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Infrastructure Regulatory Institutions and Their Impact: Papers from CCRP Workshop 2007

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INFRASTRUCTURE REGULATORY INSTITUTIONS AND THEIR IMPACT: PAPERS FROM CCRP, CITY UNIVERSITY WORKSHOP 2006

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1. Introduction

The three following papers were among those presented at the CCRP (Centre for Competition Policy), City University Summer Workshop in July 2006. They are all largely written by young economists and hence represent how their interests in utility regulation are currently developing. All three of the papers report new empirical work on the impact of infrastructure (utility) industry regulation.[1]

As is often the case, there was considerable interest in telecommunications issues and two out of our three papers are devoted to telecom regulatory issues. This is partly because telecoms is the infrastructure industry where empirical work is most developed, partly because of data availability but also because it is such a dynamic industry generating major new challenges to regulators. The two telecom related papers are, by Maiorano and Stern and a second paper by Montoya and Trillas. The third paper, by Gaggero, is devoted to the effect of regulatory risk on the stock market performance of regulated infrastructure companies – equity and asset betas as well as the cost of capital.

Most of the previous empirical on the impact of regulatory institutions has focused on estimating a relatively simple 'reduced form'[2] equation for a variable of interest where a regulatory variable (or variables) has been included as an explanatory variable. This approach has been applied – with considerable success - for fixed line telecom penetration rates and efficiency (Fink, Mattoo and Rathindran (2003), Gutierrez, 2003; Wallsten, 1999), electricity generation capacity (Cubbin and Stern, 2006), telecom company privatisation proceeds (Wallsten, 2002), telecom interconnect prices (Edwards and Waverman, 2006) and a number of others.

2. Definition of Regulatory Variables and the Use of Regulatory Indices in Models of Industry Outcomes

The earliest of the papers mentioned above (Fink et al and the Wallsten papers) perforce use a single Zero/One dummy variable as to whether "an independent regulator" is or is not present. Later papers (including Gutierrez, Cubbin and Stern as well as Edwards and Waverman) use an index of regulation which includes at least four and up to 12 or more characteristics.

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[1] I am grateful for helpful comments on this introductory paper from Federica Maiorano and Alberto Gaggero. The paper and the views expressed in it are, however, totally my responsibility.

[2] I use this term somewhat loosely here to describe all the single equation regulatory impact models rather than in its strict definition as referring to the single equation that one can derive from a system which includes only exogenous or pre-determined variables as right hand side explanatory variables.

It is regularly found that the precision of the estimates of the impact of regulation is greatly improved when an index of regulatory characteristics is used and when more index elements are included. The general results from these single equation, 'reduced form' models is that, controlling for other relevant variables (e.g. per capita GDP, relative prices, etc) regulation does have a significant positive impact on infrastructure industry and efficiency which may be reinforced by competition and/or privatisation. However, the estimated lags are long so that these positive effects only become marked after about 3-5 years.

An important issue is whether the existence of a regulatory agency and its quality can be considered as exogenous or as an endogenous variable to be explained by other characteristics. Gutierrez, Cubbin and Stern as well as Edwards and Waverman have all looked at this. They each find some evidence of endogeneity but the results change very little indeed when re-estimated by single equation (instrumental variable) methods. This is an issue to which I will return below.

Of the three papers in this set, both Montoya and Trillas (M-T) and Gaggero develop and incorporate an index of regulatory characteristics in their modelling. Indeed, M-T report painstaking work on the development of measurement of regulatory indices for Latin America and the Caribbean.

The M-T telecom regulatory indices, like all other regulatory indices so far developed, refer only to the formal, de jure properties of regulators. They compute three alternative measures of de jure regulatory quality. All three show the same trend for the sample as a whole, but two differ in the level of regulatory quality from the third and the country rankings on the three indices are interestingly different. All three of their index measures are (controlling for GDP and with country-specific fixed effects) positively and significantly associated with fixed line penetration rates for their sample countries. The different indices produce similar, but by no means identical, coefficient estimates for regulatory impacts – and similar to those in Gutierrez. However, M-T also report that forthcoming work will compute indices of regulatory quality in operational terms – de facto regulatory quality. This is interesting and will be an important new development. It should be particularly valuable for developing country performance where de jure and de facto regulatory quality can be very different (as M-T recognise in their footnote on Argentinean telecom regulation in recent years).

3. Regulatory Indices, Stock Market Risk and the Cost of Capital

Gaggero uses a regulatory index to try to establish whether or not his sample of regulated utilities from Australia, Canada, Ireland, New Zealand, UK and USA, during the period 1995-2004 had higher equity or asset betas (or a higher cost of capital) if subject to riskier more high-powered price regulatory methods. In other words, did companies regulated by price-cap or similar methods have higher betas than those regulated by rate of return regulation? Previous work (e.g. by Alexander et al 1996) had suggested that they do have higher betas. However, at least for this sample, Gaggero's analysis suggests that they do not.

Gaggero's index is not an index of the quality of the regulatory institution but of the method of price/profit/revenue regulation. Again, though, he uses a composite variable made up of 8 elements rather than a single (and simple) dummies for price cap/rate of return and this provides a lot more discrimination for estimating the impact of different methods of regulation.

The Gaggero paper represents a noticeable advance on previous work on whether and how the risks associated with particular regulatory methods affect the commercial and financial risks faced by companies. However, the countries in his sample are countries with high quality institutions and country governance where regulatory agencies have typically been in place for a considerable period. Hence, in these countries (which also have relatively stable currency exchange rates), the regulatory risks of price cap versus rate of return regulation are arguably not significantly different – indeed some commentators have suggested that with repeat regulation, at least in the UK and similar countries, they are "opposite sides of the same coin" (Stern, 2003, p. 21).[3] In addition, Gaggero's sample is for a later period for which regulatory predictability should have increased.

It would be interesting to see whether Gaggero's results would be replicated in a sample of developing countries where, because of more young regulators, regime switches might be more frequent. Also a sample of such countries would include more regulators building up their reputation. In addition, in countries where regulatory quality is more variable (between countries and over time), the difference in the regulatory risks of price cap versus rate of return regulation are much more likely to be significantly different. Estache, Guasch and Trujillo (2003) found that, in Latin American concession contracts for water facilities and toll roads, price caps[4] implied significantly *higher* prices (and lower levels of investment) and also a higher rate of early renegotiation. (But, see Alexander (2003) for counter-arguments to Estache et al on the potential benefits of price cap regulation in developing countries.)

The question about changes of regime is also important for econometric methodology. The M-T paper, like all the others listed in the introduction, focuses heavily on estimates from a *fixed effects* (FE) model applied to panel data. They are able to do this because a very large percentage of the sample *either* introduce their regulator *and/or* observably change features of the regulatory regime during the observed sample period. In such circumstances, FE models are very powerful. However, Gaggero's sample has only a relatively small percentage (17%) of companies affected by regulatory regime switches. Hence, estimates of the effects of the regulatory regime in FE models provide coefficient estimates only for those experiencing a regime switch.

These are not only a small percentage but are likely to be unrepresentative of the sample as a whole. Hence, Gaggero focuses on the results from the RE modelling on the grounds that it provides a better (i.e. more efficient) estimator *for the sample as a whole*. This is not just important in theory as Gaggero reports results from both FE and RE models and finds that low risk, rate of return regulation *is* significantly associated with lower betas and cost of capital in an FE model. However, for the reasons given above, he concludes that this result should be ignored for the sample as a whole in favour of the RE results[5].

This raises the question of which result we should prefer and why. For various reasons, including his sample of countries as well as the econometric arguments, I am prepared to accept the

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[3] See also the papers by Alexander, Bolt and Littlechild in the same conference volume. Bolt took broadly the same view as Stern. Littlechild (not surprisingly) forcefully argued that they are still fundamentally different.

[4] Pure price caps as well as hybrid models with some element of cost pass-through. The ranking was clear on renegotiations. The highest incidence of renegotiation was with pure price caps, the lowest with rate of return and intermediate for hybrid models (which included all price cap models with elements of cost pass-through).

[5] I am very grateful for helpful discussions with Frank Windmeijer on this issue.

suggestion that Gaggero's RE results are the ones to be preferred – at least for the sample as a whole. However, Gaggero does set out the arguments clearly and fairly and others may well prefer the very different FE results *at least for the sample of companies with a regulatory regime switch*.

More importantly, the issue demonstrates graphically how and why the choice of econometric method must be carefully considered in the light of the data characteristics of the sample. Where there are a high percentage of regulatory changes per country/company/contract etc, FE models estimated on panel data are likely to remain the main choice for modelling regulatory impacts but they are clearly not going to be the most appropriate in all circumstances.

4. Beyond the Single Equation Model: Multi-equation Systems and Regulatory Endogeneity

I briefly mentioned endogeneity issues in Section 2.

On the impacts of country regulators, the question always arises as to whether the existence and/or quality of the regulator is significantly associated with other characteristics of the country that might affect the performance of the regulated utilities (including investment and efficiency). These factors include items such as the degree of the rule of law, the level of corruption, the openness and sympathy to markets, the degree of state ownership and government intervention, political ideology, etc.

One attraction of single equation FE models is that, at least for countries where the performance – or at least the country ranking – changes very slowly, the estimated country specific fixed effect is likely to soak up much of this impact. That, presumably, is a major reason why estimating simple, 'reduced form' FE models has been so popular and so productive. But, they are clearly not the end of the story. In such single equation models, correcting for endogeneity using instrumental variables (IV) has only a small effect on the estimated coefficients (e.g. Cubbin and Stern, Edwards and Waverman, Gutierrez op cit.)

There have been a few previous attempts at estimating models in which the decision of whether or not to have a regulator is considered as endogenous and explicitly modelled in its own regression equation while estimating the impact of regulation in a companion equation. (See Gual and Trillas 2004 for an example where telecom liberalisation and the existence of a regulator are treated as endogenous. Separate equations are each estimated using instrumental variables.

More recently, attention has focused on models where infrastructure industry output and investment is positively affected by per capita GDP levels but that *in addition*, the level of GDP is affected by the level of infrastructure capacity. An example of such a paper is Esfahani and Ramirez (2003). More recently, Waverman et al (2005) have modelled the growth and impact of mobile telecoms in developing countries using a three-equation system.

The Maiorano and Stern paper (M—S) in this issue take the system approach further, again focusing on mobile telecoms in developing countries but with an explicit equation to model whether or not a regulatory agency for telecoms exists in the country. The sample is of 30 low and middle income countries for the period 1990-2004.

The M-S paper has three equations. Firstly, there is an equation for mobile penetration rates which includes as explanatory variables GDP per capita, the existence of an independent regulator, the degree of private ownership and competition and the prices of fixed and mobile services[6]. The second equation is for GDP per capita which includes as explanatory variables mobile penetration rates as well as normalised capital and labour inputs and country governance variables; and the third equation is for the existence of an independent telecom regulator which includes country governance variables as explanatory variables, the degree of competition and privatisation in the industry as well as GDP per capita and other variables. All the equations are estimated by OLS, RE and FE regressions. However, since (where it exists) most of the countries introduced their telecoms regulator during the observation period, the main focus can reliably be placed on the FE results.

The key point about the paper is that estimating the three equations together as a system (using three stage least squares) produces significantly different results from estimating it equation-by-equation. In particular, the estimated impact of the regulator in the mobile penetration equation and the estimated impact of mobile penetration rates on GDP per capita are markedly higher in the system estimates[7] and indeed higher than in the single equation estimates that deal with endogeneity using an instrumental variable estimator. This is in spite of the relatively poor quality of the equation to explain the existence of the regulator – a problem found in Gual and Trillas and other studies[8].

The key point about the M-S paper is that it not only models regulatory endogeneity explicitly but also both in a system as well as on a single equation basis. Overall, the results on regulatory impact do not suggest very large effects but that may be due to the need to use a single variable to describe the regulator. Alternatively, it may be that the existence of an independent regulator is just not as important for mobile telecoms as for fixed line telecoms let alone electricity or water industry capacity.

The M-S paper provides interesting and hopefully useful results but is also important for moving on the modelling approach. For instance, a systems approach allows the derivation of explicit reduced forms (in the strict sense) rather than more loosely derived single equation models as well as providing a multi-equation model. Developing these aspects and allowing the incorporation of fuller descriptions of regulation is likely to be a fruitful route to follow in the years ahead. Going down this route should help provide a much better understanding of *how* and *why* infrastructure regulation has its impacts as well as *whether* it has an impact. The last is now relatively well established in the affirmative

This reasoning also applies in understanding better the impact (*how* and *why* as well as *whether*) of the introduction of competition, private finance and ownership into infrastructure industries and the role of country governance. Hence it applies to estimating the impact of all the main

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6 On relative prices, the results were somewhat mixed; the estimated coefficient on mobile prices was always correctly signed (negative) and statistically significant, but the estimated coefficient on fixed prices was typically very close to zero and insignificant.

7 But the estimated impact of mobiles on per capita GDP is still lower than as estimated in Waverman et al.

8 As one might expect, (majority) privatisation is strongly associated with the existence of a regulator as, in the system is telecom liberalisation. These are sensible and plausible results but, at least in this system, are not associated with higher mobile penetration rates.

elements of infrastructure industry reform, not just of regulation. I look forward to seeing further work on these lines.

5. Conclusion

The papers reported in this special issue show some recent developments by younger economists in estimating the impact of infrastructure regulation. They report significant advances and hold out the promise of a better understanding of the issues. It is to be hoped that they provide the potential for further significant developments.

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REFERENCES

Alexander, I. (2003), "The UK model and developing and transition economies: Common issues and misconceptions", in "The UK Model of Utility Regulation", ed I Bartle, University of Bath, pp.221-233.

Bolt, C., (2003), "The future of RPI-X and the implications for utility investment in the UK", in "The UK Model of Utility Regulation", ed I Bartle, University of Bath, pp.65-87.

Cubbin, J.S. and Stern, J., (2006), "The impact of regulatory governance and privatization on electricity generation capacity in developing countries", *World Bank Economic Review*, Vol. 20 No 1, March 2006, pp 115-141.

Edwards, G. and Waverman, L., (2006), "The Effects of Public Ownership and Regulatory Independence on Regulatory Outcomes", *Journal of Regulatory Economics*, Vol. 23:1 pp. 23-67.

Esfahani, H.S. and Ramirez, M.T. (2003), "Institutions, Infrastructure and Economic Growth", *Journal of Development Economics*, Vol. 70 No. 2, pp 443-477.

Estache, A., Guasch, J.L., and Trujillo, L. (2003), "Price caps, efficiency, pay-offs and infrastructure contract renegotiation in Latin America" in "The UK Model of Utility Regulation", ed I Bartle, University of Bath, pp.173-199.

Fink, C., Mattoo, A. & Rathindran, R., (2002), "An assessment of telecommunications reform in developing countries", *World Bank Working Paper No. 2909*.

Gaggero, A., (2007) [Paper in this issue of UP]

Gual, J. and Trillas, F., (2004), "Telecommunications policies: Determinants and impacts", CEPR Discussion Paper, No. 4578.

Gutierrez, L.H., (2003), "The effect of endogenous regulation on telecommunications expansion and efficiency in Latin America", *Journal of Regulatory Economics*, Vol. 23:3 pp. 257-286

Littlechild, S. (2003), "The birth of RPI-X and other observations" in "The UK Model of Utility Regulation", ed I Bartle, University of Bath, pp.31-51.

Maiorano, F. and Stern, J. (2007), [Paper in this issue of UP]

Montoya, M. and Trillas, F. (2007), [Paper in this issue of UP]

Stern, J., (2003), "What the Littlechild Report actually said", in "The UK Model of Utility Regulation", ed I Bartle, University of Bath, pp. 7-31.

Wallsten, S., (1999), "An empirical analysis of competition, privatisation and regulation in telecommunication markets in Africa and Latin America", *World Bank Working Paper No. 2136*.

Wallsten, S., (2002), “Does sequencing matter? Regulation & privatisation in telecommunication reform”, *World Bank Working Paper No. 2817*.