Does a Leapfrogging Growth Strategy Raise Growth Rate?

--Evidence from across Countries and within China

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Motivation:
A story about the Lenovo

In 1995, a decade after the company was founded, the two co-founders, Liu Chuanzhi, the CEO, and Ni Guannan, the main software designer had a major debate and public split.

Ni wanted to leapfrog the technology and to invest aggressively to design a new generation of computer chips in order to challenge Intel, while Liu just wanted to produce and sell cheap computers, because that was what the market wanted.

The dispute was reported in the media as an epoch flight between "the technology school" vs "the market school". In the end, Liu won and Ni left the company.

Today, Lenovo is one of the world's largest PC makers.

Motivation:
Pros and Cons of Leapfrog Strategy

Pro-arguments

(Hausman, Hwang and Rodrik):

- Market failure:
  - Some goods have higher "spillover effects"
  - Positive externalities via learning-by-doing

- Counter-arguments

(Lin and Wang):

  - Government failure
    - Bad incentives, corruption, etc
  - Success of one or two industries could be more than offset by lack of development in other industries due to distorted resource allocation

Motivation

- Apparent success stories:
  - Ireland, Singapore, Korea
- Countries trying:
  - Philippines, Malaysia, China

- *Does leapfrogging really work? Are what you exports really matters?*

- The efficacy of the leapfrogging strategy needs to be settled empirically

Outline

- Basic empirical framework
- Measurement issues: Exports Sophistication and Leapfrogs
- Econometric issues
- Evidences:
  - Cross country (cross section and panel regression)
  - Within country – across Chinese Cities
- Conclusion

Basic Evaluation Framework

Export sophistication = f (factor endowments, leapfrog policies, other factors)

The original regression estimated by HHR

$$LnGDPc_{it} - LnGDPc_{it-1} = \alpha_0 + \alpha_1 LnGDPc_{it-1} + \alpha_2 ExpSophis_{it-1}$$
$$+ \alpha_3 HumanCap_{it-1} + \alpha_4 Institution_{it-1} + \omega_{it}$$

Two Stage Regression:

Stage 1: Isolate the variation due to leapfrogging

$$ExpSophis_{it} = \beta_0 + \beta_1 LnGDPc_{it} + \beta_2 HumanCap_{it} + \beta_3 Institution_{it} + \xi_{it}$$

Stage 2: Growth regression

$$LnGDPc_{it} - LnGDPc_{it-1} = \gamma \xi_{it-1} + \nu_{it}$$

Based on theory of multi-variable regression

$$\gamma = \alpha_2 \qquad \text{The impact of leapfrogging on growth}$$

Measure of Exports Sophistication
(Existing Measures)

- EXPY

$$PRODY_i = \sum_k^n \frac{s_{ik}}{\sum_j s_{ij}} \bullet Y_k$$

$$EXPY_k = \sum_i s_{ik} \bullet PRODY_i$$

- EDI and ESI

$$ESI_{rft} = 100 Min(\sum_i s_{irt}, s_{it}^{ref}))$$

$$EDI_{rft} = 100(\sum_i abs(s_{irt} - s_{it}^{ref}))$$

where

$$s_{irt} = \frac{E_{irt}}{\sum_i E_{irt}}$$

These measures attempt to summarize the export structure of a country to a single number

Measure of Exports Sophistication
(Modified Measure)

- Modified EXPY

$$PRODY_i = \sum_{k}^{n} \frac{s_{ik}}{\sum_{j} s_{ij}} \bullet Y_k \bullet \frac{v_{ik}}{v_{iG3}}$$

These measures attempt to summarize the export structure of a country to a single number

$$EXPY_k = \sum_{i} s_{ik} \bullet PRODY_i$$
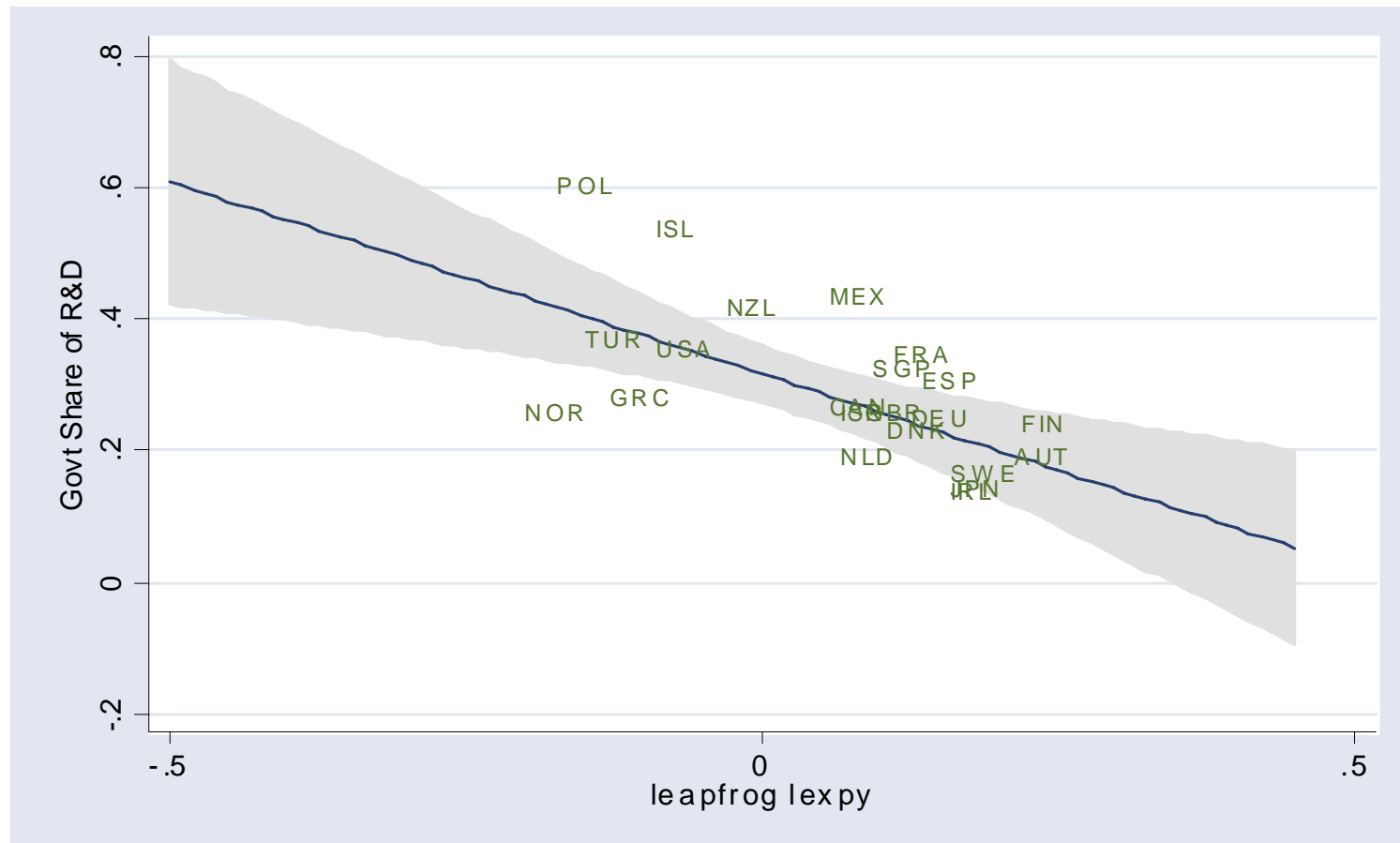
Measure of Exports Sophistication
(A New Measure)

- ATP (advanced technological products) Share in Total Exports (conditional on income)

- US Census (HS 10, 700 high tech goods out of 20,000 HS-10); OECD (195 from 5 digit SITC)

- Our measure: a list of "high tech" good concorded at 6 digits-HS for US Census and OECD lists

- 3 indexes: narrow (92), broad(157), unit value cutoffs (84)

- Not require assuming richer countries exports more sophisticated products

Measures of Export Sophistication and leapfrog policy

- Modified EXPY further disaggregate the range of quality of exports than EXPY. It created
  - more variation SD (0.39 vs. 0.73)
  - expanded its value range (8.0 to 9.7 vs. 6.9 to10)
- Countries with higher level of development, also has a higher level of productivity, and higher level of export sophistication.
  - Correlation between GDP per capita and the level of export sophistication: EXPY: 0.79 ; modified EXPY: 0.45: narrow ATP: 0.28; broad ATP: 0.45; EDI: -0.50.
- While countries engage in "leapfrogging" are typically not already well developed.

Export Sophistication and Government share of R&D, 2005

Replicate HHR regression with EXPY, then apply the same regression to other export sophistication measures

- Our regression results on EXPY are very similar, if not exactly same, to HHR's and indicate sophistication in the export structure does seem to be a robust contributing factor to growth. All estimated coefficients are the same (up to two places after the decimal point) and statistically significant as HHR (Table 1).

- Same regression on modified EXPY, broad ATP share and EDI, their coefficients are statistically insignificant, while estimated coefficients for other explanatory variables stay very similar (Tables 2,3,4,5).

- Only narrow ATP share has significant coefficient estimates as EXPY

Does export sophistication imply leapfrogging?

- A country produces sophisticated goods according to its comparative advantage is not a leapfrogger;

- A country whose government implements industry policies to promote relevant sectors beyond what would naturally emerge from its factor endowment is a leapfrogger.

- Holding initial export sophistication constant, check whether countries have faster increase in export sophistication also growth faster.

Include changes in exports sophistication as a proxy of government intervention (leapfrog policies)

Dependent variable: growth in real GDP per capita, 1992-2003

	(1)	(2)	(3)	(4)	(5)
Log initial GDP per capita	-0.028 [0.005]**	-0.02 [0.005]**	-0.02 [0.005]**	-0.02 [0.005]**	-0.02 [0.005]**
Human Capital	0.016 [0.010]	0.021 [0.011]	0.022 [0.010]*	0.019 [0.010]	0.023 [0.011]
Regulation quality	0.018 [0.006]**	0.015 [0.007]*	0.015 [0.006]*	0.016 [0.006]*	0.018 [0.007]*
Log initial EXPY	0.032 [0.009]**				
Growth in log EXPY	0.252 [0.240]				
Log initial modified EXPY		0.005 [0.240]			
Growth in log modified EXPY		0.081 [0.153]			
initial ATP share (narrow)			0.04 [0.031]		
Growth in ATP share (narrow)			0.891 [0.567]		
initial ATP share (broad)				0.026 [0.023]	
Growth in ATP share (broad)				0.731 [0.388]	
initial log EDI					-0.001 [0.015]
Growth in log EDI					-0.003 [0.407]
Observations	41	41	41	41	39
R-squared	0.51	0.36	0.44	0.43	0.33

Robust standard errors in brackets; * significant at 5%; ** significant at 1%

Special Conclusions (1)

- EXPY variable – in both level and growth – tends to be significant across specifications in cross country regressions;

- When export sophistication is measured on alternative ways (modified EXPY, ATP share low and high, and EDI), its significant impact on growth may disappear.

- HHR's claim about the positive association between export sophistication and growth depends crucially on the construction of the export sophistication measures.

Econometric Issues

Endogeneity with the export sophistication measure

- Instrument variables used in HHR (land and population) do not have much time variation, are likely to be invalid (their instruments do not pass the Hansen-J test).

- We used an alternative set of instruments which yield more time variation: the profession and education background of political leaders.

- Data set of the profession and education for more than 500 political leaders from 73 countries during 1970-2002 (Dreher, Lamla, Lein, and Somogyi, 2008)

Econometric Results
5-year panel regression

A. EXPY

	(1)	(2)	(3)
	OLS	FE	IV
log initial GDP/cap	-0.0103	-0.0479	-0.0113
	[0.0027]**	[0.0060]**	[0.0104]
log initial EXPY	0.0208	0.0027	0.0223
	[0.0055]**	[0.0091]	[0.0423]
log human capital	0.0116	-0.0102	0.0088
	[0.0027]**	[0.0065]	[0.0078]
Observations	640	640	369
R-squared	0.39	0.47	
First stage F stat			1.35
Hansen J-statistics			0.186

B. EDI

	(1)	(2)	(3)
	OLS	FE	IV
log initial GDP/cap	-0.0065	-0.0517	-0.0097
	[0.0026]*	[0.0062]**	[0.0054]
Initial log EDI	-0.0117	0.004	-0.0271
	[0.0071]	[0.0191]	[0.0180]
log human capital	0.0128	-0.0256	0.0081
	[0.0030]**	[0.0079]**	[0.0041]*
Observations	475	475	314
R-squared	0.43	0.59	
First stage F stat			3.08
Hansen J-statistics			0.089

Special Conclusions(2)

- No robust evidence from cross country data in supporting leapfrogging strategy.

- There are both measurement problems and econometric specification errors in HHR's work reporting evidence that support such a comparative advantage-defying development strategy.

Additional evidences:
within-China investigation

- Cross country growth regressions are criticized for ignoring the role of culture, legal systems, and other institutions, suffer from a serous omitted variable bias

- Relative to across country comparisons, legal systems, political and other institutions are more similar within a country. So we complement the cross-country regressions with evidence from comparing different cities within a single country (China).

- This within-China investigation provide additional complementary evidence on the efficacy of a leapfrogging strategy.

Evidences from cross Chinese city data

Dependent variable: growth rate over 1997-2006 -OLS

	(1)	(2)	(3)	(4)	(5)	(6)
log initial GDP/cap	0.0089 [0.0050]	0.0095 [0.0051]	0.0103 [0.0049]*	0.0096 [0.0051]	0.0094 [0.0050]	0.0065 [0.0057]
initial Human Capital	0.1505 [0.1501]	0.1372 [0.1484]	0.153 [0.1489]	0.135 [0.1488]	0.1624 [0.1468]	0.1045 [0.1528]
SEZdummy	-0.0053 [0.0080]	-0.0046 [0.0079]	-0.0028 [0.0079]	-0.0039 [0.0081]	-0.0036 [0.0078]	-0.0068 [0.0089]
log initial ATP share (narrow)	0.0549 [0.0215]*					
log initial ATP share (broad)		0.0103 [0.0158]				
log initial ATP share (UV cut)			-0.0354 [0.0248]			
log initial EXPY				-0.0073 [0.0077]		
log initial modified EXPY					-0.0084[0.0030]**	
log initial EDI						-0.0556 [0.0623]
Observations	209	209	208	208	208	208
R-squared	0.04	0.04	0.06	0.04	0.06	0.04

Robust standard errors in brackets; * significant at 5%; ** significant at 1%

General Conclusions

- To be able to transform an economy's economic structure ahead of its income level toward higher domestic value added and more sophisticated sectors is desirable in abstract.

- However, there is no strong and robust evidence that a leapfrogging industrial policy can reliably raise economic growth across the world and across regions within China.

- There may be individual success stories. But there are failures. If leapfrogging is a policy gamble, there is no systematic evidence that suggests that the odd is favorable.

Do the Proposed Measures Capture Export Sophistication ?

	Country	EXPY	Country	Modified EXPY	Country	EDI
1	Luxembourg	22,720	**Ireland**	24,589	France	66.5
2	Switzerland	17,830	Switzerland	23,098	Netherlands	89.7
3	Finland	16,994	Luxembour	17,634	Japan	91.5
4	Japan	16,760	Japan	17,269	Italy	95.5
5	Sweden	16,608	Austria	17,261	Spain	98.3
6	Germany	16,148	Sweden	16,634	Austria	99.8
7	Austria	15,819	Germany	16,348	Belgium	99.8
8	Canada	15,311	Finland	16,303	Sweden	101.9
9	United Kingdom	15,305	Israel	15,534	Belgium-Luxembourg	103.4
10	United States	15,228	United Stat	15,305	Canada	106.3
11	Denmark	14,978	**Singapore**	15,169	Czech Republic	111.7
12	France	14,812	United King	15,103	**Mexico**	112.6
13	**Ireland**	14,653	Belgium	14,859	Denmark	115.2
14	Korea, Rep.	14,418	France	14,456	Switzerland	119.8
15	Belgium-Luxembourg	14,367	Taiwan, Ch	14,190	Brazil	122.9
16	**Singapore**	14,304	Belgium-Lu	13,878	Korea, Rep.	124.1
17	Italy	14,287	Italy	13,769	Australia	124.5
18	Netherlands	14,120	Denmark	13,519	Hungary	126.1
19	Slovenia	14,114	Anguila	13,474	Norway	126.3
20	Czech Republic	14,077	French Poly	13,394	**Singapore**	126.3
21	Spain	14,030	Spain	13,382	Argentina	127
22	Belgium	14,021	Czech Rep	13,133	Taiwan, China	130.3

Problems

- Assume that goods exported by wealthy countries are more sophisticated

- Larger and more advanced countries export a larger set of commodity space

- The rankings from table 3 show that the top ranking countries according to the original EXPY are mostly wealthy countries
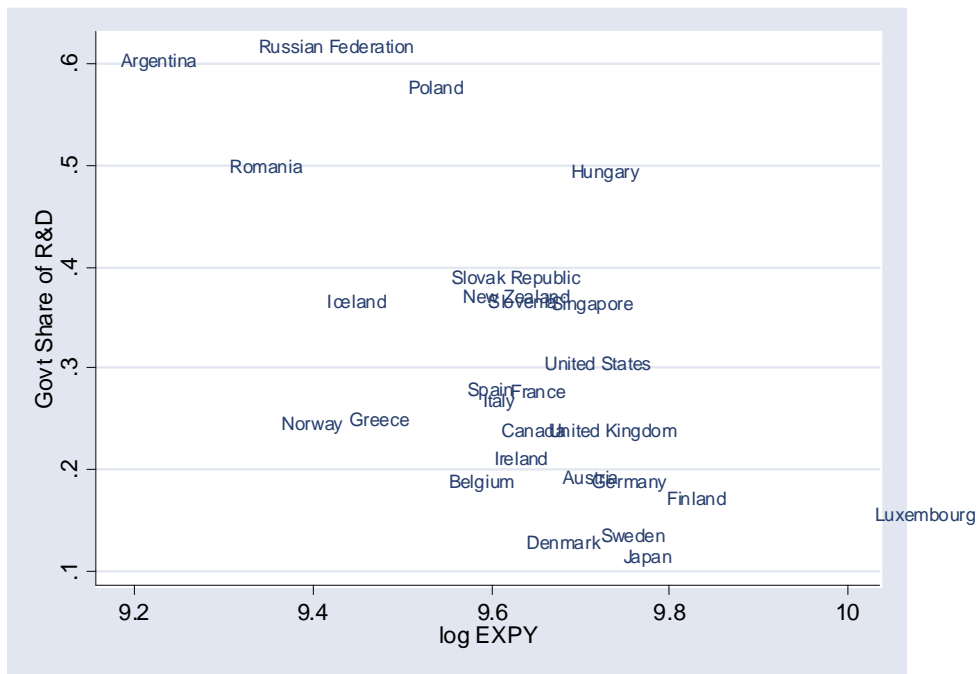
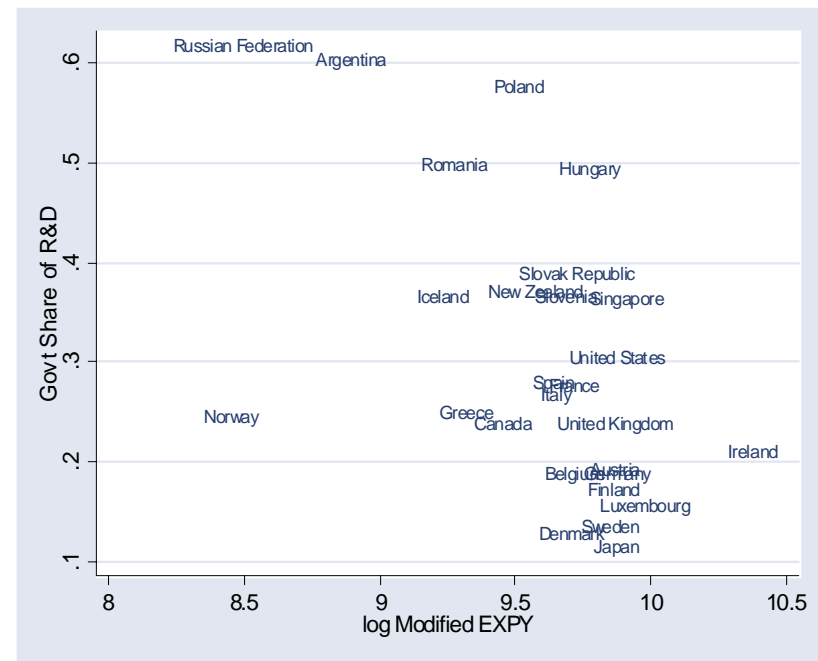# Measure of Exports Sophistication
(A New Measure)

High Tech
HS 6
Category
Line
Examples
…

| Sector Label	HS 6 Product Line
Life Science	Compound optical microscopes
Opto-Electronics	Digital automatic data processing with a central processing unit
Information & Communications	Digital automatic data processing with storage, input or output units
Flexible Manufacturing	Machines and apparatus for resistance welding of metal, fully or partly automatic
Advanced Materials	Optical fibre cables
Aerospace	Turbo-propellers
Electronics	Digital monolithic integrated units
Biotechnology	Antisera and other blood fractions, vaccines

Export Sophistication and Government share of R&D, 2005

EXPY

Negative correlation observed: higher share of government R&D with lower level of export sophistication: Russia, Argentina, Poland, Romania. Lower share of government R&D with higher level of export sophistication: Japan, Sweden, Denmark, Luxembourg.

Export Sophistication and Government share of R&D, 2005
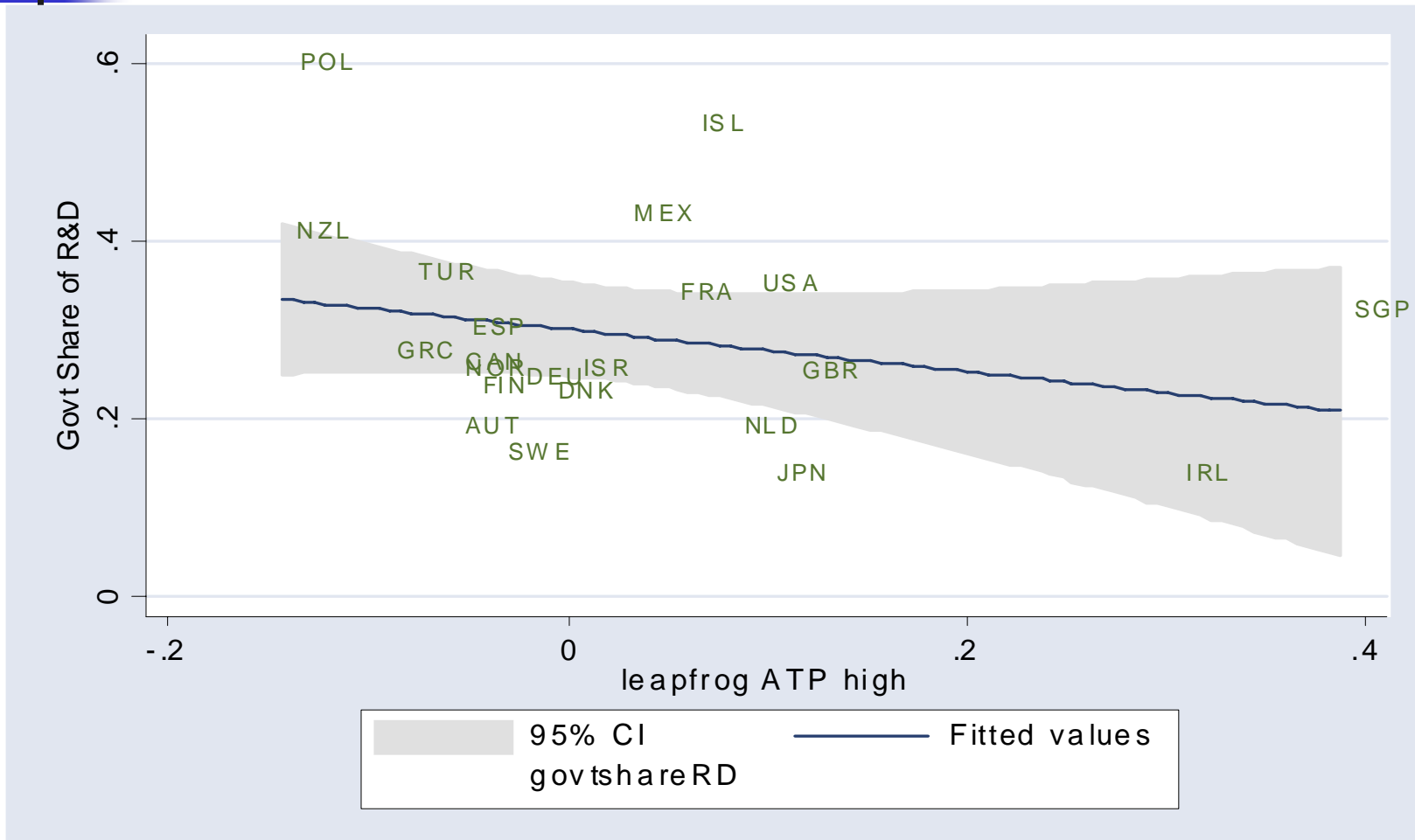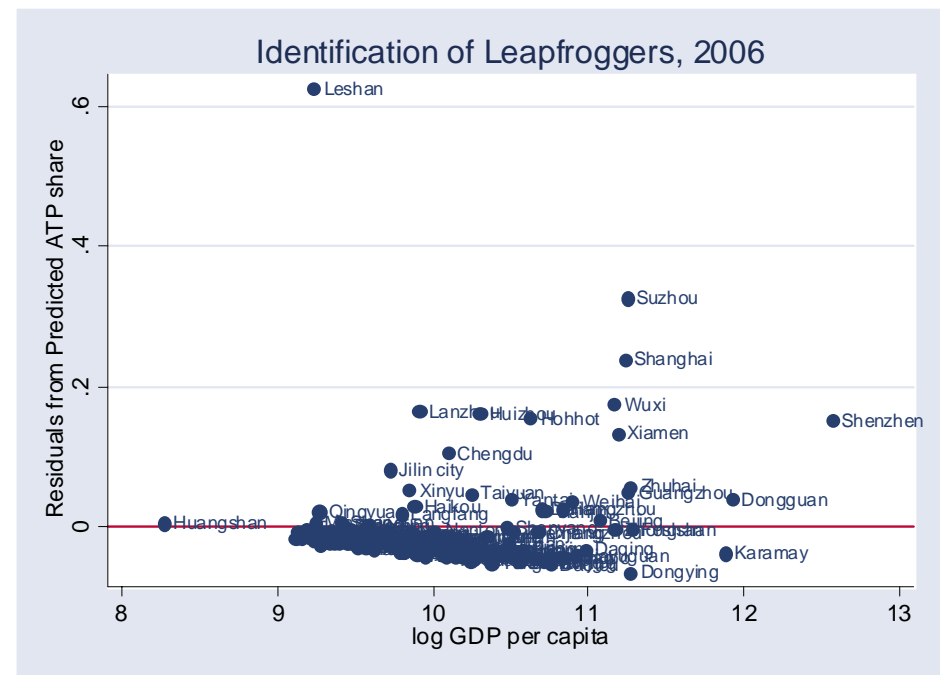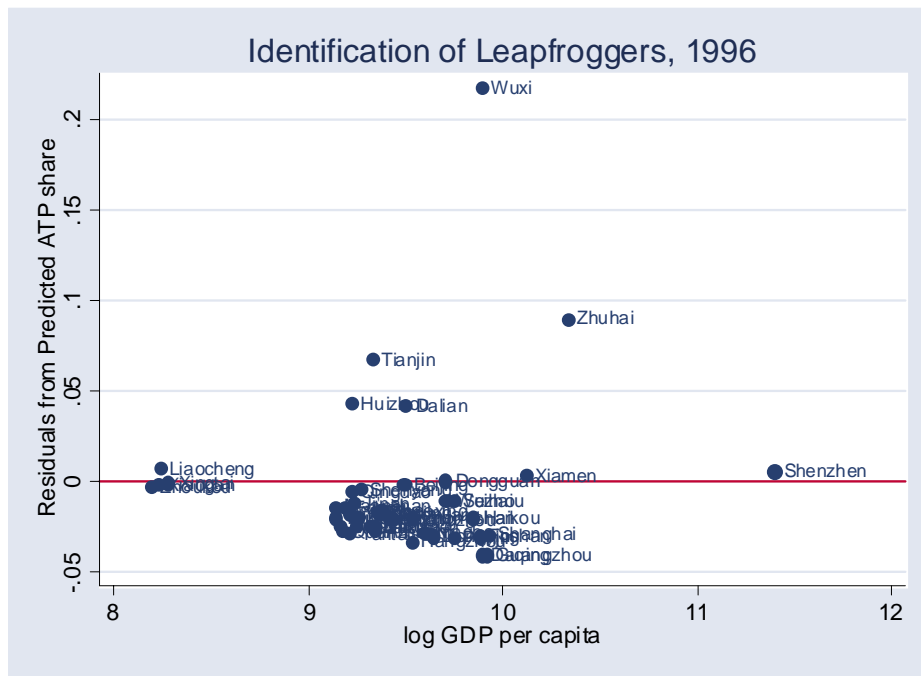
Econometric Issues

- Possible specification errors in HHR regression
  - Omission errors: Productivity shifter (policy variables) may not log-linear in growth
  - Unobserved heterogeneity: The growth rate of productivity (leapfrog policy) are not common across countries
- Rodriguez (2007) shows a linear regression of a nonlinear data generation process will only produce the average policy affect if the policy variables are distributed according to a normal distribution.
- If leapfrog policies are an effective productivity shifter (and it is the only shifter examined), as HHR theorized, then productivity growth should not be the same across country. Thus, the common productivity growth rate assumption is not realistic.

Econometric Issues

Interpretation on the coefficient of EXPY

- Results of Shapiro-Wilk and Skewness/Kurtosis normality test:
    - Normality in the distribution of EXPY and the ATP share are rejected in both tests.
    - Modified EXPY and EDI passed the normality test.

- A linear regression may not give a meaningful interpretation on the coefficient of EXPY, even if it correctly capture the degree of leapfrogging, which itself is questionable .

- Modified EXPY also appears to be a better regreessor in linear regression from econometric point of view.

Chinese Cities Leapfrogers

Identification of Leapfrogers, 1996

Identification of Leapfrogers, 2006

ATP shares in Chinese Cities