

Mahadevan, M. (2024). The price of power: Costs of political corruption in Indian electricity. *American Economic Review*, 114(10), 3314-3344.

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Outline of today's discussion

1 Introduction

- Preview
- Literature and Contribution
- Institutional Background

2 Empirical Analysis

3 Conclusion and Discussion

Motivation

- Fact: Political corruption is pervasive in the allocation of public resources yet often difficult to directly observe. India's electricity sector, as a very essential public utility, has long suffered from chronic commercial losses and high rates of electricity theft.
- Research Gap: The existing literature predominantly examines the indirect impacts of corruption on economic growth or policy objectives, but there remains a notable absence of direct measurements concerning both the institutional losses incurred by public agencies and the aggregate welfare implications.

Quick Check of The Main Story

- 印度西孟加拉邦的执政党在赢得选举后通过提供不合规的电力补贴来偏袒、回馈其支持者。
- * 支持执政党的地区电费账单有很多数字上的“异常”和虚低。
- * 通过分析卫星夜间灯光数据，支持执政党的地区的实际电力消费量在选举结束后显著增加。
- * **实际**消费和**汇报**消费的反向变化之间，受益的用户仅支付了实际用电量费用的 60%。
- 通过估算福利，电力公司的损失超过 18 亿美元，而受益消费者获得了 12 亿美元的剩余，最终账单操纵行为仅在西孟加拉邦就造成了 6 亿美元的无谓损失。

Related Literature

- A classic concern in political economy is the extent to which legislators or bureaucrats favor the interests of some groups over others for political gain (Finan and Schechter, 2012).
- At the broadest level, the paper contributes to a vast literature that aims to identify political patronage and corruption.
- Other work has demonstrated the extent to which politicians have incentives to favor constituents, motivated by expected rewards in subsequent election cycles (Fujiwara et al., 2020; George et al., 2018; Zimmermann, 2021).
- 腐败的成因与后果；政治偏袒的社会成本

Main Contribution

- While research on manipulation in administrative data has explored anomalies arising from measurement error, misreporting by consumers, insufficient incentives for data collectors, and eligibility manipulation, the possibility of politically motivated manipulation remains largely unexplored. 这篇文章较为巧妙且合理定义和识别了数据的操纵与背后的政治激励动因。
- Measuring the scale of welfare costs from corruption is challenging and given the limited evidence on it , an important contribution of this paper. This paper advances the literature by considering an efficiency loss that goes beyond transfers. 有福利分析, 虽然不是—般均衡框架, 但已经在 reduce form 里尽可能做了讨论。

Indian Electricity Sector

- State-owned utilities and political influence.
- Importance of electricity in elections.
- Potential for patronage and corruption.
- Electricity supply is a critical issue in Indian elections. Surveys reveal that 55% of Indian businesses have experienced power outages, and more than half of the companies reported needing to offer "gifts" to secure electricity supply.

Outline of today's discussion

1 Introduction

2 Empirical Analysis

- Data
- Empirical Design
- Results

3 Conclusion and Discussion

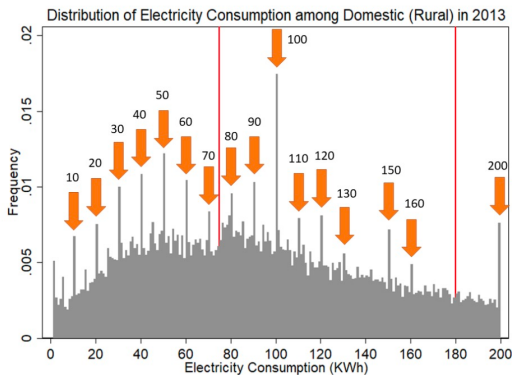
Data Sources

- West Bengal State Electricity Distribution Corporation Limited (WBSEDCL): include consumption for residential and commercial users in both rural and urban areas between 2011 and 2016.
- * 有居民的也有商户的电费账单
- * 用其中的 reported consumption 刻画被操纵的用电
- Satellite nighttime light data as an objective measure of actual electricity consumption to verify the reliability of the consumption figures reported in administrative data.
- * 地区真实用电的代理变量

Measurement of political manipulation

- 整十倍数的数字不正常的高峰出现。
- 用电抄表不会这么恰好，自然数也不是这么分布的。

Figure 1: Consumption Distribution for Residential Consumers



Measurement of political manipulation

≡ 本福特定律 [编辑]

文 33种语言 ▼条目 讨论 汉 漢 大陆简体 ▼阅读 编辑 查看历史 工具 ▼

维基百科，自由的百科全书

在数学中，**本福特定律**（英语：Benford's law）描述了真实数字数据集中首位数字的频率分布。一堆从实际生活得出的数据中，以1为首位数字的数的出现**概率**约为总数的三成，接近直觉得出之**期望** $1/9$ 的3倍。推广来说，越大的数，以它为首几位的数出现的概率就越低。它可用于检查各种数据是否有造假。但要注意使用条件：1.数据之间的差距应该足够大。2.不能有人为操控。[来源请求]

不完整的解释 [编辑]

一组平均增长的数据开始时，增长得较慢，由最初的数字 a 增长到另一个数字 $a + 1$ 起首的数的时间，必然比 $a + 1$ 起首的数增长到 $a + 2$ ，需要更多时间，所以出现率就更高了。

从数数目来说，顺序从1开始数，1,2,3,...,9，从这点终结的话，所有数起首的机会似乎相同，但9之后的两位数10至19，以1起首的数又大大抛离了其他数了。而下一堆9起首的数出现之前，必然会经过一堆以2,3,4,...,8起首的数。如果这样数法有个终结点，以1起首的数的出现率一般都比9大。

Measurement of political manipulation

本福特定律说明在 **b 进制**中，以**数 n** 起头的数出现的概率为：

$$P(n) = \log_b(n+1) - \log_b(n) = \log_b\left(\frac{n+1}{n}\right),$$

其中 $n = 1, 2, \dots, b-1$.

本福特定律不但适用于个位数字，连多位的数也可用。

在**十进制**首位数字的出现概率（%，小数点后一个位）：

n	$P(n)$	$P(n)$ 的相对大小
1	30.1%	
2	17.6%	
3	12.5%	
4	9.7%	
5	7.9%	
6	6.7%	
7	5.8%	
8	5.1%	
9	4.6%	

Measurement of political manipulation

- The measure is the normalized distance of the distribution of the first digit of consumption for each assembly-year from the expected distribution. This metric, which is the same as the chi-squared goodness-of-fit statistic, represents the degree of manipulation in the underlying data.
- * 数字在账单里出现的概率与理论概率的偏离（标准化算出一个差距值）
- The second measure is the fraction of consumers in an assembly, in any given year, who have a reported consumption that is a multiple of ten.
- * 账单报告的电力消费量为 10 的倍数的账户比例
- 理论上，消费数据应呈现平滑分布，因此在 10 的倍数附近不应出现显著的不连续增长。
- 如果账单被篡改以显示低于实际消费量的数据，这实际上相当于对选民的一种间接补贴。

Summary Statistics

Table A1: Summary Statistics for Outcomes in Winning and Losing Legislative Assemblies

	Full Sample			BW: 4.17 pp			BW: 4500 votes			BW: 6500 votes			BW: 8500 votes		
Lights data analysis															
No. of assemblies in each sample	Total	Won	Lost	Total	Won	Lost	Total	Won	Lost	Total	Won	Lost	Total	Won	Lost
	226	184	42	50	25	25	35	17	18	47	25	22	67	41	26
	Mean	Difference		Mean	Difference		Mean	Difference		Mean	Difference		Mean	Difference	
Lights Density	250122.79	274442.59		34895.92	28288.77		28999.65	17327.99		36325.12	27302.38		76690.49	85318.41	
Log Light Density	10.87	1.42		9.74	0.21		9.72	0.23		9.76	0.20		9.85	0.23	
Billing data analysis															
No. of assemblies in each sample	Total	Won	Lost	Total	Won	Lost	Total	Won	Lost	Total	Won	Lost	Total	Won	Lost
	184	148	36	41	22	19	32	15	17	41	22	19	58	35	23
	Mean	Difference		Mean	Difference		Mean	Difference		Mean	Difference		Mean	Difference	
Reported cons. of Electricity (KWh)	250.84	101.31		230.80	96.34		156.01	-9.42		230.80	96.34		230.87	93.62	
Data manipulation	25.31	16.42		23.51	16.12		16.47	13.85		23.51	16.12		24.38	16.79	
Total Bill (Rs.)	1473.33	652.65		1352.83	626.81		865.59	-62.92		1352.83	626.81		1350.01	604.86	
Total Arrears in bill (Rs.)	86.56	48.64		82.53	53.10		42.07	-3.04		82.53	53.10		82.83	51.94	
Avg. energy price (Rs./KWh)	3.84	0.43		3.76	0.44		3.41	-0.08		3.76	0.44		3.77	0.44	
Total Subsidies in Bill (Rs.)	-149.66	-56.12		-144.72	-62.96		-98.92	-2.55		-144.72	-62.96		-143.69	-59.79	
Connected load (KVA)	1.07	0.33		1.06	0.21		0.94	0.11		1.06	0.21		1.05	0.20	

Notes: Summary statistics based on administrative billing data. The above table shows the mean level of the outcome variables by a range of bandwidths, including the optimal bandwidth for RD plots of 4.17 percentage points. I also show the difference between the means of legislative assemblies that are aligned ('Winning') and not aligned ('Losing') with the ruling party, for the 2011 election. I show billing outcomes from 2012 when my data begins.

Identification and Specification

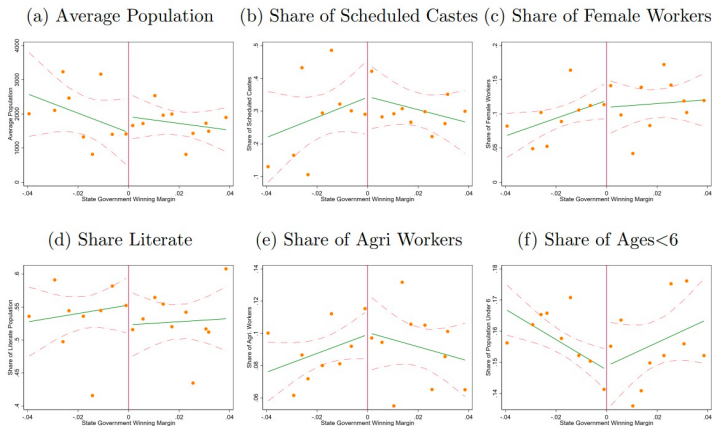
- RDD: Close election (即在选票“势均力敌”的时候, winner 和 loser 基本是可比的)
- 结果变量包括账单中报告的用电和夜间灯光。

$$y_{ia} = \beta 1(\text{vote-margin} > 0)_a + f(\text{vote-margin})_a + \epsilon_{ia} \text{ for } a \in BW$$

$$\log(\text{Lights})_{at} = \sum_t \beta_t (1(\text{vote-margin} > 0)_a) + \gamma_t + \mu_a + \epsilon_{at} \text{ for } a \in BW$$

Balance Check

Figure 4: Balance on demographic features across RD cutoff



Notes: I show balance in terms of village characteristics from the Indian Census 2011 across the RD cutoff for the state of West Bengal.

Baseline Results

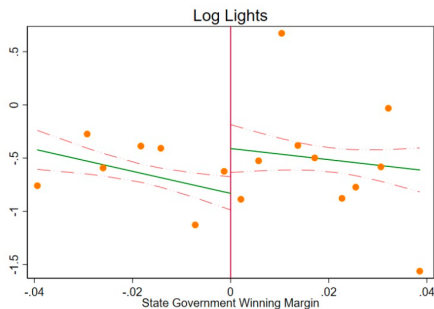
Table 2: Discontinuity in Reported Consumption

Unit Consumption in KWH						
Residential (Rural)						
RD Estimate	-135.9***	-120.2***	-123.2***	-140.3***	-155.1***	-136.8***
Std. Error	(21.64)	(24.24)	(20.47)	(21.02)	(22.44)	(23.51)
Observations	53,084	8,526	11,262	11,176	11,128	10,992
Bwidth	6500	6500	6500	6500	6500	6500
Year	Stacked	2012	2013	2014	2015	2016
Residential (Urban)						
RD Estimate	-376.8***	-304.5***	-361.2***	-377.3***	-396.5***	-428.1***
Std. Error	(80.86)	(96.76)	(83.92)	(79.25)	(76.96)	(73.02)
Observations	58,225	10,316	12,122	12,075	11,965	11,747
Bwidth	6500	6500	6500	6500	6500	6500
Year	Stacked	2012	2013	2014	2015	2016
Commercial (Rural)						
RD Estimate	62.42	119.2	46.83	77.51	-18.61	101.5
Std. Error	(75.90)	(98.40)	(78.51)	(69.61)	(80.17)	(87.96)
Observations	20,946	3,368	4,465	4,391	4,374	4,348
Bwidth	6500	6500	6500	6500	6500	6500
Year	Stacked	2012	2013	2014	2015	2016
Commercial (Urban)						
RD Estimate	-546.1**	-464.8*	-577.0**	-549.5**	-537.8**	-579.7**
Std. Error	(258.4)	(273.5)	(250.6)	(234.0)	(264.7)	(291.2)
Observations	66,623	11,975	13,917	13,656	13,686	13,389
Bwidth	6500	6500	6500	6500	6500	6500
Year	Stacked	2012	2013	2014	2015	2016

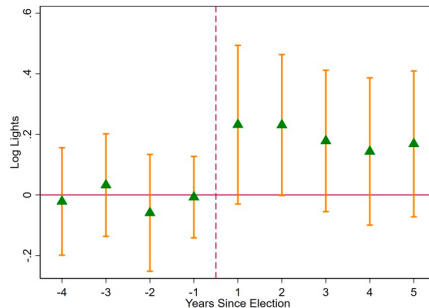
Baseline Results

Figure 5: Satellite Night Lights: RD Plot and Difference-in-discontinuities Analysis

(a) RD Plot

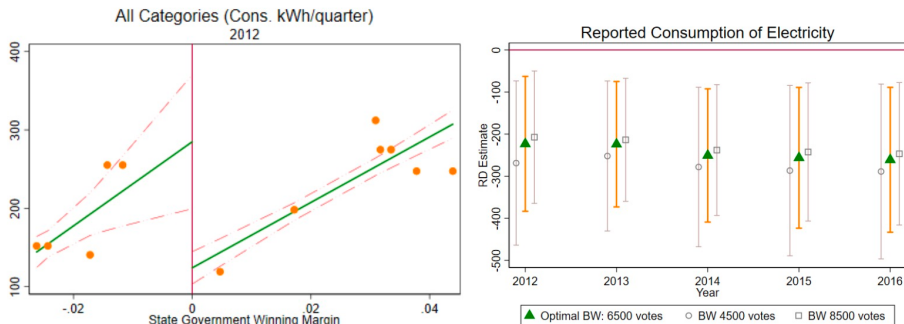


(b) Difference-in-discontinuities



Baseline Results

Figure 6: Lower reported consumption in regions where the ruling party won (2012-15)

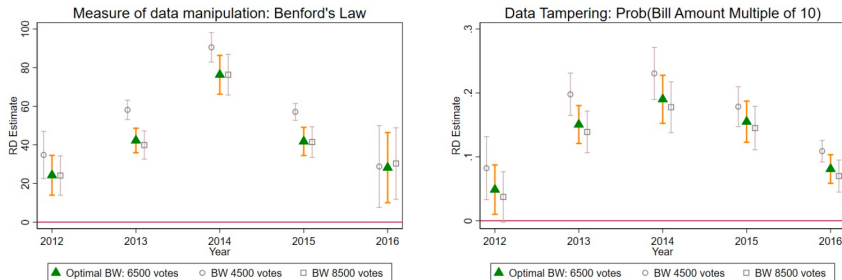


Mechanism

- baseline 的结果已足够清晰，识别方法也较为干净，机制部分很多是作者的文字陈述以及对前面特征事实的再次强调。
- Electricity meter readings provide one of the few manipulable margins on which to affect electricity prices. In order to bill consumers, electricity utilities send meter readers to account holders' premises to manually record consumption. 作者实地调研了解到，抄表员抄得的电表数字很多都没有二次核查与确认，抄表过程有比较多随意性与缺乏监督。
- Another way politicians may exploit the electricity sector is by selectively discouraging utility action against energy theft. 民间报纸轶闻说有些地区电力部门对“偷电”整一只眼闭一只眼。

Mechanism

Figure 7: RD Coefficients for Manipulation Outcomes Across Bandwidths



Notes: I plot coefficients across years for measures of data manipulation, and confidence intervals of standard errors clustered at the electrical-feeder level. Specifically, I study the distance of the observed distribution from the expected distribution as per Benford's (1938) Law and the fraction of consumers whose consumption was a multiple of ten. 'BW' indicates the bandwidth size. The bandwidth of 6500 votes corresponds to the optimal bandwidth of 4.17 pp winning margin percentage used throughout this paper. For both outcomes, I plot the RD coefficients between 2012 and 2016 and find results robust to other bandwidths – both lower and higher than the optimal bandwidth of 6500 votes (between 4500 and 8500 votes). These regressions control for the total size of the electorate within each assembly.

Welfare Consequences of Political Patronage

- 若腐败仅涉及群体间财富转移，那么从效率角度看似乎无需担忧，但实际上电费计量的扭曲将引发超越任何群体收益的无谓损失，使此类偏袒行为代价高昂。

Figure 10: Market Distortions Due to Political Corruption

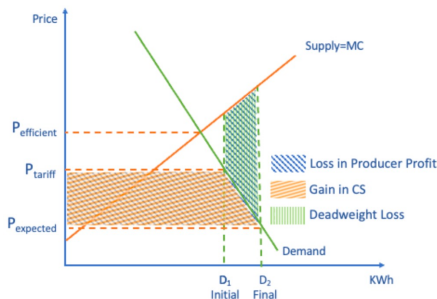
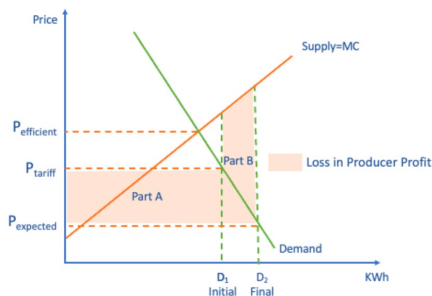


Figure A18: Losses in Producer Profits



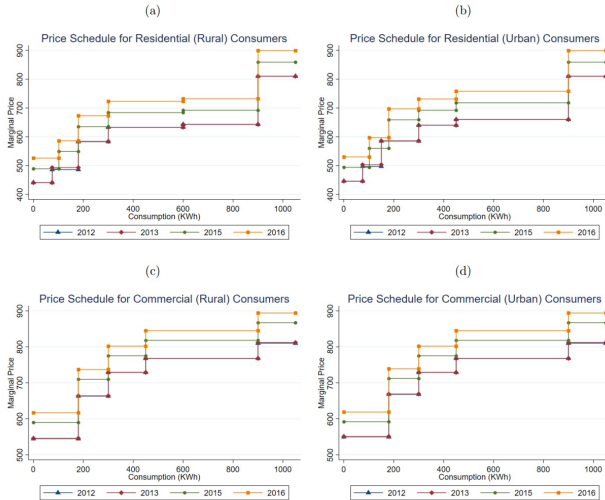
Welfare Consequences of Political Patronage

- 筛选保留符合本福特定律（真实性高）的账单数据，有 32 个区

$$\log(\text{Consumption})_{ia} = \delta_a \log(\text{MarginalPrice})_{ia} + \epsilon_{ia}$$

- 在样本期间（2011-2016 年），印度西孟加拉邦的电力公司进行了多次电价调整，这些变化由电力监管机构设定。
- 利用政策驱动的电价调整作为 IV，两阶段回归来估计价格与消费量之间的弹性系数。
- 机器学习方法去预测其他各区的这个弹性，每个区都有一个系数。

Welfare Consequences of Political Patronage



Welfare Consequences of Political Patronage

- 生产者利润损失 = 初始消费 $\times$ 价格变化 (弹性系数) $\times$ 账户数量
- 由于电力价格的隐性补贴, 消费者剩余会增加。文章通过计算消费者对价格变化的反应来估计这一增加。
- Δ 消费者剩余 = $0.5 \times (\text{初始消费} + \text{最终消费}) \times \Delta$ 价格

Welfare Consequences of Political Patronage

A部分：账单低估的直接损失

计算方法：

- 通过价格弹性 (ϵ) 反推实际价格补贴 (P_{Expected})。公式为：

$$\Delta \log(\text{Price}) = \frac{\Delta \log(\text{Consumption})}{\epsilon}$$

- 结合居民和商业用户的初始消费量 (D_1)，计算因低估导致的收入损失。

数据来源：

- 初始消费量 (D_1) 取自非执政党选区（无补贴）的平均消费数据。
- 价格弹性 (ϵ) 来自附录E的估计结果（例如，居民用户弹性为-0.56，商业用户为-2.94）。

示例计算（以居民城市用户为例）：

- 初始季度消费 $D_1 = 716 \text{ KWh}$ 。
- 价格变化 $\Delta P = P_{\text{Tariff}} - P_{\text{Expected}} = 0.85 \text{ 卢比/KWh}$ 。
- 单用户年损失： $716 \times 0.85 \times 4 = 2442 \text{ 卢比/年}$ 。

总损失：

- 执政党选区居民城市用户共274万户，总损失为 $2442 \times 2.74 \times 10^6 = 8.475 \text{ 亿卢比}$

B部分：过度消费的损失

计算方法：

- 卫星夜光数据 ($\Delta \log(\text{Lights}) = 0.44$) 通过固定乘数（例如居民城市用户乘数0.09）转化为消费增长：

$$\Delta \log(\text{Cons}) = 0.44 \times 0.09 = 0.04 \Rightarrow \text{消费增长 } 4\%.$$

- 按边际购电成本（2014年为5.70卢比/KWh）计算额外供电成本。

示例计算：

- 居民城市用户季度过度消费： $716 \times 4\% = 28.6 \text{ KWh}$ 。
- 单用户年损失： $28.6 \times 5.70 \times 4 = 653 \text{ 卢比/年}$ 。

总损失：

- 居民城市用户总损失为 $653 \times 2.74 \times 10^6 = 1.787 \text{ 亿卢比}$

Welfare Consequences of Political Patronage

Table A6: Calculation of Loss in Producer Profits

Part A: Change in producer profit from under-reporting			
	Residential (Urban)	Residential (Rural)	Commercial (Urban)
Initial cons (D1)	716	280	967
Change in price from elasticity $P_{Tariff}-P_{Expected}$ (Table A7)	0.85	0.58	0.06
Loss in profit per account (Rs. annualized)	2442	645	741
Part B: Change in producer profit from over-consumption			
Over-consumption (log(lights)) (Table 1)	0.44	0.44	0.44
Multiplier: $\Delta\log(\text{lights}) \rightarrow \Delta\log(\text{cons})$ (Figure A7)	0.09	0.15	0.05
$\Delta(\text{Log}(\text{cons}))$	0.04	0.07	0.02
% ΔCons (KWh) (%(D2-D1))	0.04	0.07	0.02
Loss in profit per account (Rs. annualized)	653	447	1323
Part C: Total loss in profit			
Accounts in AITC controlled areas (millions)	2.74	10.69	0.45
Total Loss (Part A+Part B)	3095	1092	2063
Scaled up by accounts (Mill. Rs)	8475	11677	937
Scaled up by accounts (Mill. \$)	146	201	16
Total for electoral term (Mill \$)	731	1007	81
Total (Mill \$)		1818	

Welfare Consequences of Political Patronage

消费者剩余增益体现为因价格补贴带来的消费量增加与支付价格下降的综合收益。

1. 计算方法：

- 使用需求曲线下的梯形面积计算：

$$\Delta CS = 0.5 \times (D_1 + D_2) \times \Delta P$$

- 其中, $D_2 = D_1 \times e^{\Delta \log(\text{Cons})}$, $\Delta P = P_{\text{Tariff}} - P_{\text{Expected}}$ 。

2. 示例计算（居民城市用户）：

- $D_1 = 716 \text{ KWh}$, $D_2 = 716 \times e^{0.04} \approx 745 \text{ KWh}$ 。
- $\Delta P = 0.85 \text{ 卢比/KWh}$ 。
- 单用户年增益： $0.5 \times (716 + 745) \times 0.85 \times 4 = 623 \text{ 卢比}$ 。

Welfare Consequences of Political Patronage

Table A7: Gain in Consumer Surplus from over-consumption (Elasticity from this paper)

Consumer Class	Domestic (Urban)	Domestic (Rural)	Commercial (Urban)
Elasticity estimate (ϵ) (Table A4)	-0.265	-0.564	-2.550
Initial cons level (mean qtrly. cons (KWh) - losing assemblies)	716	280	967
Lights-Cons elasticity (Figure A7)	0.09	0.15	0.05
$\Delta\text{Log}(\text{lights})$ (Table 1)	0.44	0.44	0.44
$\Delta\text{Log}(\text{cons})$ (log(D2-D1))	0.04	0.07	0.02
$\Delta\text{Log}(\text{price}) = \Delta\text{log}(\text{cons}) / \epsilon$	-0.16	-0.12	-0.01
ΔPrice ($P_{Tariff} - P_{Expected}$)	-0.85	-0.58	-0.06
$\Delta\text{CS} = 0.5 * (\text{Initial} + \text{Final cons}) * \Delta\text{Price}$ (Area of trapezoid in Fig 10)	623	167	62
No. of accounts (millions)	2.74	10.69	0.45
Total annualized gain in CS (mill. Rs.)	6832	7138	337
CS for electoral term \$ (Mill. \$)	1173		

Notes: This table shows the steps of calculating changes in consumer surplus in Figure 10. The table uses data from administrative billing records and satellite nighttime lights data to arrive at the estimates. I use an exchange rate of Rs. 58/\$ (2014). I compute $\Delta\text{Price} = (\exp(\Delta\text{log}(\text{price})) - 1) * P_{Tariff}$.

Outline of today's discussion

- 1 Introduction
- 2 Empirical Analysis
- 3 Conclusion and Discussion
 - Conclusion
 - Lighting around: related papers (Especially China Story)

Conclusion

- Political patronage can have adverse welfare implications that go well beyond the transfers caused by selective access to a few favored groups and imposes a significant efficiency loss for society.
- Given its large impact on policy-making, ability to provide public goods, and measurement of development progress, this is an important area for future study.

Political manipulation

- Henderson et al.(2022, JPubE): 土地市场的操纵。经济增长目标和晋升激励使得地方政府倾向于以较低的价格向工业用途分配土地，同时减少住宅用地的供应。
- Zeng&Zhou(2024, JUE): 通过比较 GDP 数据和夜间灯光数据，发现经济指标占政绩考核权重更大的 2013 年之前，官员年龄对 GDP 造假存在显著的激励。
- Gong et al.(2025, JPubE): 地级市的 GDP 数据会贴着上一年的目标数，出现 Bunching，且排除了是因为恰好的努力这一解释，很大可能是操纵数据。

Political connection and local favoritism

- Cai et al. (2017,JUE): 大约有 20% 的住宅开发商会违反合同中的容积率规定，其中八成以上是和政府有“关系”的开发商。
- Chen&Kung(2023,EJ): 土地市场的政商旋转门。给予企业土地折扣的地级市官员退休后相应企业聘为董事的概率增加了 3 倍。
- Cao(2024,ECMA 2ndr&r): 在本地有政商关联的开发商建造的楼，汶川地震中高出其他建筑 75% 的概率损毁。
- Tang et al.(2025,JUE): 政府采购中有明显的本土偏好，本地企业采购合同中标率远高于外地企业。但背后解释并非腐败，而是地方政府为了辖区内的税收与就业增长。
- 北大一位博士生的 WP：有 connection 的融资平台会购买更多土地。

Patronage network

- Thanks to Tang Meng (SJTU) 's help for this page!
- Connection 不仅发生在政商之间，也发生在不同层级政府之间。
- Jiang(2018,AJPS): 经由本省省长提拔第一次做市长的官员（省市领导有“恩庇”关系）有助于本市经济增长；Jiang&Zhang(2020,JPubE): 恩庇关系使得地级市政府得到了更多财政转移支付。
- Lei(2023, CPS): 在“四万亿”计划期间，Patronage Network 能够促进地方政府获得更多的公共投资。
- Xue et al.(2024, PC): 当恩庇关系被削弱，地方政府出让工业土地会减少。
- Ke et al.(2025,WP): 明朝科举中，与考官是同乡的考生在“边际”上更容易被主考官“捞一把”，然后考上进士。

Comments

- 故事总是很“显然”，但良好的自然实验场景和干净的识别机会（以及高质量的数据）是可遇不可求的；从现象到研究问题不容易，从研究中提炼出具有一般意义的经济学理论更难。
- connection 或者说 patronage 可被认为是非正式的协调。有时候它是一种润滑剂，是“好”的。但又是一个放大器，尤其是当推行的政策本就存在错配，那么这种 connection 会造成错配叠加错配、扭曲中的扭曲。
- Brainstorm and future ideas
 - * 对 local favoritism 和 political patronage 的测度。例如大量采购合同、产品标准文本、判决书等仍有待挖掘，借助 AI 能否把其中的信息进一步结构化。
 - * 政策里的说法模糊，要猜、要解读、要“摸着石头过河”，省及以下政府的官员“有关系”是否会帮助猜得更准，缓解信息层层传递的摩擦？