Optimal Inter-governmental Transfer in Developing Countries: Equity, Efficiency, and Externality

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Motivation

- Intergovernmental transfers take on critical significance in numerous countries. It is noteworthy that in developing countries, the transfer payment or tax-sharing system is largely leveraged by the sub-national governments.
  - China: Transfers accounted for 39% of national tax revenues (2019)
  - India: Aggregate transfers to states as a proportion of gross state domestic product (GSDP) of all states reached 7.3% (14th Financial Commission 2015–2020)
  - Mexico: Unconditional transfers accounted for 42% of state-level governments' tax revenues (2007)
- Developing countries face more problems that are trivial in developed countries
  - **Fiscal equity**: Considerable inter-regional economic disparities
  - Efficiency: **Information asymmetry** and **dependency on transfers** ← hidden information/flypaper effect

    ▸ Equity and dependency on transfers
  - **Externalities** caused by public goods: spillover effect, mobile factors, inter-governmental competition.

Motivation

Developing countries partially consider the issues. However, the results are not inspiring:

- Equity: Expanding inter-regional economic gaps
  - Gini coefficient of local governments' revenues in China: above 0.3 (2016–2019)
  - Human Development Index in India, 2015 vs. 1990 (Rao, 2017)
- Efficiency: High transfer dependency and economic statistics with low credibility
  - The tax effort and revenue capacity factors in India
  - The restriction of public spending in Chinese formula-based transfers, also appears in Indonesia and South Africa
- Externalities: only in specific-purpose transfers

▸ Transfer policies in developing countries: instances

Research Questions

- How can we address the efficiency and externality problems and boost the inter-regional balance in developing countries?
- Which factors above should be primarily emphasized in developing countries?
- As for the prevailing transfer policies in developing countries, how can we reform them, and what's the welfare gain?

Approaches

- We use the optimal taxation theory to build the framework to accommodate the main problems in developing countries
- We obtain the optimal transfer and economic insights behind it by using the variation approach and sufficient statistics
- We use the recent Chinese county-level fiscal data to conduct the numerical analysis

Results

- We obtain the optimal transfer payment which can be decomposed into an ABC-D form with four determinants, corresponding to the aforementioned **efficiency**, **equity**, and **externality** problems
- Our numerical simulations have the following results:
  - The prevailing policy in China is too progressive compared with the optimal transfer
  - The redistribution term rather than the hazard rate dominates the shape of the optimal transfer payment curve (Heathcote and Tsujiyama, 2021, *JPE*)
  - Externalities are critical in determining the optimal marginal transfer policy
  - The welfare improvement of policy reform equals about an increase of 6% in per capita consumption

Key Contributions

1. **Model**: Based on the method of optimal taxation theory (Mirrlees, 1971, *RES*), we apply the method to the scenario of transfer payment policies with extensions of settings (Lockwood, 1999,*JPubE*)
2. **Framework**: We focus on comprehensive problems in developing countries and give a framework to analyze these issues (Compared with Fajgelbaum and Gaubert(2020, *QJE*), Gaubert et al.(2021))
3. **Numerical Analysis**: We conduct a quantitative comparison between current and optimal transfer policies, and also evaluate the welfare improvement and sufficient statistics (Martinez-Vazquez and Sepulveda, 2011; Rao, 2017),

Roadmap

1. Introduction
2. The Model
3. Numerical Simulation
4. Conclusions

Setup

Given a country with a continuum of provinces, each of them having a heterogeneous endowment level $\xi \in \Xi \subset \mathbb{R}_+ \rightarrow$ productivity/amenities

- Residents in each region consume both private and public goods.:

$$U = u(g(\xi), e) + v(c(\xi)), \tag{1}$$

- g: non-productive public goods
  c: private consumption
  e: externalities
- $u_g > 0$, $u_{gg} < 0$, $u_e > 0$, and $u_{ge} \geq 0$

Setup

- The budget constraint for the residents in a region with endowment ξ is:

$$c = \mathcal{F}(\xi, \varepsilon) - r(\xi) \tag{2}$$

- r: lump-sum tax on residents levied by the local government
- ε: the productive expenditures of local governments
- The total output $\mathcal{F}$ is also unobservable to the central government $\rightarrow$ **information asymmetry** in China (Chen et al., 2019; Xiong, 2018; Li et al., 2019)
- The price of public goods is assumed to be equal to that of private goods

Setup

- The budget constraint for a local government with endowment level ξ satisfies:

$$\tau(g) + r(\xi) = g(\xi) + \varepsilon(\xi) \tag{3}$$

- $\tau(\cdot) \in C^2(\mathbb{R}, \mathbb{R}_+)$: non-linear transfer payment
- Principle-agent model: the central government provides a contract $\{\tau, g\}_{\xi \in \Xi}$ to local governments
- Remark: Why based on g? $\rightarrow$ Concerns about **flypaper effect**

Setup

- Externalities: Lockwood(1999); Kaplow(2012)

$$e \triangleq E(g) \tag{4}$$

- Extension of externalities:
  - Mobile households (Gaubert et al., 2021; Fajgelbaum and Gaubert, 2020 *QJE*)
  - Local governors' tournaments (Li et al., 2019, *EJ*)

Theoretical Analysis

- Rewriting the utility function:

$$U(\xi) = u(g(\xi), e) + v(\tau(g) - g(\xi) - \varepsilon(\xi) + \mathcal{F}(\xi, \varepsilon)) \tag{5}$$

The first-order conditions under the decentralized economy defined as:

$$-\frac{u_g}{v_c} = \tau'(g) - 1 \tag{6}$$

$$v_c(\mathcal{F}_\varepsilon - 1) = 0 \tag{7}$$

- Let $\mathcal{F}(\xi, \varepsilon) - \varepsilon(\xi) \triangleq n \in \mathcal{N} = [\underline{n}, \overline{n}] \subset \mathbb{R}_+$
- n: the local resources that can be employed to offer non-productive public services g and private consumption c (information unobservable for the central government)

Theoretical Analysis

- The central government's problem:

$$\begin{aligned} &\max_{\{g(n),c(n),e\}} \int_n \gamma(n)U(n)dF(n) \\ \text{s.t.} \quad &\text{IC constraint} \\ &\int_n (c(n)+g(n)-n)dF(n)=0 \\ &e=E(g) \end{aligned} \tag{8}$$

- γ: welfare weights $\rightarrow$ **fiscal equity** preference of policymakers

ABC-D Form of Optimal Transfer

The optimal marginal transfer is obtained as:

$$\frac{\tau'(g)}{\tau'(g)-1} = A(n)B(n)C(n) + D(e,n) \tag{9}$$

where

- $A(n)$: elasticity of public spending (**Efficiency: distortion of public spending induced by transfers**) ▸ Elasticities
- $B(n)$: hazard rate (**Efficiency: distribution of public goods**)
- $C(n)$: redistribution term (**Equity: fiscal equity**)
- $D(e,n)$: externality effect (**Externality**)
  - In the mobile household case, $D(V,n)$ represents the migration effect (V: indirect utility functions of local residents)
  - In the tournament case, D can be decomposed into D_1 and D_2, reflecting the competition among local governors and the reaction of central government

Data and Background

- County-level final accounts data were collected from 2016 to 2019 in 26 Chinese provinces, which were merged with population data
- The expenditures for basic public services were adopted to measure the expenditure of public goods of local governments
- The public goods can be divided into two forms: productive and non-productive public goods in Barro(1990)
- Nine types of expenditures are selected as the proxy of basic public services

▸ Basic public services

Parameters

- Utility function:

$$U(g, c, e) = \beta g^{\alpha} e^{\theta} + \frac{c^{1-\sigma}}{1-\sigma}$$

- Pre-determined parameters: $\sigma = 2$
- α: regression using an unbalanced panel with 2,619 observations in the range of 2016–2019

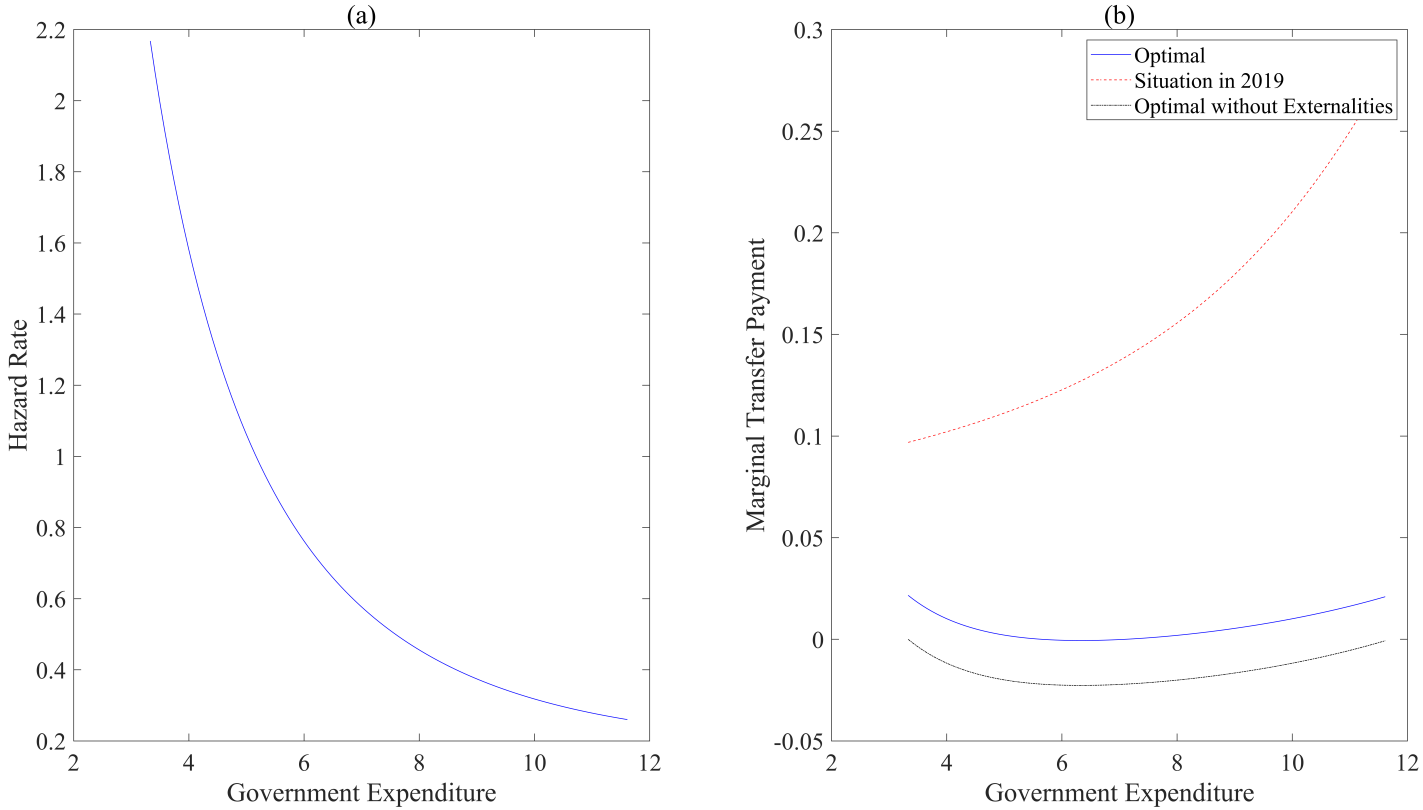
$$\alpha\beta g^{\alpha-1} e^{\theta} = (1-\tau')c^{-\sigma} \rightarrow y_{it} = (1-\alpha)\ln g_{it} + \epsilon_{it} + \chi_i + \nu_t \quad (10)$$

where $y_{it} = \sigma \ln c - \ln 1 - \tau'$

Parameters

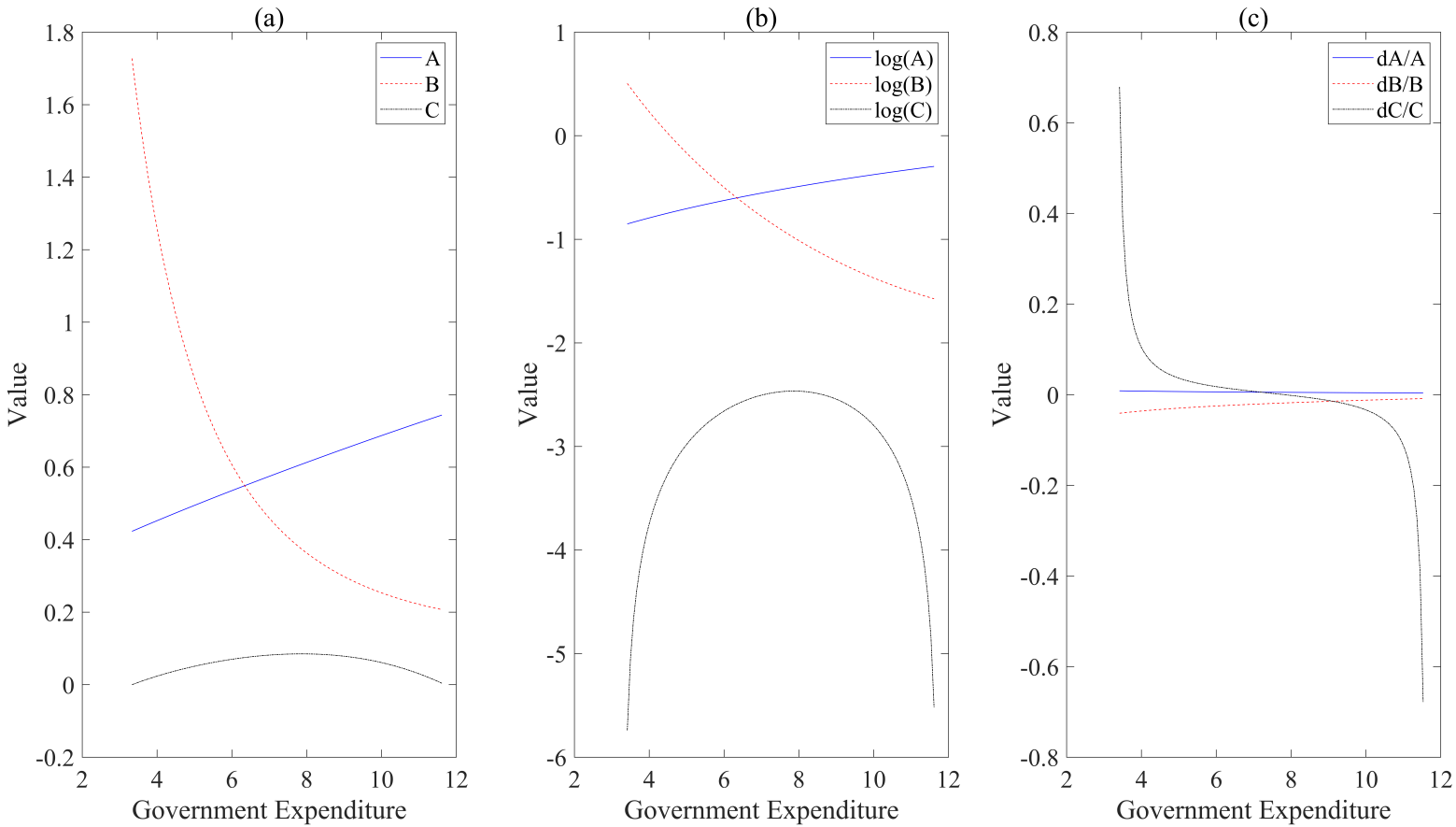
- Set $\alpha = 0.74 \in [0.732, 0.744]$ ▸ Estimation results
- β and θ are estimated by using the GMM method to fit the mean and variation of county-level total retail sales of consumer goods per capita in the range of 2016–2019
- $\beta = 0.0093$ and $\theta = 0.031$
- $\widetilde{\gamma} = 1$: utilitarian preference

Results: Comparison



- τ: GT
- g: expenditures of basic public services
- Graph (a):the hazard rate $\frac{1-H(g^*)}{gh(g)}$. Graph (b): the optimal τ' compared with the real one

Results: Decomposition of Determinants



Results: Welfare

Table: Welfare improvement relative to the current transfer policy schedule

Parameter	Welfare improvement (RMB per capita)	Percentage of $E(c_r)$ (%)	Percentage of $E(c_0)$ (%)
$\sigma = 2, \alpha = 0.75$	2.46×10^3	6.21	5.07
$\sigma = 2.5, \alpha = 0.70$	1.22×10^3	5.98	2.51
$\sigma = 3, \alpha = 0.68$	7.33×10^2	5.79	1.51

Results: Sufficient Statistics

- From the numerical results, the elasticity term $A(n)$ ranges from about -2.5 $\sim$ -1.25
- We use the following regression to estimate the price elasticity $\widetilde{\epsilon}_n^c$:

$$\begin{aligned}\ln g_{basic,i,t} =& \beta_1 \ln\left(1-\tau'_{BT,i,t}\right) + \beta_2 \ln \tau_{ST,i,t} + \beta_3 \ln\left(1-\tau'_{BT,i,t-1}\right) \\ &+ \beta_4 \ln \tau_{ST,i,t-1} + \vec{\beta}\vec{X}_{i,t-1} + \chi_i + \nu_t + \epsilon_{i,t}\end{aligned} \tag{11}$$

- The price elasticity is around -1.4$\sim$-5.9

Results: Sufficient Statistics

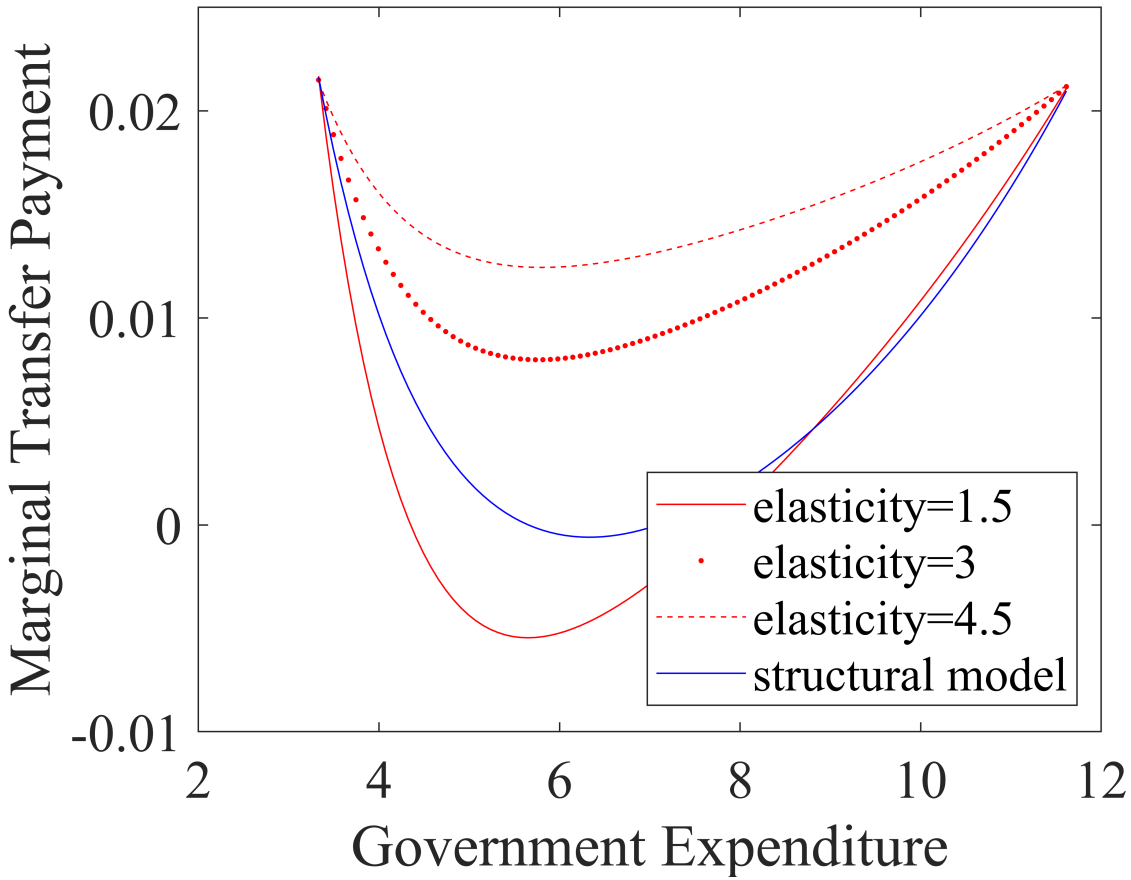


Figure: The comparison between the structural model and the sufficient statistic method

Conclusions

- Questions: The requirement of transfer payment policies in developing countries
  - To eliminate the inter-regional fiscal disparities and tackle the vertical fiscal imbalance
  - To mitigate the distortion resulting from information asymmetry
  - To address the externalities attributed to public spending
- Approaches:
  - Model: The principle-agent model with externalities to match the main problems
  - Numerical computation: Employing recent county-level Chinese data and the MWY method
- Results:
  - The theoretical results conform to the efficiency, equity, and externality issues in developing countries, indicating how they determine the design of transfer payment
  - The numerical results suggest increasing the redistribution effect of the prevailing transfer policy in China. The welfare gain is considerable. Sufficient statistics are estimated and available for the policymaker

Thank You for Listening!

Inequity and Flypaper Effect

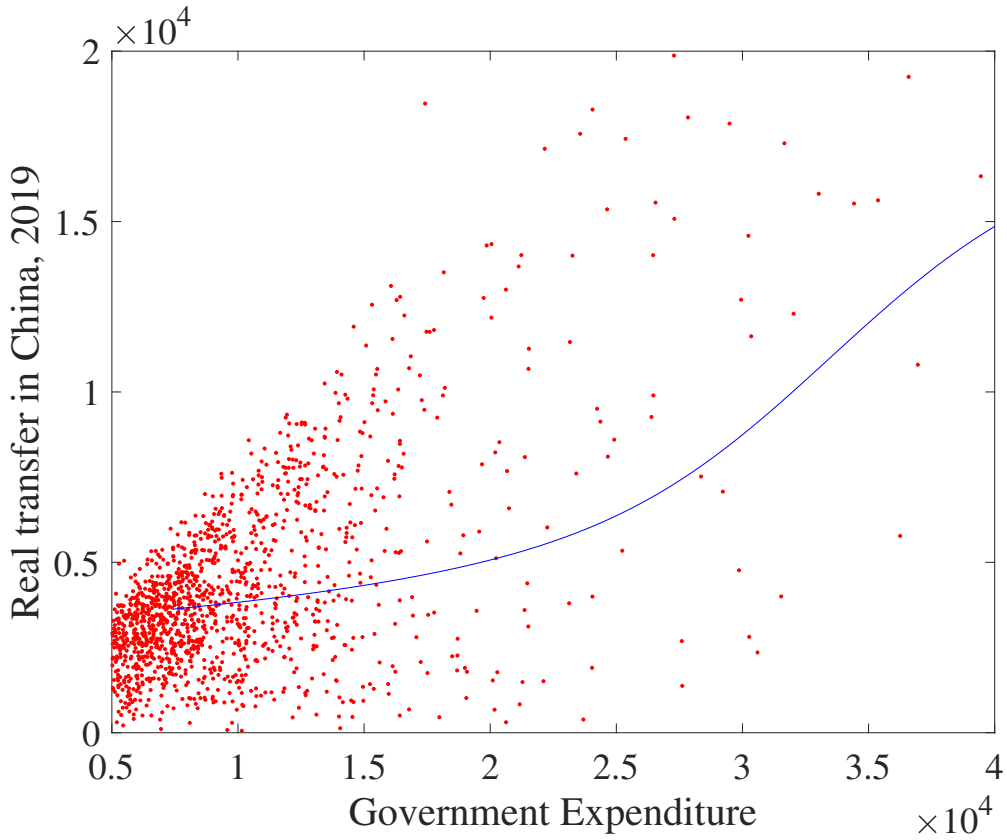


Figure: The relationship between per capita government expenditures in the general budget (horizontal axis) and per capita transfer payments (vertical axis) across county-level regions in China, 2019. Each region is depicted as a red dot located at the intersection of its transfer and spending levels. The blue solid line represents the curve fitted to the relationship between the two variables using the

Inequity and Flypaper Effect

Table: Inter-regional Disparity and Flypaper Effect of Latin American Countries

	2000	2001	2002	2003	2004	2005	2006	2007
Argentina								
coefficient of variation of GDP per capita	0.70	0.69	0.84	0.77	0.76	0.77	–	-
Correlation between GDP per capita and sharing revenues	0.23	0.21	0.36	0.29	0.25	0.23	–	–
Bolivia								
coefficient of variation of GDP per capita	0.27	0.28	0.28	0.29	0.35	0.49	0.49	0.55
Correlation between GDP per capita and sharing revenues	–	0.71	0.72	0.78	0.81	0.76	0.68	0.71
Brazil								
coefficient of variation of GDP per capita	–	–	0.44	0.54	0.54	0.54	0.54	0.53
Correlation between GDP per capita and sharing revenues	–	–	0.03	-0.22	-0.30	-0.30	-0.29	-0.31
Correlation between GDP per capita and other transfers	–	–	-0.17	0.06	0.41	0.35	0.39	0.40
Mexico								
coefficient of variation of GDP per capita	1.14	1.17	1.16	1.24	1.40	1.40	1.57	1.40
Correlation between GDP per capita and sharing revenues	0.51	0.57	0.46	0.58	0.64	0.59	0.62	0.57
Peru								
coefficient of variation of GDP per capita	–	–	–	–	0.60	0.61	0.69	0.65
Correlation between GDP per capita and sharing revenues	–	–	–	–	0.19	0.72	0.79	0.80

Source: Martinez-Vazquez and Sepulveda, 2011

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Chinese Transfer Policies

- Tax Rebates.(11.5% of total transfer payments and tax rebates in 2018)
- General Transfer Payments(55.6% in 2018)
- Special Transfer Payments.(32.9% in 2018)
- Transfer Payments for Shared Fiscal Powers (in General Public Budget) (42.9% of total transfer payments in 2019)
- Horizontal Transfer Payments

Chinese Transfer Policies: Formula Method

The Chinese central government formulated "the balanced transfer payment"(BT) program in 1995, which established the formula method.

$$BT_i = (SE_i - SR_i) \times TC_i,$$

- SE_i: the standard financial expenditure of a region i
- SR_i: the standard financial revenue of a region i
- TC_i: transfer payment coefficient of a region i

Chinese Transfer Policies: Formula Method

$$SR_i = \hat{Base}_i \times \overline{Rate},$$

- $\hat{Base}_i$: regional tax bases (mainly based on objective economic indicators that the central government can observe)
- $\overline{Rate}$: national average tax rate

$$SE_{general\ public\ service,i} = Pop_i \times \overline{Exp/Pop} \times Cost_i(\vec{W}_i, \vec{Exp}_i),$$

- $\overline{SE_i}$: necessary expenditures for **basic public services**
- $\overline{Exp/Pop}$: national standard level of expenditure of the general public service per capita
- Pop_i: population in a region i
- Exp_i: the actual expenditure of the general public service in a region i
- $Cost_i$: cost coefficient

Main Concerns for Transfers in Developing Countries

Main concerns and characteristics of transfer payment policies in developing countries:

- Inter-regional equity
- Information asymmetry
- Consideration of externalities

Question:

- Do Chinese governments solve these issues completely?
- If not, how to evaluate and reform the current policies?
- How can the concerns of the policymaker be encompassed?

▸ Back to the main part

Fredholm Equation

The optimal transfer payment problem requires to solve the standard Fredholm integral equation of the second kind as follows:

$$\Gamma(n) + \int K(m,n)\Gamma(m)dm = Q(n)M(n) \tag{12}$$

and $\hat{g}$ satisfies:

$$\hat{g} = \widetilde{\epsilon}_n^c \hat{T}' + \widetilde{\eta}_n \hat{T}/g + \frac{S_m}{1+S_{mm}}(\widetilde{\epsilon}^{g,e}\frac{g}{e}) \tag{13}$$

where $S_m = \int_{\underline{n}}^{\overline{n}}(\widetilde{\epsilon}_n^c \hat{T}' + \widetilde{\eta}_n \hat{T}/g)f(m)dm$, $S_{mm} = -\int_{\underline{n}}^{\overline{n}}(\widetilde{\epsilon}^{g,e}\frac{g}{e})f(m)dm$.
Or equivalently,

$$\frac{\hat{g}}{g} = \frac{\widetilde{\epsilon}_n^c \hat{T}' + \widetilde{\eta}_n \hat{T}/g}{\tau' - 1} + \frac{\overline{\hat{g}_{PE}}}{g}\frac{g_e}{1-\overline{g_e}} \tag{14}$$

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Mirrlees Method

Proposition 2

The optimal transfer policy among regions, subject to IC and RC constraint, can be expressed as follow:

$$\frac{\tau'(g)+\frac{\phi}{\lambda}}{\tau'(g)-1}=\frac{1}{\widetilde{\epsilon}_n^c}\cdot\frac{1-H(g)}{gh(g)}\cdot\int_g^{\overline{g}}\frac{h(g')}{1-H(g)}(\beta(g')-1)e^{\int_{g'}^{g}\frac{v_{cc}}{v_c}(\tau'-1)dg''}dg', \tag{15}$$

where $\frac{\phi}{\lambda}=-\int_{\underline{n}}^{\overline{n}}\frac{u_e}{v_c}f(n')dn'$ is the marginal social value of the effect of social welfare.

- Remark: the equivalence between the variation approach and mechanism design

▸ Back to the main part

Basic Public Service

- Two documents are referred to in this paper:
  - *Administration Measures for the Management of Reward Funds for the Central Government's Basic Financial Support Mechanism for County-level Governments*
  - *State Council Notice on the Issuance of the 13th Five-Year Plan to Promote Equalization of Basic Public Services*(13FYP)
- Three criteria are followed:
  - Whether the main expenditure purpose and direction of the expenditure item exert direct effects on the production of enterprises, industries, or society in the **short term**
  - Whether this type of expenditure is principally domestic
  - Whether this expenditure has difficulty directly affecting production and residents' utilities, or whether it has a low probability to affect production and utilities
- Expenditures with regard to general public service, national defense, public safety, education, cultural, sports, and media, social security, and employment, medical and health care, urban and rural community affairs, as well as housing security

Estimation Results

Table: The Estimation of α

VARIABLES	(1) y(GT)	(2) y(GT)	(3) y(BT)	(4) y(BT)	(5) y(GT& K)
ln(g)	0.268***	0.655***			0.235***
	(0.0880)	(0.0615)			(0.0648)
ln(basic)			0.256***	0.589***	
			(0.0569)	(0.0547)	
Observation	2,619	2,619	1,492	1,492	2,276
Number of county	1,185	1,185	803	803	1,043
R-squared	0.308	0.117	0.444	0.170	0.535
Random effect	No	Yes	No	Yes	No
County fixed effect	Yes	No	Yes	No	Yes
Year fixed effect	Yes	No	Yes	No	Yes

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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Elasticities

The income and Marshallian price elasticities are defined as:

$$(\tau'(g)-1)\frac{dg}{dn} \triangleq \widetilde{\eta}_n = -\frac{v''(\tau'(g)-1)^2}{u_{gg}+v''(\tau'-1)^2+v'\tau''} \tag{16}$$

$$\frac{dln(g)}{dln(\tau'-1)} \triangleq \widetilde{\epsilon}^u_n = -\frac{v'+gv''(\tau'(g)-1)}{u_{gg}+v''(\tau'-1)^2+v'\tau''}\cdot\frac{\tau'(g)-1}{g} \tag{17}$$

and the elasticity of compensated demand is derived as:

$$\widetilde{\epsilon}^c_n = -\frac{v'}{u_{gg}+v''(\tau'-1)^2+v'\tau''}\cdot\frac{\tau'(g)-1}{g} \tag{18}$$

A particular elasticity is involved: a global externality elasticity.

$$\widetilde{\epsilon}^{g,e}_{global} \triangleq \frac{dg}{de}\frac{e}{g} = -\left(\frac{u_{ge}}{u_{gg}+v''(\tau'-1)^2+v'\tau''}\right)^{-1}\frac{e}{g} \tag{19}$$

▸ Back to the main part