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“Mobile Telecommunications Infrastructure and Economic Growth: Evidence from China”

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THE UNIVERSITY OF TEXAS AT ARLINGTON

Paper's Contributions

1. Economic Growth Tied to Mobile Phone Infrastructure
 - Separate Fixed from Mobile
 - Separate by Time Period
2. Application to China
 - Largest Telecom Market in the World
 - Fast rise from “backward” to “middle income”
3. Econometric Challenges
 - Panel Data – province by year
 - Lagged Endogenous System GMM Estimator
 - Instrument for Infrastructure using Telecom Policy Variables



How Mobile Could Generate Growth

Developing Countries

- Aker and MBiti (2010) suggest:
 - Facilitating day labor markets
 - Reminding AIDS patients about aspects of their care
 - Reporting confrontations
 - Bypassing cumbersome banking practices
- Jensen (2007) – More efficient fish markets in south India
- Aker (2010) – Market efficiencies for Nigerian agriculture

Developed Countries

- Vu (2001) suggests:
 - Fostering technology diffusion and innovation
 - Enhancing the quality of decision-making by firms and households
 - Reducing production costs
 - Generally increasing demand
- Nelson (1992) – Evidence of lower transactions costs



Macro Studies on Telecom and Growth

Cross Country

- Röller and Waverman (2001) – Causal effect from telecom. infrastructure beyond a high critical mass of deployment in OECD
- Dimelis and Papaioannou (2011) – Compare the US to the EU
- Gruber and Koutroumpis (2011) Extended analysis to nearly 200 countries and separate out fixed versus mobile phone connections

China Specific

- Démurger (2001) – Sources include transport and telecom.
- Wei and Hao (2010) – Disparities in China due to demographic shifts
- Ding et al. (2008) – Explicitly model effect of telecom. on convergence
- Weeks and Yao (2007) and Shiu and Lam (2008) – Uneven growth rates from east/west technology progress differences



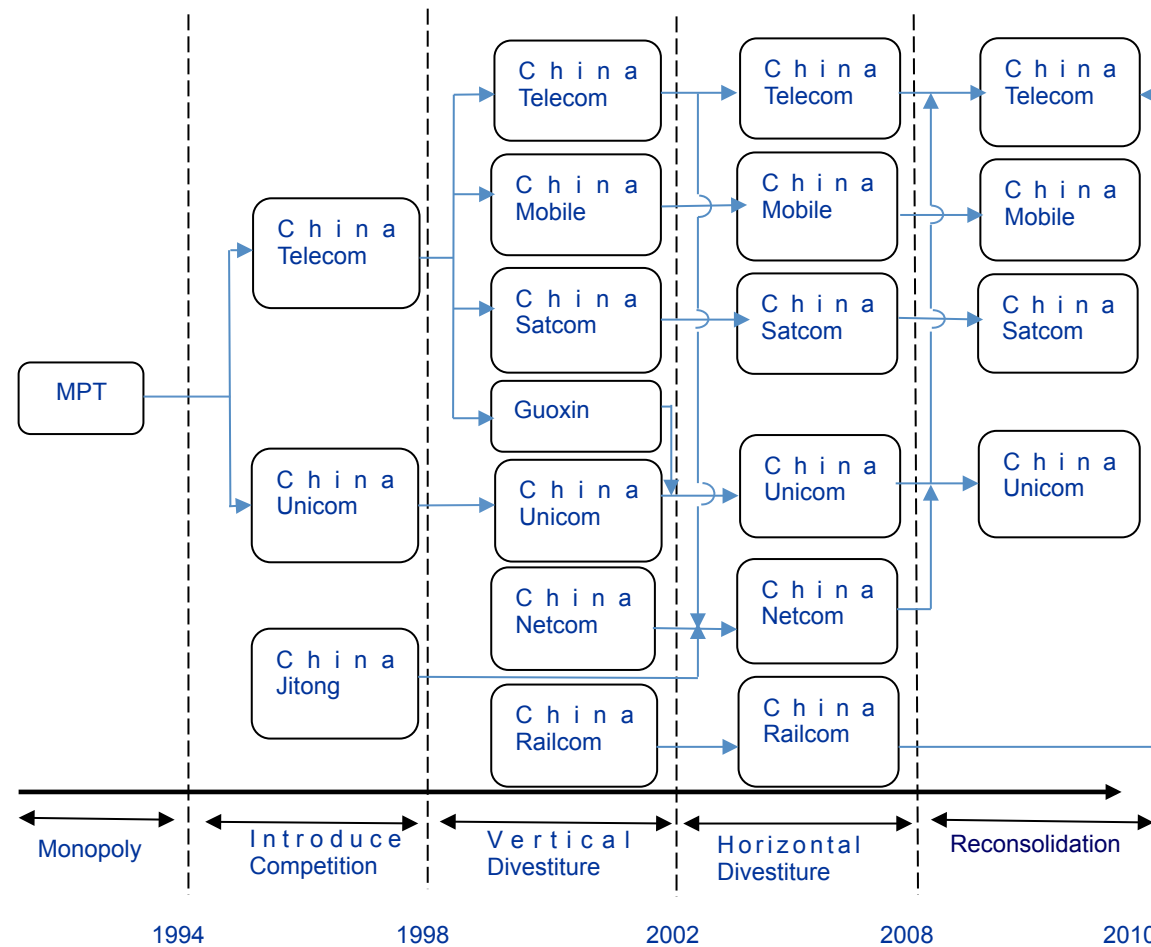
Liberalization of Chinese Telecom

- Pre-1994 – State Monopoly
- 1994 – Regulator separated from provider, first small competitors, problems with interconnection (Wu, 2009)
- 1999 – Regulator split between posts & telecom., Dominant carrier split along three lines of business, new ‘greenfield’ entry
- 2002 – Two main competitors for fixed service, Dominant provider split into two regions
- 2008 – Some consolidation to three main players, 3G introduced



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Changes in Industry Structure



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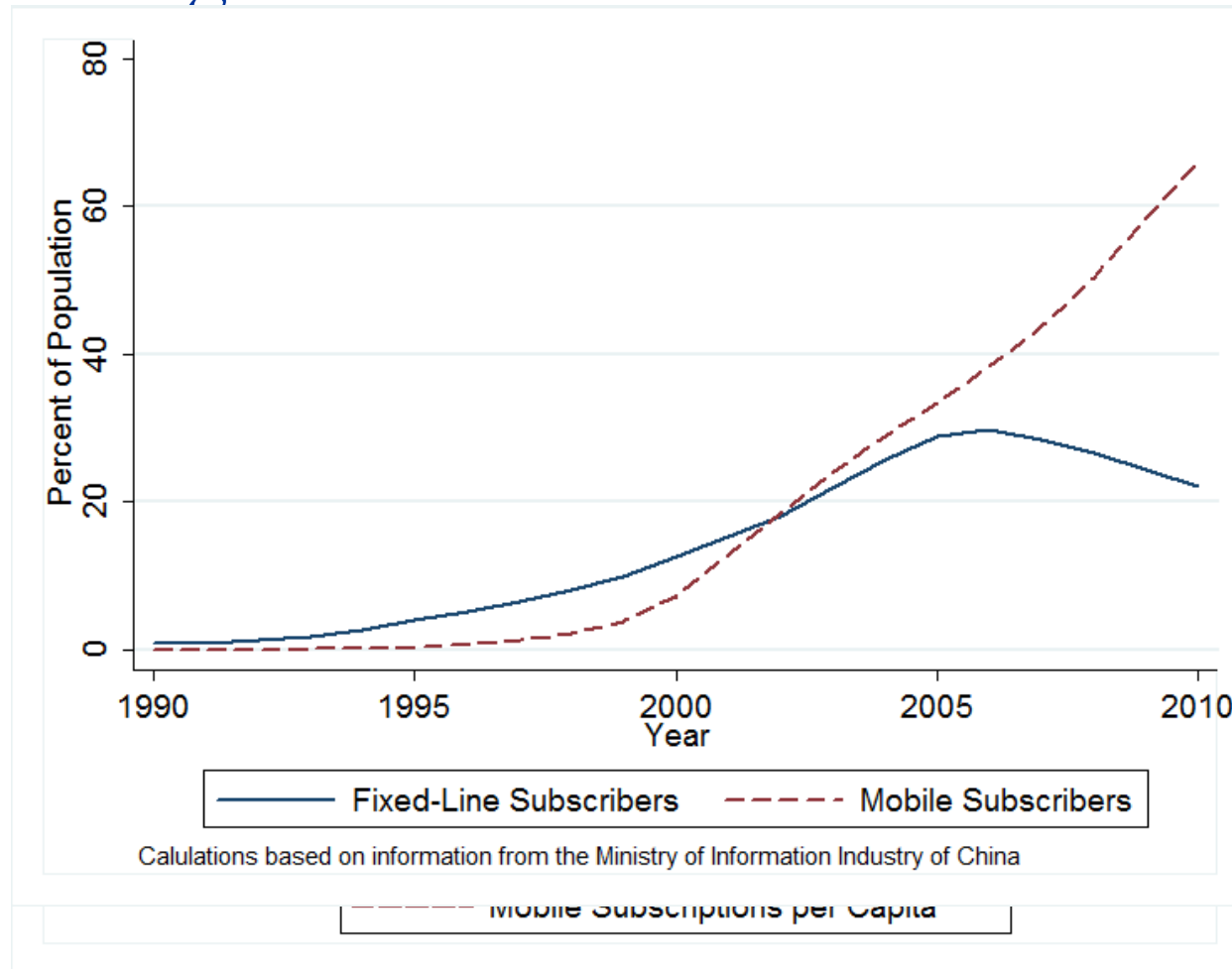
Privatization of Chinese Telecom

- Foreign entry prohibited
- But State Owned Enterprises (SOEs) sought external financing by selling some shares on international markets
- Up to 49% foreign ownership
- Province by province listings
- Desire to attract new capital ‘disciplines’ managers (Groves et al, 1994; Qian, 1996; Qian & Roland, 1996).
- 2008 – Some consolidation to three main players, 3G introduced
- Reforms have led to substantial increases in consumer welfare (Zheng and Ward, 2011) and a more dynamic industry (Ward and Zheng, 2012)



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Huge Growth in Chinese Telecom



Modeling Growth

- Build on existing panel data growth framework (Barro and Sala-i-Martin, 1991; Islam, 1995).

$$\%Chg\ Inc\ Capital_{i,t} = \alpha Inc\ Capital_{i,t-1} + \beta Telecom_{i,t} + \gamma X_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}$$

- Growth related to:
 - Lag levels
 - Telecommunications infrastructure
 - Time and cross-section varying controls
 - Province fixed effects
 - Year fixed effects
 - Error term



Modeling the Error Term I

- Growth rates may adjust slowly to exogenous shocks
- If so, $\varepsilon_{lit} = \mu_{lit} + \rho \% Chg Inc Cap_{lit-1}$
- Induces serial correlation and we need to include the lagged dependent variable
- Induces endogeneity that needs instruments (Arellano & Bond, 1991; Arellano & Bover, 1994)
- Employ System GMM estimator that uses past levels and first differences as IVs



Modeling the Error Term II

- Telecommunication infrastructure may be endogenous to growth
 - Reverse causality
 - Simultaneously determined
- Need additional identifying assumptions:
 - Exclusion restrictions in a supply & demand system: Röller and Waverman (2001) and Gruber and Koutroumpis (2011)
 - Granger causality: Chakraborty and Nandi (2011)
 - Stochastic-Frontier: Thompson and Garbacz (2007) and Baquero (forthcoming)
- We employ privatization and liberalization measures:
 - Concentration (HHI) and privatization (State Owned %) measures
 - Same measures for nearest five provinces – non-overlapping groups in a network (Bramoullé et al, 2009)
- Previous success with these measures: Zheng and Ward (2011)



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Provinces of China



Number of total and (fixed) telecom operators



Data Sources

- Data for 31 Provinces and up to 21 Years
- From National Bureau of Statistics of China:
 - Income
 - Population
 - Gross fixed investment
 - Size of government (government consumption as a fraction of income)
 - International openness (international trade as a fraction of income)
 - Ministry of Information Industry of China (MII)
- From Ministry of Information Industry of China (MII):
 - Revenues, Subscribers, Minutes for both fixed and mobile
 - Allows us to create HHI measures
- From Telecommunications firms' annual reports
 - Share sales and the shares held privately and those held by the state by province
 - Allows us to create percent state-ownership



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Summary Statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
Percent growth of GDP per capita	0.103	0.044	-0.158	0.390
Mobile subscribers per capita	19.095	25.114	0.000	117.654
Fixed-line subscribers per capita	14.403	13.366	0.227	81.308
Share International Trade	0.300	0.409	0.032	2.257
Gross Fixed Investment / GDP	0.408	0.143	0.072	1.106
Govt. share of Consumption	0.156	0.110	0.049	1.086
Population Growth Rate	0.011	0.026	-0.139	0.358
GDP per capita	3,508	3,885	408	29,605
Mobile Hirschman-Herfindahl Index (HHI)	0.766	0.213	0.421	1.000
Fixed Hirschman-Herfindahl Index (HHI)	0.932	0.092	0.574	1.000
Nearest Five Provinces' Average Mobile HHI	0.765	0.209	0.455	1.000
Nearest Five Provinces' Average Fixed HHI	0.930	0.088	0.711	1.000



Results Summary

- Estimators
 - OLS rejected in favor of Dynamic Panel System GMM
 - System GMM with Telecom assumed exogenous rejected in favor of IV approach
 - System GMM IVs from same province or nearby provinces yield similar results
- Estimates
 - Early Period (1991-2000): Positive effect of Mobile, Positive effect of Fixed only through complementarity with Mobile
 - Later Period (2001-2010): Positive effect of Mobile, Negative effect of Fixed
 - Abandonment of “Little Smart”
 - Duplicative entry



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Two-way Fixed Effect OLS Results

	(1)	(2)	(3)	(4)
Log Mobile Subscribers per capita	0.005** (0.002)		0.006*** (0.002)	0.004** (0.002)
Log Fixed Subscribers per capita		0.001 (0.005)	-0.006 (0.006)	0.010** (0.005)
Mobile-Fixed Interaction				0.002*** (0.000)
Lag log GDP per capita	-0.079*** (0.013)	-0.067*** (0.012)	-0.079*** (0.013)	-0.032*** (0.007)
Share International Trade	0.013* (0.007)	0.011 (0.007)	0.012* (0.007)	0.010 (0.007)
Gross Fixed Investment / GDP	0.096*** (0.014)	0.101*** (0.014)	0.098*** (0.014)	0.108*** (0.014)
Govt. share of Consumption	-0.023 (0.033)	-0.007 (0.034)	-0.018 (0.034)	0.010 (0.030)
Population Growth Rate	-0.998*** (0.039)	-1.006*** (0.042)	-1.008*** (0.040)	-0.973*** (0.042)
Year Dummies	X	X	X	X
Province Dummies	X	X	X	X



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Dynamic Panel – Exogenous Telecom

	(1)	(2)	(3)	(4)
Lag Growth Rate in GDP per capita	0.482*** (0.144)	0.404*** (0.131)	0.491*** (0.147)	0.491*** (0.147)
Log Mobile Subscribers per capita	0.004* (0.002)		0.004** (0.002)	0.005** (0.002)
Log Fixed Subscribers per capita		0.002 (0.004)	-0.006 (0.004)	-0.004 (0.004)
Mobile-Fixed Interaction				0.000 (0.001)
Lag log GDP per capita	-0.005** (0.003)	-0.004 (0.003)	-0.002 (0.003)	-0.004 (0.004)
Share International Trade	0.014*** (0.005)	0.015*** (0.004)	0.015*** (0.005)	0.014*** (0.005)
Gross Fixed Investment / GDP	0.019* (0.011)	0.022** (0.010)	0.021* (0.011)	0.022** (0.011)
Govt. share of Consumption	-0.012 (0.012)	-0.019 (0.012)	-0.013 (0.012)	-0.012 (0.012)
Population Growth Rate	-1.162*** (0.062)	-1.137*** (0.058)	-1.171*** (0.065)	-1.169*** (0.064)



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Dynamic Panel – Exogenous Telecom by Period

	1991-2000		2001-2010	
Lag Growth Rate in GDP per capita	0.509*** (0.065)	0.227 (0.193)	-0.102 (0.251)	0.442*** (0.119)
Log Mobile Subscribers per capita	0.005* (0.003)	0.005** (0.002)	0.010** (0.004)	0.013** (0.006)
Log Fixed Subscribers per capita	0.012 (0.007)	0.021*** (0.008)	-0.017** (0.007)	0.006 (0.008)
Mobile-Fixed Interaction		0.001** (0.001)		-0.005** (0.002)
Lag log GDP per capita	-0.029*** (0.008)	-0.036*** (0.008)	0.021** (0.008)	0.007 (0.006)
Share International Trade	0.005 (0.006)	0.006 (0.006)	-0.019 (0.015)	0.022** (0.009)
Gross Fixed Investment / GDP	0.050** (0.022)	0.053*** (0.020)	0.045*** (0.009)	0.032*** (0.011)
Govt. share of Consumption	-0.220*** (0.056)	-0.321*** (0.077)	-0.025** (0.012)	-0.004 (0.010)
Population Growth Rate	-1.213*** (0.062)	-1.114*** (0.058)	-0.951*** (0.065)	-1.170*** (0.064)



Diagnostics

- Much is not robust across periods
 - Lagged endogenous coefficient
 - Lag level coefficient
- Possibly correlated with telecom variables
 - Suggests the need for additional IVs for telecom variables
 - Use own province HHI and State-Owned % variables
 - Use neighboring province HHI and State-Owned % variables



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Dynamic Panel – Endogenous Telecom

Own Province Industry Structure as IVs

	1991-2000		2001-2010	
Lag Growth Rate in GDP per capita	0.548*** (0.069)	0.344*** (0.130)	0.431*** (0.114)	0.214** (0.094)
Log Mobile Subscribers per capita	0.010* (0.006)	0.021** (0.010)	0.017* (0.009)	0.024** (0.010)
Log Fixed Subscribers per capita	-0.021 (0.023)	0.005 (0.022)	-0.032* (0.019)	-0.028** (0.012)
Mobile-Fixed Interaction		0.002** (0.001)		-0.004 (0.003)
Lag log GDP per capita	-0.001 (0.021)	-0.035** (0.017)	0.011 (0.009)	0.023*** (0.008)
Share International Trade	0.009 (0.009)	-0.009 (0.009)	0.013 (0.008)	0.007 (0.008)
Gross Fixed Investment / GDP	0.052** (0.023)	0.071*** (0.022)	0.025** (0.012)	0.032*** (0.009)
Govt. share of Consumption	-0.183*** (0.062)	-0.264*** (0.070)	-0.007 (0.011)	-0.017** (0.008)
Population Growth Rate	-1.195*** (0.197)	-1.109*** (0.184)	-1.166*** (0.051)	-1.097*** (0.039)



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Dynamic Panel – Endogenous Telecom

Neighbor Provinces Industry Structure as IVs

	1991-2000		2001-2010	
Lag Growth Rate in GDP per capita	0.559*** (0.071)	0.315** (0.133)	0.413*** (0.114)	0.213** (0.098)
Log Mobile Subscribers per capita	0.010* (0.006)	0.018** (0.009)	0.018** (0.008)	0.027*** (0.010)
Log Fixed Subscribers per capita	-0.027 (0.024)	0.008 (0.021)	-0.032* (0.017)	-0.034*** (0.012)
Mobile-Fixed Interaction		0.002** (0.001)		-0.003 (0.003)
Lag log GDP per capita	0.006 (0.022)	-0.035** (0.017)	0.011 (0.008)	0.022*** (0.007)
Share International Trade	0.011 (0.010)	-0.006 (0.009)	0.011 (0.008)	0.005 (0.008)
Gross Fixed Investment / GDP	0.050** (0.023)	0.066*** (0.021)	0.023** (0.011)	0.028*** (0.009)
Govt. share of Consumption	-0.174*** (0.064)	-0.275*** (0.069)	-0.007 (0.010)	-0.016* (0.008)
Population Growth Rate	-1.196*** (0.201)	-1.083*** (0.181)	-1.158*** (0.051)	-1.093*** (0.041)



Diagnostics

- “Non-robustness” across periods disappears
 - Lagged endogenous coefficient
 - Lag level coefficient
- Test of IVs
 - Sargan test fails to reject exogeneity.
 - But column (4) for own-province IVs is border-line
 - Not borderline for neighbor provinces
 - However, no appreciable difference in coefficient values across sets of IVs



Results

- Significant differences across periods
 - Mobile coefficient larger in later period
 - Fixed has little effect – negative (!) in later period
- Why negative?
- “Little Smart” – wireless local loop using fixed network
 - 2006: peaked with 90 million subscribers
 - All spectrum to be taken away by 2011
 - 2010: 3 million subscribers
- Fixed line competition
 - 2002: Regional split
 - Subsequent entry into other territories
 - Stranded investment



Telecom Contribution to Growth

- Long term effects
 - Calculate as: with $\beta / (1 - \rho)$
 - Multiply by average (across provinces) change in variable values
- Early Period: 1991-2000
 - Average growth 10.1%
 - Mobile contribution 2.12%
 - Fixed contribution (through complementary effect) 0.03%
- Later Period: 2001-2010
 - Average growth 11.0%
 - Mobile contribution 0.82%
 - Fixed contribution (through complementary effect) -0.29%



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Thank You!



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