the spillover within the region?
    - Positive if there is a leakage in demand
    - Negative if production factors (e.g., labor) relocate across prefectures
3. How large is the LFM on expenditure components of GDP?
    - Crowding-out or crowding-in?
    - Spillover in expenditure components

This paper

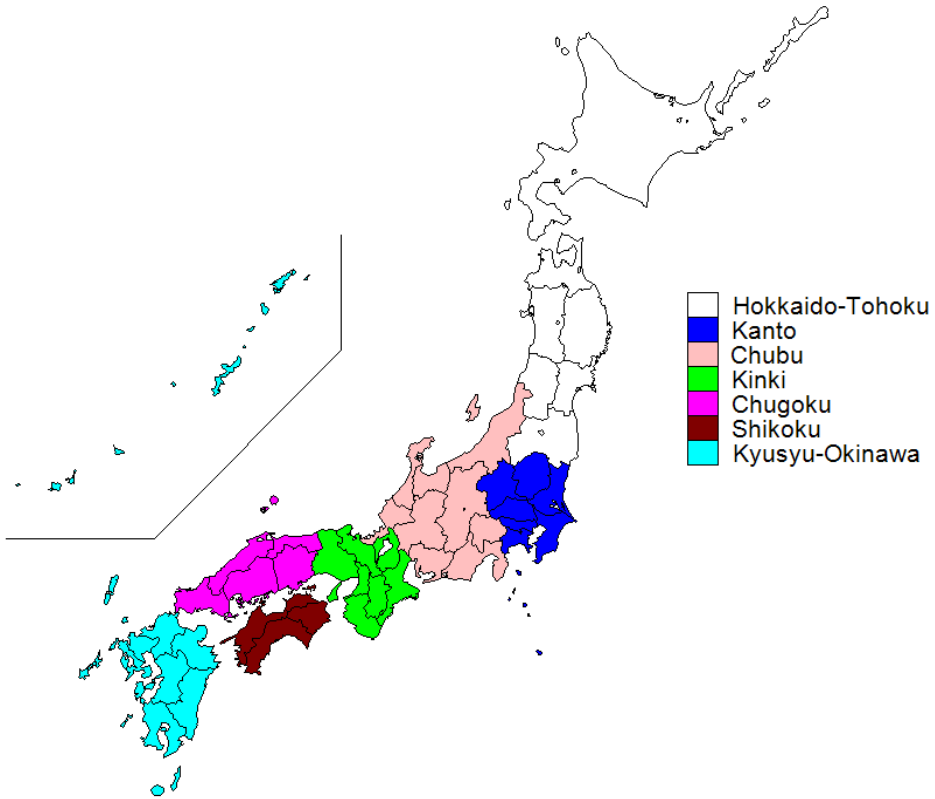
1. Estimate LFM at regional level
   - Separate the country into regions
   - Regional fiscal multiplier (RFM)
2. Decompose RFM into prefectural fiscal multiplier (PFM) and region-wide spillover

$$\text{RFM} \simeq \text{PFM} + \text{Region-wide spillover}$$

3. Decompose RFM into expenditure components

$$\text{RFM} \simeq \text{RFM}_\text{C} + \text{RFM}_\text{I} + \text{RFM}_\text{G} + \text{RFM}_\text{NX}$$

Regions



- Definition of "Region" used in *Prefectural Accounts* ▸ Estimation

Why Japan?

- Prefectural accounts in JPN are constructed in a way highly comparable to the national account
- Cabinet Office in JPN publishes C, I, G and NX at the prefectural level
  - BEA in the US does not publish I, G and NX at the state/county level

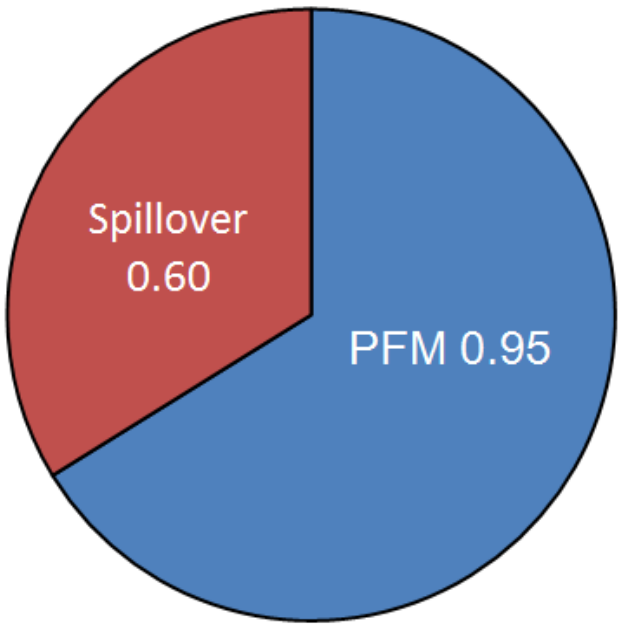
Main findings

- RFM $= 1.55$

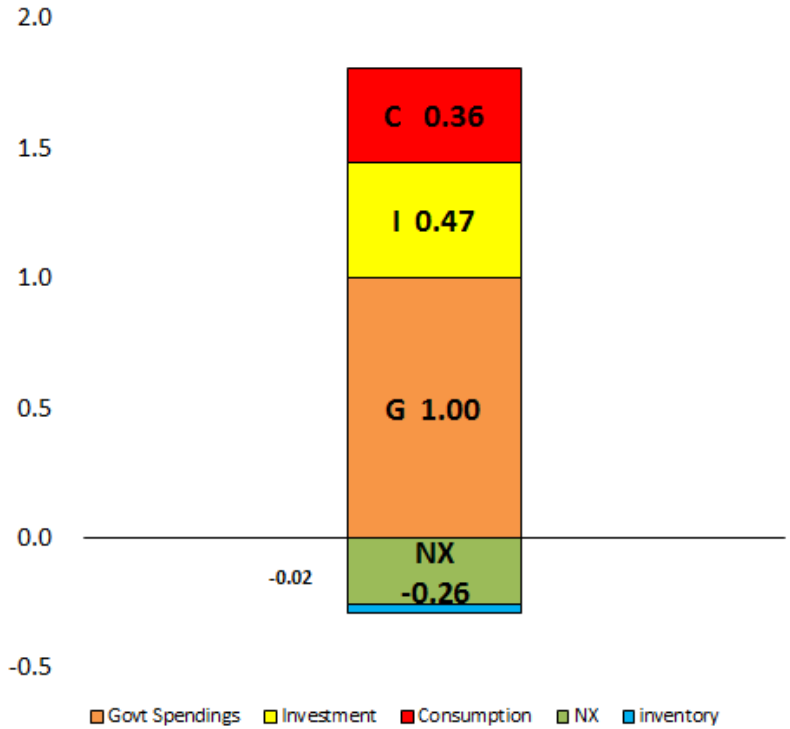
Main findings

- RFM = 1.55

Geographic decomposition



Expenditure decomposition



Literature on local fiscal multipliers

- Most studies are based on the US state/county
  - ARRA papers estimate "Jobs-multiplier" and "cost-per-job"
    - using state-level employment data of BLS
    - Chorodow-Reich et al. (2012), Conley and Dupor (2013), Wilson (2012), Dupor and McCroy (2017) among others
  - Non-ARRA papers focus on output multiplier or income multipliers
    - Nakamura and Steinsson (2014), Clemens and Miran (2012), Shoag (2016), Suárez-Serrato and Wingender (2016)

Literature on local fiscal multipliers

- Most studies are based on the US state/county
  - ARRA papers estimate "Jobs-multiplier" and "cost-per-job"
    - using state-level employment data of BLS
    - Chorodow-Reich et al. (2012), Conley and Dupor (2013), Wilson (2012), Dupor and McCroy (2017) among others
  - Non-ARRA papers focus on output multiplier or income multipliers
    - Nakamura and Steinsson (2014), Clemens and Miran (2012), Shoag (2016), Suárez-Serrato and Wingender (2016)
- International evidence
  - Japan: Brückner and Tuladhar (2014) focus on the 1990s and relationship with financial distress
  - Italy: Acconcia et al. (2014), China: Guo et al. (2016)
- Our focus: spillover and expenditure components

Empirical strategy

Estimation equation used in the literature

- Typical estimation eq.

$$\frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}} = \beta_R \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \alpha_r + \delta_t + \varepsilon_{r,t}$$

  - $Y_{r,t}$: per capita GDP in region r
  - $G_{r,t}$: per capita gov't spending in region r
  - β_R: (two-year cumulative) RFM ▸ region

- We do not estimate this equation, but ...

Our estimation equation

- We use the prefecture data...

$$\frac{y_{r,p,t} - y_{r,p,t-2}}{y_{r,p,t-2}} = \gamma_P \frac{g_{r,p,t} - g_{r,p,t-2}}{y_{r,p,t-2}} + \eta_{r,p} + \delta_t + \varepsilon_{r,p,t}$$

  - $y_{r,p,t}$: per capita GDP in prefecture p that belongs to region r
  - $g_{r,p,t}$: per capita gov't spending in p
  - $\eta_{r,p}$: entity fixed effect

- An interpretation
  - γ_P: PFM
  -

Our estimation equation

- ... together with regional gov't spending:

$$\frac{y_{r,p,t} - y_{r,p,t-2}}{y_{r,p,t-2}} = \gamma_P \frac{g_{r,p,t} - g_{r,p,t-2}}{y_{r,p,t-2}} + \gamma_S \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \eta_{r,p} + \delta_t + \varepsilon_{r,p,t}$$

  - $y_{r,p,t}$: per capita GDP in prefecture p that belongs to region r
  - $g_{r,p,t}$: per capita gov't spending in p
  - $\eta_{r,p}$: entity fixed effect

- An interpretation
  - γ_P: PFM
  - γ_S: region-wide spillover

Geographic decomposition

- Take the weighted average of estimation eq.

$$\Rightarrow \frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}} \simeq \underbrace{(\gamma_P + \gamma_S)}_{\beta_R} \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \alpha_r + \delta_t + \varepsilon_{r,t}$$

  - Weight $\omega_{r,p}$: time-series mean of the GDP share of p to r
  - $\alpha_r = \sum_{p \in r} \omega_{r,p} \eta_{r,p}$, $\varepsilon_{r,t} = \sum_{p \in r} \omega_{r,p} \varepsilon_{r,p,t}$

- Bottom line: Under some assumptions for approx. more

$$\text{PFM} + \text{region-wide spillover} \simeq \text{RFM}$$

- The same calculation can be made for expenditure components of GDP

Data and Instruments

Data

- Sample period: 1990 – 2012
  - *Annual Report on Prefectural Accounts*
  - *Annual Statistical Report on Local Government Finance*
- 7 regions and 47 prefectures
- Local gov't spending: more
  - Gov't consumption + public investment
    - e.g., Blanchard and Perotti (2002)

Instruments: Treasury disbursements

- Gov't spending is endogenous
- To instrument gov't spending, we use cross-sectional variations in treasury disbursements
  - Transfers from the *central gov't*

Why treasury disbursements?

1. Important revenue source for the local gov't
    - Large vertical fiscal gap btwn the central and local gov'ts

Why treasury disbursements?

1. Important revenue source for the local gov't
   - Large vertical fiscal gap btwn the central and local gov'ts
2. Financed by national tax revenue pooled by the central gov't
   - unlikely to be affected by local business cycle

Why treasury disbursements?

1. Important revenue source for the local gov't
   - Large vertical fiscal gap btwn the central and local gov'ts
2. Financed by national tax revenue pooled by the central gov't
   - unlikely to be affected by local business cycle
3. Program-based transfers
   - e.g., Grants for compulsory education, public health, construction (roads, ports, rivers, ...)
   - Some grants are mandatory by the *Local Public Law*
   - Other grants are discretionary, but the outline of programs is determined by the central gov't, not by local gov't
   - We can remove transfers associated with local business cycle (e.g., Great East Japan earthquake) in constructing instrument

Components of treasury disbursements

Program	% (as of 2012)	Used for IV?
Education	30.3	Yes
Construction	21.3	Yes
Grants related to local business cycle[1)]	11.2	No
Disaster	9.2	No
Other earmarked transfers[2)]	4.7	Yes
Unknowns[3)]	23.3	No

1. e.g., supplemental social security income for low income people, unemployment measures, etc.
2. subsidies for national projects (Cost for elections, census, statistical data, subsidy for electric power plants, ...)
3. referred to "others" in *Annual Report of Local Government Finance* ▸ graph

Results

Benchmark results

Output growth	OLS		2SLS	
RFM (β_R)	1.14**		**1.55****	
	(0.20)		(0.27)	
PFM (γ_P)	0.44**	0.60*	0.95**	1.18**
	(0.13)	(0.13)	(0.27)	(0.21)
Spillover (γ_S)	0.70**		0.60	
	(0.19)		(0.35)	
P-value of J-test			0.12	0.17
Observations	987	987	987	987
Adj. R^2	0.55	0.54	0.51	0.49

Note: *5% significance level, ** 1% significance level. Time FE and Prefectural FE are included. SE clustered by prefectures. Angrist-Pischke's first-stage F is 17.9 for $\left(g_{r,p,t} - g_{r,p,t-2}\right) / y_{r,p,t}$ (Adj. $R^2 = 0.69$) and 763.4 for $\left(G_{r,t} - G_{r,t-2}\right) / Y_{r,t}$ (Adj. $R^2 = 0.86$). We include the dummy for Great East Japan Earthquake as a control variable.

- In 2SLS
  - The estimated RFM is larger than one
  -

Benchmark results

Output growth	OLS		2SLS	
RFM (β_R)	1.14**		**1.55****	
	(0.20)		(0.27)	
PFM (γ_P)	0.44**	0.60*	0.95**	1.18**
	(0.13)	(0.13)	(0.27)	(0.21)
Spillover (γ_S)	0.70**		**0.60**	
	(0.19)		(0.35)	
P-value of J-test			0.12	0.17
Observations	987	987	987	987
Adj. R^2	0.55	0.54	0.51	0.49

Note: *5% significance level, ** 1% significance level. Time FE and Prefectural FE are included. SE clustered by prefectures. Angrist-Pischke's first-stage F is 17.9 for $\left(g_{r,p,t} - g_{r,p,t-2}\right) / y_{r,p,t}$ (Adj. $R^2 = 0.69$) and 763.4 for $\left(G_{r,t} - G_{r,t-2}\right) / Y_{r,t}$ (Adj. $R^2 = 0.86$). We include the dummy for Great East Japan Earthquake as a control variable.

- In 2SLS
  - The estimated RFM is larger than one
  - Positive spillover, but imprecisely estimated

Expenditure components in GDP

- RFM =1.55
  - Crowding-in effect must be observed
  - What expenditure components?

Private consumption, investment and net exports

	Consumption	Investment	Net exports
RFM (β_R)	**0.36***	**0.47****	-0.26
	(0.15)	(0.14)	(0.32)
PFM (γ_P)	-0.04	0.22	-0.24
	(0.17)	(0.13)	(0.30)
Spillover (γ_S)	0.41**	0.25**	-0.03
	(0.15)	(0.10)	(0.38)
Observations	987	987	987
Adj. R^2	0.21	0.58	0.14

Note: *5% significance level, ** 1% significance level. In all cases, tests of overidentifying restrictions fail to reject the null at conventional significance level.

- Crowding-in effect in consumption and investment
-

Private consumption, investment and net exports

	Consumption	Investment	Net exports
RFM (β_R)	0.36*	0.47**	-0.26
	(0.15)	(0.14)	(0.32)
PFM (γ_P)	-0.04	0.22	-0.24
	(0.17)	(0.13)	(0.30)
Spillover (γ_S)	**0.41****	**0.25****	-0.03
	(0.15)	(0.10)	(0.38)
Observations	987	987	987
Adj. R^2	0.21	0.58	0.14

Note: *5% significance level, ** 1% significance level. In all cases, tests of overidentifying restrictions fail to reject the null at conventional significance level.

- Crowding-in effect in consumption and investment
- Spillover is economically and statistically significant in consumption and investment ▸ More

Summary: benchmark regressions and absorption

	GDP	Absorption
RFM (β_R)	1.55**	1.81**
	(0.27)	(0.20)
PFM (γ_P)	0.95**	1.19**
	(0.27)	(0.23)
Spillover (γ_S)	**0.60**	**0.63****
	(0.35)	(0.19)
Observations	987	987
Adj. R^2	0.51	0.58

- "Absorption": domestic expenditure within the prefecture
- Spillover is economically and statistically significant in "domestic absorption" ($c_{r,p,t} + i_{r,p,t} + g_{r,p,t}$)
- ▸ Robustness

Back-of-envelope calculation of nation-wide spillover

- Consider a hypothetical eq.

$$\frac{Y_{r,t} - Y_{r,t-2}}{Y_{r,t-2}} = \beta_R \frac{G_{r,t} - G_{r,t-2}}{Y_{r,t-2}} + \beta_S \frac{G_t - G_{t-2}}{Y_{t-2}} + \alpha_r + v_{r,t}$$

  where G_t denotes the national gov't spending and
  β_S =nation-wide spillover

- β_S is very difficult to identify because we cannot use time-fixed effect

Back-of-envelope calculation of nation-wide spillover

- We can back-of-envelope calculate β_S

$$\frac{Y_t - Y_{t-2}}{Y_{t-2}} \simeq \Big(\underbrace{\beta_R + \beta_S}_{\text{national FM}}\Big) \frac{G_t - G_{t-2}}{Y_{t-2}} + \alpha + v_t$$

- Compare our β_R with the national fiscal multiplier estimated by *previous studies*

	National FM	β_R	Nation-wide spillover
Time series			
Miyamoto et al. (2016)	1.70	1.55	0.15
Watanabe et al. (2010)	1.56	1.55	0.01
Macro-econometric			
BOJ (2016)	1.40	1.55	-0.15
ESRI (2015)	1.24	1.55	-0.31

Note: National fiscal multipliers in the tables are the previous studies' estimates

Conclusion

1. How large is the local fiscal multiplier?
    - 1.6
2. How large is the region-wide spillover?
    - About 1/3 of RFM
3. How large is the RFM on expenditure components of GDP?
    - Crowding-in effect
    - Economically and statistically significant spillover in demand within prefecture

Remarks on geographic decomposition

- The approximation result is

$$\text{RFM} \simeq \text{PFM} + \text{region-wide spillover}$$

- This interpretation is valid as long as
  1. Distributions of output and population within a region are stable during the sample periods:
  2. Regions are defined as a group
  3. Control variables may weaken the approximations
- back

Remarks on gov't spending

1. Our definition

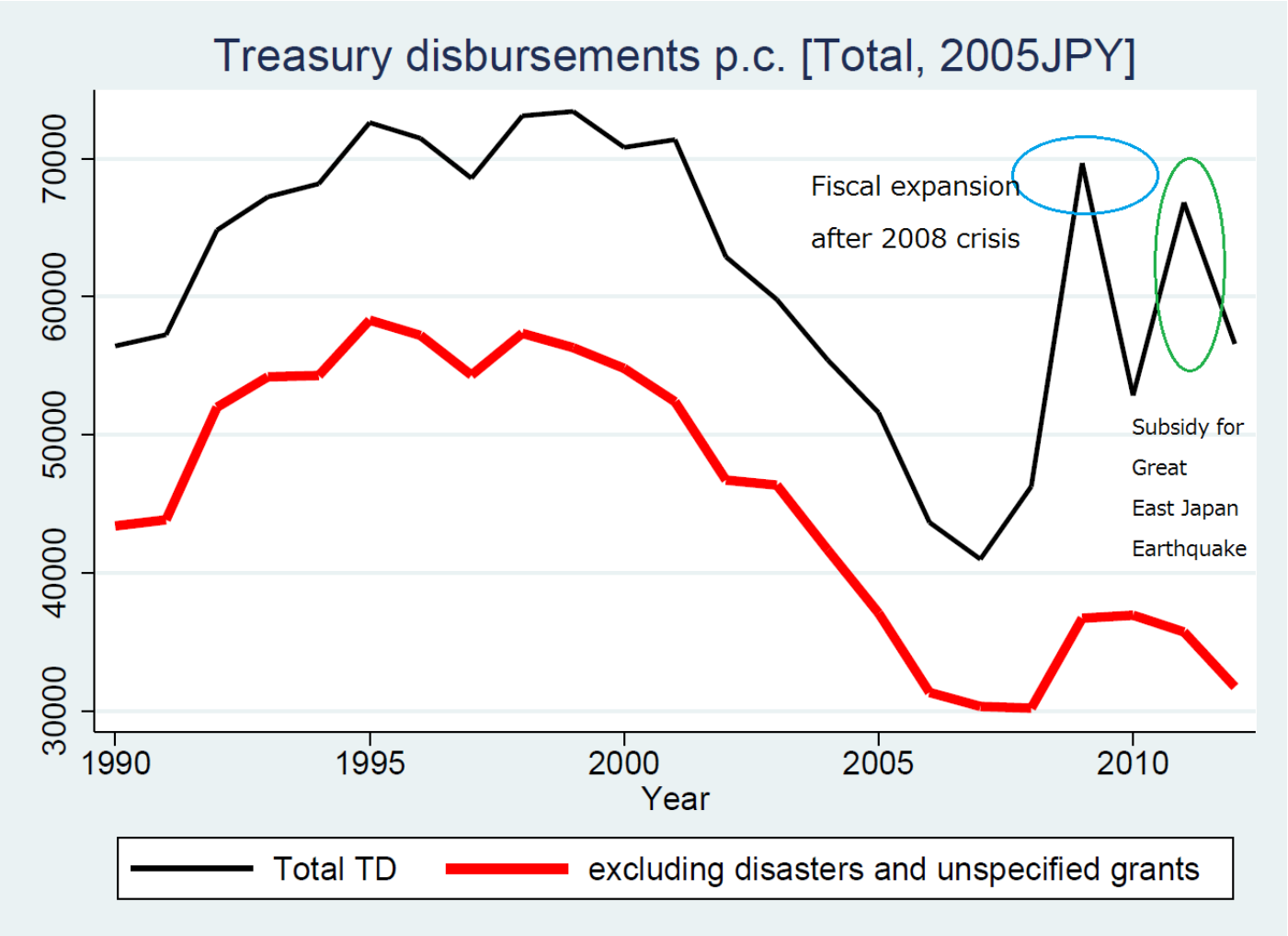
   - $g_{r,p,t}$ =gov't consumption + public investment
   - Similar results when $g_{r,p,t}$ = public investment

2. Due to lack of data, gov't spending

   - $g_{r,p,t}$ =local gov't spending + direct spending in p by central gov't
   - On average, 60% of spending are made local governments (prefectures + municipalities) and 40% is made by the central gov't

back

Treasury Disbursements (national level)



back

Hypothesis

- Small PFM due to two offsetting effects
  1. Expenditure-switching effect
     - Increase in $g_{r,p,t}$ $\Rightarrow$Increase in domestic relative prices$\Rightarrow$ *Decline* in domestic demand
  2. Income effects on liquidity constrained agents
     - Increase in $g_{r,p,t}$ $\Rightarrow$ *Increase in* domestic demand

Hypothesis

- Small PFM due to two offsetting effects
  1. Expenditure-switching effect
     - Increase in $g_{r,p,t}$ $\Rightarrow$Increase in domestic relative prices$\Rightarrow$ *Decline* in domestic demand
  2. Income effects on liquidity constrained agents
     - Increase in $g_{r,p,t}$ $\Rightarrow$ *Increase in* domestic demand
- Large region-wide spillover due to complementary effects
  1. Expenditure-switching effect
     - Increase in $G_{r,t}$ $\Rightarrow$ Decline in domestic relative prices$\Rightarrow$*Increase* in demand for domestic goods
  2. Income effects
     - Increase in $G_{r,t}$ $\Rightarrow$ Leakage in demand $\Rightarrow$Increase in income $\Rightarrow$*Increase* in demand for domestic goods

back

Robustness

- Adding controls
  - Population growth rate (due to assumption of the stable population distribution)
- Dropping samples prefectures that may be an outlier
  - Hokkaido and Okinawa
  - Tokyo
  - Dropping samples of Fukushima, Iwate, Ibaraki, Miyagi after 2011 ($D^E_{r,p,t} = 1$)
- Our multiplier is two-year cumulative multiplier
  - 1 year or 3 years?
- Fiscal multiplier of public investment
- back

Robustness check (i): Adding Pop. growth, Lagged dependent var.

- Adding population growth

	Output	Absorption
RFM (β_R)	1.53**	1.76**
	(0.28)	(0.23)
PFM (γ_P)	0.95**	1.17**
	(0.28)	(0.24)
Spillover (γ_S)	0.59	0.58**
	(0.35)	(0.21)
Observations	987	987
Adj. R^2	0.51	0.58

Back

Robustness check (i): Adding Pop. growth, Lagged dependent var.

- Adding the lagged dependent variable

	Output	Absorption
RFM (β_R)	1.54**	1.94**
	(0.27)	(0.20)
PFM (γ_P)	1.08**	1.29**
	(0.30)	(0.2)
Spillover (γ_S)	0.46	0.65**
	(0.32)	(0.17)
Observations	893	893
Adj. R^2	0.54	0.62

Back

Robustness check (i): Adding Pop. growth, Lagged dependent var.

- Adding the population growth and lagged dependent variable

	Output	Absorption
RFM (β_R)	1.46**	1.87**
	(0.25)	(0.21)
PFM (γ_P)	1.06**	1.27**
	(0.29)	(0.22)
Spillover (γ_S)	0.40	0.60**
	(0.30)	(0.19)
Observations	893	893
Adj. R^2	0.54	0.63

Back

Robustness check (ii): Dropping samples...

- Dropping Hokkaido and Okinawa

	Output	Absorption
RFM (β_R)	1.62**	1.72**
	(0.29)	(0.20)
PFM (γ_P)	1.03**	1.07**
	(0.25)	(0.24)
Spillover (γ_S)	0.59	0.65**
	(0.37)	(0.20)
Observations	945	945
Adj. R^2	0.51	0.60

- Hokkaido and Okinawa: the most northern and southern islands of JPN

Back

Robustness check (ii): Dropping samples...

- Dropping Tokyo

	Output	Absorption
RFM (β_R)	1.54**	1.82**
	(0.28)	(0.21)
PFM (γ_P)	0.94**	1.21**
	(0.28)	(0.24)
Spillover (γ_S)	0.60	0.62**
	(0.35)	(0.18)
Observations	966	966
Adj. R^2	0.51	0.58

- Tokyo is the most influential on other prefectures

Back

Robustness check (ii): Dropping samples...

- Estimation based on the sample before the global financial crisis

	Output	Absorption
RFM (β_R)	1.79**	2.04**
	(0.30)	(0.25)
PFM (γ_P)	0.86**	1.22**
	(0.25)	(0.24)
Spillover (γ_S)	0.93*	0.81**
	(0.41)	(0.33)
Observations	799	799
Adj. R^2	0.42	0.53

Back

Robustness check (ii): Dropping samples...

- Estimation dropping the disaster-hit prefectures (after the Great East Japan Earthquake in 2011)

	Output	Absorption
RFM (β_R)	1.74**	1.86**
	(0.28)	(0.22)
PFM (γ_P)	1.21**	1.25**
	(0.24)	(0.24)
Spillover (γ_S)	0.53	0.61**
	(0.34)	(0.19)
Observations	979	979
Adj. R^2	0.50	0.56

Back

Robustness check (iv): Cumulative fiscal multiplier

Output	1 year	2 years	3 years
RFM (β_R)	1.49**	1.55**	1.71**
	(0.30)	(0.27)	(0.28)
PFM (γ_P)	0.85**	0.95**	0.91**
	(0.21)	(0.27)	(0.27)
Spillover (γ_S)	0.65*	0.60	0.80*
	(0.32)	(0.35)	(0.34)
Observations	799	987	940
Adj. R^2	0.46	0.51	0.48

- The impact multipliers are estimated from the sample period before 2009

Robustness check (iv): Cumulative fiscal multiplier

Absorption	1 year	2 years	3 years
RFM (β_R)	2.15**	1.81**	2.06**
	(0.29)	(0.20)	(0.26)
PFM (γ_P)	1.29**	1.19**	1.20**
	(0.27)	(0.23)	(0.21)
Spillover (γ_S)	0.86*	0.63**	0.86**
	(0.36)	(0.19)	(0.26)
Observations	799	987	940
Adj. R^2	0.45	0.58	0.59

- The impact multipliers (1 year) are estimated from the sample period before 2009

Back

Robustness check (v): Multipliers of public investment

	Output	Absorption
RFM (β_R)	2.06**	2.19**
	(0.30)	(0.28)
PFM (γ_P)	0.99**	1.30**
	(0.32)	(0.27)
Spillover (γ_S)	1.06**	0.89**
	(0.40)	(0.26)
Observations	987	940
Adj. R^2	0.51	0.57

- RFM and spillover are both larger when we use public investment for gov't spending

Back

Constructing instruments

- Let
  - $s_{r,p,t}$ is prefecture-specific treasury disbursements after removing components related to local economies
  - $S_{r,t}$ is the region analog
- Our instruments are $\Delta s_{r,p,t}$, $\Delta s_{r,p,t-1}$, $\Delta S_{r,t}$, $\Delta S_{r,t-1}$ (scaled by lagged output)
  - We also use regional dummies interacted with $\Delta S_{r,t}$ and $\Delta S_{r,t-1}$ to allow for variation in sensitivity to regional variables across regions (Nakamura and Steinsson 2014)

Control variables

- In benchmark regression, we control for the negative impact of Great East Japan Earthquake
  - Dummy $D^E_{r,p,t}$ that takes one if the prefecture are strongly influenced by the earthquake and year $t > 2011$

$$D^E_{r,p,t} = \begin{cases} 1 & \text{if Fukushima, Ibaraki, Iwate, Miyagi and } t > 2011 \\ 0 & \text{otherwise.} \end{cases}$$

- Local tax rate?
  - We did not control for local tax rate, b/c local tax rates almost fully comove over time
  - Time fixed effect could remove the variations

back