scottish institute for research in economics

SIRE DISCUSSION PAPER

SIRE-DP-2009-51

Institutions and the Scale Effect

Alex Trew

University of St Andrews

www.sire.ac.uk

Institutions and the Scale Effect*

Alex Trew†
University of St Andrews

SEPTEMBER 2009
REVISED: APRIL 3, 2011

ABSTRACT

Growth models which imply a scale effect are commonly refuted on the basis of empirical evidence. A focus on the extent of the market as opposed to the scale of the country has led recent studies to reconsider the role that country scale plays when conditioning on other factors. We consider a variant of a simple learning by doing model to account for the potential role for institutions in determining the strength – and direction – of the scale effect. Using cross-country data, we find a significant interaction between property rights institutions and the effect of scale on long-run growth: In countries with poor property rights institutions, scale is positively related with income per capita; where property rights institutions are good, higher scale is associated with lower per capita incomes. We find no evidence of such role for contracting institutions.

JEL Classification: O11, O40, O43.
Keywords: Scale and growth, learning by doing, institutions.

* Thanks go to seminar participants at St Andrews and Stirling, and, without implication, to Arnab Bhattacharjee, Ian Lange, Helmut Rainer, Geethanjali Selvaretnam, Gary Shea and David Ulph for helpful discussions, and to Daron Acemoglu for providing some of the data used in this paper..

† School of Economics and Finance, University of St. Andrews, St. Andrews, Fife, UK, KY16 9AL. Tel: +44(0)1334 461950. Email: alex.trew@st-andrews.ac.uk. Web: www.st-andrews.ac.uk/cdma/a.trew.html.

1 Introduction

An implication of early models of endogenous growth such as Romer (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992) is that the scale of the economy – the size of the research sector or the population of the country – should be related positively with level of economic growth. Such scale effects are also a implication of models based on learning by doing following Arrow (1962) and Romer (1986) in which technology spillovers in larger economies generate faster growth.

A number of doubts about the empirical validity of the scale implication have been raised. Lucas (1993) contrasted the growth records of Singapore and India in suggesting that it was an unwelcome implication. A series of influential econometric results found little evidence of a link between scale and growth: Barro and Sala-i-Martin (2004) employed data from a cross section of countries; Backus et al. (1992) used industry level data; and, Jones (1995b) made the argument in the context of trends over time within countries. Motivated by such empirical evidence, there emerged theories, for example Jones (1995a), Aghion and Howitt (1998) and Young (1998), which could generate endogenous growth without an implied relationship between scale and growth.[1]

Those models succeed in their purpose of removing the implication that greater scale means higher long-run growth. The relevance of some of the empirical evidence, especially that based on cross-country analysis, has been questioned, however. In particular, the conception of scale as country or sector aggregates misses parts of what determines the extent of the market for a given firm or industry. As

[1]Some of these models – the 'semi-endogenous' models such as Jones (1995a) – relocate the scale problem to an implied relationship between the rate of growth of population and the rate of growth of the economy. By contrast, 'Schumpeterian' models of product proliferation and endogenous growth, such as Dinopoulos and Thompson (1998) and Aghion and Howitt (1998), have no scale implication and no reliance on population growth. Ha and Howitt (2007) have demonstrated that the Schumpeterian models perform better than semi-endogenous alternatives when considered against data. The focus in this paper is on whether the implications of the first-generation endogenous growth models can be reconciled with evidence on scale when we take into account variations in institutional quality.

Sokoloff (1988) and Ciccone and Hall (1996) find, the extent of the market, or its density, is the conception of scale relevant to pace of technological progress. Indeed, as Davis (2008) points out, Singapore is arguably part of a much larger international economy, while India does not attain markets as large as country-level measures of its scale would suggest. Motivated in part by a focus on market extent, Alesina et al. (2000) have shown that conditioning on measures of openness can mean that a significant role for country scale can exist in explanations of differences in growth across countries.

Given the potential role for institutions in determining market extent, the focus of this paper is on an interaction between institutions and the scale effect. There is a substantial body of evidence that institutions matter *directly* for economic development.[2] The current paper then asks whether institutions matter *indirectly*: Is the appearance of a scale effect conditional on institutional quality? There are a number of potential mechanisms at work. For example, a higher risk of expropriation of international investment might make the scale of the internal market a more important growth-determinant. It might be that improving the ability to write enforceable contracts can mean that larger domestic markets can be formed in countries that have greater scale, while those gains are not realised in smaller countries. Poor internal governance might depress development more in larger countries because the scale of rents is greater.

In order to frame our empirical approach, we consider a simple model of growth based on learning by doing and spillovers, presenting in an Appendix a variant of the basic growth model in which the extent of the market determines the reach of the spillovers. Using data for 180 countries over the period 1985–2004, we test whether there are significant interactions between the quality of institutions and the importance of country scale in explaining development. We characterize in-

[2]See also Knack and Keefer (1995), Hall and Jones (1999), Easterly and Levine (2003), Rodrik et al. (2004) and Acemoglu and Johnson (2005) for evidence on the role that insitutions can play in explaining economic development.

stitutions, following North (1981) and Acemoglu and Johnson (2005), into two categories: 'Contracting institutions' affect the costliness of transacting and the costs of forming contracts; 'property rights institutions', in contrast, reflect the security of private property and the risk of expropriation by an elite. We test for interactions using five different measures of each type of institutional quality (including all those in Acemoglu and Johnson (2005)) and proxy for scale using both country population and the level of real GDP. We proxy for growth using both the average growth in real GDP per capita over the period and the level of real GDP per capita.

On the basis of these estimates, we find a consistently significant interaction between property rights institutions and the log of income per capita: In countries with poor property rights institutions, scale is positively related with the level of development; where property rights institutions are good, greater scale is associated with lower development. Without conditioning on institutional quality, scale does not appear to be related significantly with development. By including an interaction between institutions and scale we can see part of the explanation for why: On average, scale does not appear to matter because the opposing forces from different quality institutions can cancel each other out. We find no evidence of such a role for contracting institutions and no connection with growth averaged over the sample period.

The paper is structured as follows. Section 2 discusses the ways in which institutions and the scale effect might interact and presents a modified learning by doing model with market extent to account for the potential role for institutions. Section 3 introduces the measures of institutional quality that we use, presents descriptive statistics, and discusses the main empirical results. Section 4 contains some concluding remarks.

2 Institutions and Scale

A useful way to think about different institutions and their affect on economic outcomes is to follow North (1981) and Acemoglu and Johnson (2005) in characterizing two broad classes of institutions: First, 'contracting institutions' are those which affect the costliness of transacting and the costs of forming contracts; 'property rights institutions', in contrast, reflect the security of private property and the risk of expropriation by an elite. Using various proxies for each institution, Acemoglu and Johnson find evidence that property rights institutions can robustly be related to economic outcomes such as the level of income per capita, while contracting institutions generally cannot.

There are two potential ways in which institutional quality in a country can interact with market extent. First, they can directly affect the extent of the market; second, they can make the scale of the country a more or less important determinant of market extent. Our intention in this Section is to lay out the channels through which institutional quality could impact scale and growth and proceed in Section 3 to test for them in the data.

Direct Effects of Institutions

The direct effects contracting institutions are intuitive, and follow the arguments of Coase (1960), Williamson (2000) and Fafchamps (2004), that poor contracting institutions and high transactions costs limit the ability to diversify against risks, to form large markets and to choose optimal organizational structures. A small country with good contracting institutions has firms that might trade more widely than a larger country with worse institutions. We can think of property rights in a similar way. De Soto (2001), among others, has argued that weak property rights institutions can impact on the ability to obtain scale, while Dollar and Kraay (2003) have drawn attention to the correlation between international trade and

institutional quality. Firms might look to minimise the exposure of their profits to expropriation by forming closer markets based on social capital; international trade can be hampered because of the possibility of asset seizures. As property rights institutions improve, impersonal exchange grows and the belief in security of owned assets means that international and domestic trade can expand.

Interactions with Country Scale

High quality contracting institutions in a country can benefit competition in international markets, to the point that country scale, per se, matters less as a determinant of market extent. When contracting institutions are poor, from this perspective, country scale becomes a more important determinant of market extent as international markets are less accessible. In contrast, when contracting institutions are good, it may be that country scale can matter more if firms prefer to trade with other firms that enjoy a similar (domestic) quality of contracting institution.

The costs of supporting institutions over a large scale can be significant, as Alesina et al. (2005) and Davis (2008) have noted. As such, high quality contracting institutions may mean that greater scale *reduces* growth. Suppose that the proportionate costs of contracting institutions are increasing in the size of the economy (as found by Wallis and North (1986)). It may be then that the costs of supporting high quality contracting institutions in a country with larger scale outweigh the learning by doing gains associated with the larger markets. That is, good quality institutions may reverse the effect of scale on growth.

An interaction between the importance of scale and property rights institutions can also be hypothesized. Poor property rights institutions might mean that larger country scale can damage growth since the scale of the economy can increase incentives for the elite to exploit poor property rights and extract rents. Scale and property rights institutions can interact in other ways, as Rock and Bonnett (2004) have found in the context of the East Asian paradox. They show that various

measures of corruption are positively related to growth in large countries, and negatively related in smaller countries. They argue that a larger internal market can increase the gains from ignoring corrupt institutions and increase the probability of getting away with being corrupt. Governing a large country under a secure property rights system can also be costly, perhaps to the point that increasing scale brings demands upon the institution that lead to lower growth in a similar way to that discussed in the context of contracting institutions. The multi-dimensional heterogeneity of large countries, discussed in Alesina et al. (2005), potentially reinforces the costliness of good property rights institutions.

2.1 Learning By Doing, Institutions and the Scale Effect

We wish to capture the two ways in which institutions might impact on growth via market extent: The direct effect of institutions on market extent and the affect of institutions on the importance of country scale. Consider a country n with institutional quality z_n, where a higher z_n implies better institutions. In order to consider the importance of country scale in the context of a larger global market, we need to think of a country's proportionate scale. So let us define $S_n \in (0,1)$ as country n's scale as a proportion of world scale.[3] Our question then is how important is country n's relative size for country n's growth, and does conditioning on the quality of institutions affect the appearance of a scale effect.[4]

Appendix A generalizes a simple learning by doing model of growth to consider the extent of the market instead of country scale. Specifically, suppose that the Φ_n

[3]Just as the theory in Alesina et al. (2005) takes country size relative to the world. With a scale effect based on absolute size, market extent in country n is, for example, $\phi \cdot (L_n)^s$ where s is the parameter which captures the importance of country scale. When $s = 0$ clearly market extent is ϕ. Where $L_n > 1$, market extent is larger for any $s > 0$. So growth is increasing in s always. However, we would like s to capture the importance of a country's scale for its growth rate; it may be that when country scale matters less, growth is higher since the economy can be part of a larger market than its population suggests. Using proportionate scale, $S_n \in (0,1)$, permits us to think of the scale effect as capturing the importance of the size of the country for growth: When $s = 0$, country scale does not matter for growth; when $s = 1$, country scale matters a lot.

[4]Our empirical results are based on purely cross-sectional data, so thinking of the relationship between relative size and growth is the same as thinking of that between absolute size and growth.

denotes the scale of the market for a firm in country n relative to the size of country n. The learning by doing scale which determines growth is then not just the scale of the country but also Φ_n; the *extent of the market* is $(\Phi S)_n$. A Cobb-Douglas production function and CES preferences result in growth rates being equal to,

$$\gamma_n = \theta^{-1}\left[A_0[(\Phi S)_n]^{1-\alpha} - \rho\right] \tag{1}$$

where θ is the constant elasticity of substitution of consumption across time, ρ the rate of time preference, α the share of capital in output and A_0 a scaling parameter in the production function.

Growth can differ between countries with identical scale if their Φ differs. This measure of market extent has a natural interpretation. When Φ is greater than one, it means that on average the economy has a market extent equivalent to a measure of openness greater than one. The benefit of conceiving of Φ as separate from openness is that when Φ is less than one, it captures a measure of average non-integration of the domestic market; even though there may be some level of interaction with international markets, on average, the market extent for a given firm is smaller than the size of the domestic economy.

Suppose that market extent is related to z_n both directly and via interaction with country scale. We can write,

$$(\Phi S)_n = \phi(z_n)(S_n)^{s+\delta(z_n)}, \tag{2}$$

$\phi(z_n)$ reflects the direct effect (with $\phi' \geq 0$) and $\delta(z_n)$ captures the affect of institutions on the importance of country scale. We do not know the sign of δ'. When $z_n = 0$ the scale effect works through the autonomous effect of country size, s, on market extent.

Better institutions, z_n higher, can make country size more or less important, depending on the sign of δ'. If $\delta' > 0$ (< 0) then better institutions make country

scale a more (less) important determinant of market extent. If $s+\delta(z_n) > 0$ then a normal scale effect is present. Clearly, institutions can make scale *bad* for growth if $\delta' < 0$ and $s+\delta(z_n) < 0$. The typical approach to the scale effect tests for whether $s = 0$, but without conditioning on institutions this is equivalent to testing that on average, $s+\delta(z_n) = 0$.

The relationship between $(\Phi S)_n$ and z_n (and so that between growth and z_n) clearly depends on the functions $\phi(z_n)$ and $\delta(z_n)$,

$$\frac{\partial(\Phi S)_n}{\partial z_n} = (S_n)^{s+\delta(z_n)} \left[\phi'(z_n) + \phi(z_n)\delta'(z_n)\ln(S_n)\right]. \tag{3}$$

If better institutions make country scale more important ($\delta' > 0$), then the effect of improving institutions can be to *reduce* market extent if the country is sufficiently small (i.e., if $\ln(S_n)$ is sufficiently negative relative to the gain from $\phi'(\cdot)$). Where better institutions make country scale less important ($\delta' < 0$), they will always increase market extent. Using equation (2) and (1),

$$\gamma_n = \theta^{-1}\left\{A_0\alpha\left[\phi(z_n)(S_n)^{s+\delta(z_n)}\right]^{1-\alpha} - \rho\right\}. \tag{4}$$

So institutions can affect growth in two ways. First, by directly expanding market size they increase growth through greater learning by doing. Second, by affecting the importance of country scale in determining market extent they affect the importance of country scale in determining growth. The effect of scale on growth can be higher or lower – or even negative – when institutions are good. These two effects, one independent of scale and one interacting with scale, can be tested for in the data, as we will see below.

3 Empirical Evidence on Institutions and the Scale Effect

The two channels by which institutions might affect market extent and growth can be tested for using appropriate data. Our empirical evidence is based on permutations of two proxies for scale (log population and log real GDP) and two proxies for growth (log real GDP per capita and average growth in real GDP per capita). All scale and growth data are from Penn World Table (Heston et al., 2006). We use five proxies for each type of institutional quality, including all those used by Acemoglu and Johnson (2005). Results in this Section are based on all forty permutations of scale, growth and institutional variable, and for the same forty with additional control variables, all of which are presented in the Appendix.

3.1 Institutional Data and Descriptive Statistics

Table 1 gives a breakdown of the institutional variables we employ. The median populations in the sample of 180 countries are Hong Kong and Tajikistan at 5.8 and 6.3 million, respectively. For the purposes of this table, we split the sample into countries with greater and less than 6 million people.

A detailed breakdown of data sources and variable definitions is given in the Appendix. The five rows below the growth variables are proxies for property rights institutions. Executive constraint is a measure of constraint on executive power using data from Polity IV (2006), on a scale between 1 (unlimited authority) and 7 (full accountability/subordination of the executive). The private property variable from Gwartney and Lawson (1997) is a score indicating the extent of protection of private property from 1 (very low) to 5 (very high). We also use data employed in Knack and Keefer (1995) from the International Country Risk Guide. First, expropriation protection reflects the risk of expropriation of private foreign investments, between 0 (highest risk) and 10 (lowest risk). Second, repudiation measures

(between 0 and 10) the risk of modification of a contract (by full repudiation, postponement or scaling down) due to government pressure. The measure of corruption is from La Porta et al. (1999), and scores from 0 to 10 the level of corruption in government. Each of these proxies are direct measures of institutional quality, so should be positively correlated with economic outcomes.

The final five rows are contracting institutions proxies. A measure of legal formalism from Djankov et al. (2003) indicates the formality of legal procedures for collecting on a bounced cheque, measured from 1 (low formalism) to 7 (high). Two variables from the World Bank (2004) *Doing Business* studies are the number of procedures and the procedural complexity (scored from 0 to 10) involved in collecting a commercial debt of 50% of per capita income. We use two variables from the recent work of Djankov et al. (2008). They survey lawmakers in regard to the likely course for a hypothetical case where a company defaults on its single creditor due to a temporary liquidity problem. The debt efficiency variable reflects the present value of the net worth of company as a proportion of its total worth, while debt cost is the estimated cost of the insolvency proceeding, again as a proportion. All the contracting variables (except debt efficiency) are measures of institutional *bad*ness, so should be inversely related with economic outcomes.

As can be seen from Table 1, there are no significant differences in institutional quality across countries of different scale. Across all five proxies, property rights institutions appear to be, on average, slightly worse in large countries. Proxies for contracting institutions are less consistent. Four of the five proxies suggest that contracting institutions are worse in large countries but, again, the differences are small.[5]

[5]Bivariate regressions of institutional proxies on the log of population confirm the insignificance of scale in explaining the quality of institutions. Of the ten proxies, only property security and the number of procedures are significantly correlated with log population.

Table 1: Descriptive Statistics

	Whole sample			Pop > 6m			Pop < 6m		
	n	avg	s.d.	n	avg	s.d.	n	avg	s.d.
Growth rate	180	1.58	2.30	90	1.44	1.95	90	1.71	2.60
log(GDP per capita)	180	8.46	1.14	90	8.32	1.16	90	8.61	1.10
Exec. constraint	149	4.42	2.07	87	4.33	2.02	62	4.55	2.15
Prop. security	130	3.35	1.17	81	3.20	1.20	49	3.61	1.10
Expr. protection	116	7.12	1.82	78	7.02	1.88	38	7.35	1.69
Repudiation	87	6.70	1.97	58	6.59	2.04	29	6.93	1.85
Corruption	121	5.67	1.49	78	5.62	1.41	43	5.77	1.65
Formalism	111	3.67	1.07	71	3.72	1.04	40	3.59	1.12
Procedures	122	26.92	26.92	82	24.65	10.25	40	31.58	14.15
Complexity	121	5.78	1.39	82	5.80	1.39	39	5.73	1.42
Debt Efficiency	85	52.97	25.16	53	51.96	26.42	32	54.65	23.24
Debt Cost	85	0.13	0.10	53	0.14	0.10	32	0.12	0.09

N.B. Variable descriptions and data sources are given in the Appendix (Table 13).

3.2 Empirical Strategy and OLS Results

Our purpose is to take cross country data to the potential interactions between institutions, scale and growth captured in equation (4). Suppose that $\phi(z_c) = \hat{\phi} \cdot z_c$ and $\delta(z_c) = \hat{\delta} \cdot z_c$ where $\hat{\phi}$ and $\hat{\delta}$ are constants. Then we can estimate a growth regression of a form similar to those on interactions between openness and scale in Alesina et al. (2000),

$$\ln(\gamma_n) = \beta_0 + \beta_1 \ln(S_n) + \beta_2 \ln(z_n) + \beta_3 z_n \cdot \ln(S_n) \tag{5}$$

This functional form follows from the form of the growth equation, (4). The estimates of β_1 and β_2 will tell us whether there is a growth effect from the country scale and institutional variable, respectively. The coefficient β_3 will reflect the interaction between institutions and the scale effect, and whether it is significantly positive or negative.

There is a potential identification problem in that institutions can both de-

termine and be determined by the left-hand side variable. Natural historical instruments for each type of institutional variable are available (see Acemoglu and Johnson (2005)) but the inclusion of an interaction term means that the first-stage regressions in a 2SLS regression suffer from severe multicollinearity, making inference at the second stage difficult.[6] A potential strategy to combat such problems is dynamic panel estimation with lags of variables as instruments as in Dollar and Kraay (2003) and Bhattacharyya (2009). Again, the presence of the interaction term means that this approach is affected by significant multicollinearity between the explanatory variables.

A number of studies, such as Acemoglu and Johnson (2005), have shown that when instrumenting appropriately a robust role for institutional quality (particularly proxies for property rights institutions) remains. Dollar and Kraay (2003) and Bhattacharyya (2009) have shown that a robust role for institutions exists even when conditioning on trade and human capital, respectively. We proceed with OLS results, therefore, with the proviso that our estimates will likely be upper bounds on the significance of the institutional variables. As we will see, the results are consistent enough across all forty permutations of institutional and economic proxies (and forty more permutations again with control variables) that we can make some confident inferences about the role of institutions in the scale effect.

Tables 3–12 report OLS results for all ten institutional proxies. The two different dependent variables are average growth in real GDP per capita and the logarithm of the level of real GDP per capita. The two proxies for country scale are the logarithm of country population as a proportion of the world population and, the

[6]That is, including the instrument plus an interaction between the instrument and scale causes multicollinearity in the first stage regression, making all standard errors in the second stage large. As such, using the Acemoglu and Johnson (2005) methodology and data on the sample of former colonies, we find that coefficient estimates on for all scale, institutions and interaction terms have low t-statistics regardless of the proxy for scale or the measure of growth. Alesina et al. (2000) are able to estimate 2SLS results using instruments for openness that do not appear to cause inference problems, probably because the instruments they use for openness are dummy variables with many zeros.

logarithm of real GDP as a proportion of world real GDP as the proxies for country scale. All data are averages over the period 1985-2004.

A clear pattern emerges from the regressions: When log GDP per capita is the dependent variable, there exists a consistently significant interaction between the quality of property rights institutions and country scale. The interaction between property rights institutions and the scale variable is always negative and is highly significant in nine of the ten baseline permutations; in seven of those nine cases, there is a highly significant and positive role for scale independent of institutions in explaining long-run growth. In other words, country scale is positively related with growth, but less strongly so (and perhaps negatively) when property rights institutions are good (we draw out the quantitative implications below). No such role exists for contracting institutions (except for the measure of debt efficiency), and there is little significance of either type of institution in explaining variations in measures of average growth (except the measure of property security).

That is, when property rights institutions are of higher quality, country size is a less important part of what explains growth over the long-run, and not over the short run. When property rights institutions are poor, the country size plays a significant part in constraining growth. That contemporaneous measures of economic growth are not characterized by this interaction suggests that the effects of property rights institutions on the scale effect appear only over the long-run. That contracting institutions do not in general play a significant explanatory role supports the findings of Acemoglu and Johnson (2005); it may be that inadequacies in the quality of contracting institutions do not affect economic outcomes because optimizing individuals can compensate by changing the way they form contracts, and so on. In contrast, the economic consequences of the property rights institutions are, by their nature, harder to avoid by individual changes of behaviour.

Robustness of the Results

In order to check the robustness of the baseline results, we present in Tables 3–12 OLS estimates when we condition on a number of other variables. Given that many of the institutional measures we consider are related to the quality of government, we condition on the level of government spending as a proportion of GDP.[7] We also condition on openness and the exchange rate in order to ensure that the effect of institutions and their interaction with scale is not simply picking up the importance of openness found in Alesina et al. (2000) and Alcalá and Ciccone (2003). As can be seen from the Tables, these additional variables do not affect the key results noted from the baseline regressions.

To save space, we do not report a number of other robustness checks. Including an interaction between openness and scale in addition to openness, as in Alesina et al. (2000), has little effect on the reported results. Additional controls not reported include the measure of exchange rate overvaluation from Acemoglu et al. (2003) as an alternative to the exchange rate data used, the level of investment as a proportion of output, and including initial income per capita in the regressions with economic growth as the dependent variable. None of these additional controls substantially affect our results. Using GDP per capita in a single year (such as 1995, as in Acemoglu and Johnson (2005)), instead of an average over 1985–2004, or using a longer average for all data (such as 1975–2004), does not affect results.

The significance of the interaction between institutions and scale is affected by conditioning on measures of financial depth from Beck et al. (2000) and educational data from, for example, Barro and Lee (1996). Including these additional variables reduces the sample size significantly, and their impact on estimates of institutional variables can also be due to multicollinearity; Acemoglu and Johnson (2005) do not condition on human capital variables for similar reasons.[8] As noted above,

[7] See, for example, Alesina et al. (2002), Barro and Sala-i-Martin (2004), for empirical studies of the relationship between government spending and growth.

[8] Consider the baseline GDP per capita regression from Table 3 that takes executive constraint

work such as Bhattacharyya (2009) has shown that the institutions and measures of human capital are both robust determinants of growth when one instruments in a dynamic panel setting, and so supports the general implications of Acemoglu and Johnson (2005) that property rights institutions are a fundamental determinant of long-run growth. In the absence of results based on instrumental variable estimates, we must take the OLS results as upper bounds on the actual explanatory power of institutions and their interaction with scale.

Quantitative Implications and Interpretations

The negative coefficient on the interaction term between institutional quality and scale leaves the possibility that good institutions can make greater scale *detrimental* to long-run growth, i.e., when $s + \delta(z_n) < 0$ in equation (2). For an idea of the implications of the interaction on the scale effect, consider one of the baseline results in Table 5, which regresses log per capita income on average protection against expropriation, the log of population and an interaction between them. Table 2 gives the implications for the log level of GDP per capita of different levels of scale and institutional quality.[9] Consider three possible levels of population: 2m, 6m and 20m; and, three levels of the institutional quality: 5.5, 7 and 8. These hypothetical values correspond approximately to the quartile values of population and expropriation protection.[10]

Better property rights institutions are related with higher per capita incomes, regardless of the scale of the country. The direction of the scale effect is dependent

as institutional proxy and population as the scale variable; the sample comprises 149 countries. When we include the credit to GDP ratio from Beck et al. (2000) and the 1980–90 average of spending on primary level schooling Barro and Lee (1996) the sample becomes 55 countries. In that regression, the coefficient on credit is significant and positive, while those on schooling, scale, institutions and their interaction with scale are insignificant even at 10%. Education spending is significant when we include it without the credit to GDP variable.

[9]Since average expropriation is insignificant on its own, it does not enter independently into the calculations of Table 2 (though doing so makes no difference to the qualitative implications).

[10]Numbers calculated in the table include the intercept, 7.61, which was unreported in Table 5. The variable used for scale is population as a fraction of the world population. Reported numbers are implied levels of real GDP per capita.

Table 2: Scale, Institutions and Income Per Capita

	Scale		
Inst.	2m	6m	20m
5.5	1529	1589	1657
7	3517	3256	2993
8	6127	5254	4439

on the level of institutional quality, however. Without conditioning on institutional quality, scale does not appear to be related significantly with long-run growth. By including an interaction between institutions and scale we can see part of the explanation for why: Where good property rights institutions exist, larger countries are characterized by lower per capita incomes; in contrast, countries with poorer property rights seem to do better when they are large. On the average, scale does not appear to matter because these opposing forces cancel out.

One interpretation may be that countries with poor property rights institutions rely more heavily on their internal scale because the potential for international trade and foreign investment is limited. The scale of the country is then a far more important determinant of market extent, and so growth. At the same time, and as pointed out by Rock and Bonnett (2004), a country with poor property rights institutions is better placed to engage with the international economy if it is larger: A small country with poor property rights institutions can be subjected more easily to sanctions and trade restrictions; at the same time, the potential gains to outsiders of engagement with larger countries means that issues of poor governance may be more likely to be overlooked. That this does not appear to happen in the quality of contracting institutions supports the findings of Acemoglu and Johnson (2005) that impediments resulting from poor contracting institutions can be obviated by private agents. The risk of losing an entire contract to government expropriation, on the other hand, cannot.

The finding that greater scale can be associated with lower levels of GDP per capita is harder to interpret. The costs of supporting property rights institutions of a given quality may play a role through its impact on government spending and taxation. A large country with a very secure property rights system might have to allocate a greater proportion of its wealth to maintaining that institution, perhaps to the point that increasing scale brings demands upon the institution that lead to lower incomes. In other words, the costs of institutional quality of a given level increase disproportionately with country size as more is put into maintaining institutions over a more diverse geographic, demographic and political spectrum. This suggests that the costs of size noted by, among others, Alesina et al. (2005) and Davis (2008), can indeed be significant.

4 Concluding Remarks

We have found evidence of a role for property rights institutions in interacting with country scale to explain differences in economic growth. It appears that a positive (negative) scale effect exists over the long-run where property rights institutions are poor (good). We have interpreted this relationship as reflecting the role that property rights institutions play in determining market extent. The findings contribute to the literature on the existence of a positive scale effect, as well as to that which that stresses the potential costs of country size.

Clearly, the empirical methodology employed in this paper is open to criticism in view of the potential endogeneity problems. However, given the robust role for institutions found in many studies, even those conditioning on human capital and trade, we have argued that the OLS results can be interpreted as strong evidence for the existence of important interactions between scale and institutions. A number of potential explanations of the results have been suggested, but much work remains to understand the exact mechanisms through which institutions and scale interact.

References

Acemoglu, D. and Johnson, S. (2005). 'Unbundling Institutions'. *Journal of Political Economy*, 113(5):949–95.

Acemoglu, D., Johnson, S., Robinson, J. A., and Thaicharoen, Y. (2003). 'Institutional Causes, Macroeconomic Symptoms: Volatility, Crises and Growth'. *Journal of Monetary Economics*, 50:49–123.

Aghion, P. and Howitt, P. (1992). 'A Model of Growth Through Creative Destruction'. *Econometrica*, 60(2):323–51.

Aghion, P. and Howitt, P. (1998). *Endogenous Growth Theory*. The MIT Press.

Alcalá, F. and Ciccone, A. (2003). 'Trade, Extent of the Market, and Economic Growth 1960-1996'. Universitat Pompeu Fabra, Working Paper 765.

Alesina, A., Ardagna, S., Perotti, R., and Schianterelli, F. (2002). 'Fiscal Policy, Profits and Investment'. *American Economic Review*, 92:571–89.

Alesina, A., Spolaore, E., and Wacziarg, R. (2000). 'Economic Integration and Political Disintegration'. *American Economic Review*, 90(5):1276–96.

Alesina, A., Spolaore, E., and Wacziarg, R. (2005). 'Trade, Growth and the Size of Countries'. In Aghion, P. and Durlauf, S., editors, *Handbook of Economic Growth*, chapter 23, pages 1499–1542. North Holland.

Arrow, K. J. (1962). 'The Economic Implications of Learning By Doing'. *Review of Economic Studies*, 29:509–27.

Backus, D. K., Kehoe, P. J., and J., K. T. (1992). 'In Search of Scale Effects in Trade and Growth'. *Journal of Economic Theory*, 58:377–409.

Barro, R. and Lee, J. W. (1996). 'International Measures of Schooling Years and Schooling Quality'. *American Economic Review: Papers and Proceedings*, 86(2):218–23.

Barro, R. J. and Sala-i-Martin, X. (2004). *Economic Growth*. MIT Press, 2nd edition.

Beck, T., Demirgüç-Kunt, A., and Levine, R. (2000). 'A New Database on Financial Development and Structure'. *World Bank Economic Review*, (14):597–605. May 2009 revision. The dataset is updated at the World Bank Finance Research website, http://econ.worldbank.org/.

Bhattacharyya, S. (2009). 'Unbundled Institutions, Human Capital and Growth'. *Journal of Comparative Economics*, 37:106–20.

Ciccone, A. and Hall, A. (1996). 'Productivity and the Density of Economic Activity'. *American Economic Review*, 86(1):54–70.

Coase, R. H. (1960). 'The Problem of Social Cost'. *Journal of Law and Economics*, 3:1–44.

Davis, L. S. (2008). 'Scale Effects in Growth: A Role for Institutions'. *Journal of Economic Behavior and Organization*, 66:403–19.

De Soto, H. (2001). *The Mystery of Capital*. Black Swan.

Dinopoulos, E. and Thompson, P. (1998). 'Schumpterian Growth Without Scale Effects'. *Journal of Economic Growth*, 3(4):313–35.

Djankov, S., Hart, O., McLiesh, C., and Shleifer, A. (2008). 'Debt Enforcement Around the World'. *Journal of Political Economy*, 116(6):1105–49.

Djankov, S., La Porta, R., Lopez-de Silanes, F., and Shleifer, A. (2003). 'Courts'. *Quarterly Journal of Economics*, 118(May):453–517.

Dollar, D. and Kraay, A. (2003). 'Institutions, Trade, and Growth'. *Journal of Monetary Economics*, 50:133–62.

Easterly, W. and Levine, R. (2003). 'Tropics, Germs and Crops: How Endowments Influence Economic Development'. *Journal of Monetary Economics*, 50(1):3–39.

Fafchamps, M. (2004). *Market Institutions in Sub-Saharan Africa: Theory and Evidence*. MIT Press.

Grilliches, Z. (1990). 'Patent Statistics as Economic Indicators: A Survey'. *Journal of Economic Literature*, 28(4):1661–1707.

Grossman, G. and Helpman, E. (1991). 'Quality Ladders in the Theory of Economic Growth'. *Review of Economic Studies*, 58(1):43–61.

Gwartney, J. D. and Lawson, R. (1997). *Economic Freedom of the World: 1997 Annual Report*. Heritage Foundation.

Ha, J. and Howitt, P. (2007). 'Accounting for Trends in Productivity and R&D: A Schumpeterian Critique of Semi-Endogenous Growth Theory'. *Journal of Money, Credit and Banking*, 39(4):733–74.

Hall, R. E. and Jones, C. I. (1999). 'Why Do Some Countries Produce So Much More Output Per Worker Than Others?'. *Quarterly Journal of Economics*, 114(1):83–116.

Heston, A., Summers, R., and Aten, B. (2006). 'Penn World Table Version 6.2'. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

Jones, C. I. (1995a). 'R&D-Based Models of Endogenous Growth'. *Journal of Political Economy*, 103(4):759–84.

Jones, C. I. (1995b). 'Time Series Tests of Endogenous Growth Models'. *Quarterly Journal of Economics*, 110(2):495–525.

Knack, S. and Keefer, P. (1995). 'Institutions and Economic Performance: Cross-Country Tests Using Alternative Institutional Measures'. *Economics and Politics*, 7(3):207–27.

Kremer, M. (1993). 'Population Growth and Technological Change: One Million B.C. to 1990'. *Quarterly Journal of Economics*, 108(3):681–716.

La Porta, R., Lopez-de Silanes, F., and Shleifer, A. (1999). 'The Quality of Government'. *Journal of Law, Economics and Organization*, 15(1):222–79.

Lucas, Jr., R. E. (1993). 'Making a Miracle'. *Econometrica*, 61:251–72.

North, D. C. (1981). *Structure and Change in Economic History*. Norton.

Polity IV (2006). 'Polity IV Annual Time-Series 1800-2007'. Integrated Network for Societal Conflict Research (INSCR), Center for Systemic Peace. Available at http://www.systemicpeace.org/inscr/inscr.htm.

Rock, M. T. and Bonnett, H. (2004). 'The Comparative Politics of Corruption: Accounting for the East Asian Paradox in Empirical Studies of Corruption, Growth and Investment'. *World Development*, 32(6):999–1017.

Rodrik, D., Subramanian, A., and Trebbi, F. (2004). 'Institutions Rules: The Primacy of Institutions over Geography and Integration in Economic Development'. *Journal of Economic Growth*, 9:131–165.

Romer, P. (1986). 'Increasing Returns and Long-Run Growth'. *Journal of Political Economy*, 94(5):1002–37.

Romer, P. (1990). 'Endogenous Technological Change'. *Journal of Political Economy*, 98(5.2):S71–S102.

Sokoloff, K. L. (1988). 'Inventive Activity in Early Industrial America: Evidence From Patent Records'. *Journal of Economic History*, 48:813–50.

Wallis, J. J. and North, D. C. (1986). 'Measuring the Transaction Sector in the American Economy, 1870–1970'. Chapter 3 in Engerman, S. L. and Gallman, R. E. (eds.). *Long-Term Factors in American Economic Growth*. University of Chicago Press.

Williamson, O. E. (2000). 'The New Institutional Economics: Taking Stock, Looking Ahead'. *Journal of Economic Literature*, 38(September):595–613.

World Bank (2004). *Doing Business in 2004: Understanding Regulation*. Oxford University Press.

Young, A. (1998). 'Growth Without Scale Effects'. *Journal of Political Economy*, 106(1):41–63.

Appendix

A Learning By Doing and Extent of the Market

We first present in Subsection A.1 a simple model of learning by doing and technology spillovers from Barro and Sala-i-Martin (2004), based upon models with spillovers of Arrow (1962) and Romer (1986). In Subsection A.2 we extend that model to account for market extent.

A.1 Learning By Doing and Complete Spillovers

A continuum of identical firms are indexed $i \in [0, 1]$. Each firm has a labour augmenting technology and a standard neoclassical production function,

$$Y_i = F(K_i, A_i L_i). \tag{6}$$

We make two crucial assumptions about A_i: First, learning by doing works through net investment so the level of technology is proportional to the capital stock; second, firm knowledge is a public good, and spills over completely into the rest of the economy. As such, we can replace A_i in equation (6) by a factor proportional to the *aggregate* capital stock, K; so scale in this model is the aggregate stock of a factor of production over the economy, not the total supply of labour in a specific research sector as in the models after Romer (1990). Define $k_i = K_i/L_i$ and note that in equilibrium, $k_i = k$ for all i. Assuming the firm production function is homogeneous of degree one, we can write average product of capital as, $F(k_i, K)/k_i = f(L)$. Then, the *private* marginal product of capital as $F_1(k_i, K) = f(L) - Lf'(L) < f(L)$, which is increasing in L. Profit maximization by firms and a utility function with constant elasticity of substitution θ and rate of time preference ρ yields the balanced

path growth rate,

$$\gamma = \theta^{-1} \left[f(L) - Lf'(L) - \rho \right]. \tag{7}$$

which is increasing in L, that is, there is a scale effect arising from learning by doing and the assumption that firm-level technical progress is a public good.

A.2 Market Extent and Scale

Assume that technological spillovers can be limited to the 'market' in which a firm competes, as Grilliches (1990) has noted. This market can be domestic and international. Assume homogeneity of all firms, domestic and international, and, for simplicity, zero tariffs incurred in international trade.[11] Suppose that each firm in the domestic economy, $i \in [0, 1]$, can costlessly travel a distance $\Phi/2 \in \mathbb{R}^1_+$ in either direction to compete with neighboring firms. The parameter Φ is our measure of market extent relative to the size of the domestic economy (empirically, we will think of it as country specific, Φ_n where n indexes countries). Suppose that all non-domestic firms are arranged in $(-\infty, 0) \cup (1, +\infty)$.[12] So, if $\Phi > 1$ then all domestic firms are competing internationally, that is, there is some positive openness on average. The market of a firm i is then comprised of firms in the interval $[i - \Phi/2, i + \Phi/2]$, and the capital stock of firms in the market, K_m, is,

$$K_m = \int_{j \in [i-\Phi/2, i+\Phi/2]} K_j dj = \Phi K \tag{8}$$

Learning by doing still occurs within each firm, but now a firm's technical progress is proportional to the capital stock of the market, so $A_i = K_m$. Suppose further that

[11] So the only distinction we make between the domestic and the international is in the definition of country aggregates as the sum of domestic firms.

[12] Since there are no strategic interactions, we do not need to be specific about the arrangement of non-domestic firms into countries. We only assume that the international firms comprise a countable infinity of other countries, and that those firms lie in two path-connected sets $(A, 0)$ and $(1, B)$ where $A < 0$, $B > 1$ and we require $\Phi/2 \leq \min\{-A, B\}$ for the second equality of (8) to hold.

an individual firm is not necessarily a negligible part of its market, so $\frac{\partial K_m}{\partial K_i} \geq 0$.[13] Since the spillovers are now partially internalized, the scale of K_m determines the rate of growth via learning by doing and the private marginal return to capital. Now we have, where $L_m = \Phi L$ is the labour supply in the market,

$$\gamma = \frac{\dot{c}}{c} = \theta^{-1}\left[f(L_m) - \left(L_m - \frac{\partial K_m}{\partial k_i}\right) f'(L_m) - \rho\right].$$

From (8), we have that $K_m = \int_{j\in[i-\Phi/2, i+\Phi/2]}(k_j L_j)dj$ so,

$$\gamma = \theta^{-1}\left[f(L_m) - (L_m - L_i)\, f'(L_m) - \rho\right]. \tag{9}$$

We now have a direct connection between the size of a firm relative to its market and the rate of growth. We still have a positive scale effect in L_m or, equivalently Φ, since,

$$\frac{\partial \gamma}{\partial L_m} = \theta^{-1}\left[-(L_m - L_i) f''(L_m)\right]. \tag{10}$$

Equation (9) shows that scale is doing more than increase growth. Increasing scale affects the distance between the decentralised growth rate and the social planner growth rate. When L_m is relatively close to L_i, learning by doing growth is small but the decentralised growth rate is closer to that of the social planner because more of the spillover is internalized. Nonetheless, (10) shows that increasing the size of the market (L_m) holding the size of a firm (L_i) constant means higher growth because the learning by doing gain outweighs the larger spillover loss.

[13] So each firm comprises at least an atom in the mass of all firms. Despite this, we are neglecting the potential implications for market structure; all firms remain perfectly competitive since the 'market' defines the extent of spillovers, and does not necessarily imply market power.

Cobb-Douglas Production Function

Adopting a Cobb-Douglas production function, we can use data on population and growth rates to back out implied values of Φ for each country. Specifically, assume that output for a firm i in country n takes the following form,

$$Y_{i,n} = A_0(K_{i,n})^{\alpha}(\Phi_n K_n L_{i,n})^{1-\alpha}, \tag{11}$$

where $\alpha \in (0,1)$ and $A_0 > 0$ is an exogenous technological parameter. The average product of capital is, $\frac{y_{i,n}}{k_{i,n}} = f(L_n) = A_0(\Phi_n L_n)^{1-\alpha}$, while the marginal product of capital is,

$$\frac{\partial F(k_{i,n}, \Phi K_n)}{\partial k_{i,n}} = A_0 \left\{(\Phi L_n)^{-\alpha} \left[\alpha \Phi L_n + (1-\alpha) L_{i,n}\right]\right\}. \tag{12}$$

So balanced growth in country n with exogenous Φ_n and country scale L_n is,

$$\gamma_n = \theta^{-1}\left[A_0 \left\{(\Phi_n L_n)^{-\alpha} \left[\alpha \Phi_n L_n + (1-\alpha) L_{i,n}\right]\right\} - \rho\right]. \tag{13}$$

In the formulation of equation (1), we take the conception of scale to be relative (i.e., country labor supply is normalised by world labor supply) and we assume that an individual firm is sufficiently small so that we have $L_{i,n} = 0$.

B Empirical Results

Table 3: Property Rights Institution I: Executive Constraint

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.14	0.24**	0.57**	0.54**
	(0.10)	(0.10)	(0.08)	(0.06)
log(inst)	-0.07	-0.34	-0.93**	-0.80**
	(0.43)	(0.39)	(0.38)	(0.31)
log(scale)*inst	-0.04**	-0.04**	-0.06**	-0.05**
	(0.02)	(0.02)	(0.02)	(0.01)
log(govt share)		-0.69**		-0.39**
		(0.18)		(0.14)
log(openness)		0.40**		0.64**
		(0.15)		(0.11)
log(xrat)		-0.15**		-0.10**
		(0.03)		(0.02)
R^2	0.25	0.45	0.47	0.66
Obs.	149	149	149	149

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.06	0.30	0.18	0.23
	(0.23)	(0.25)	(0.20)	(0.21)
log(inst)	0.91	0.48	0.75	0.83
	(0.97)	(0.98)	(0.99)	(0.99)
log(scale)*inst	-0.0004	-0.01	0.0009	0.01
	(0.04)	(0.04)	(0.04)	(0.04)
log(govt share)		-0.06		0.16
		(0.45)		(0.46)
log(openness)		0.84**		0.80**
		(0.37)		(0.34)
log(xrat)		-0.05		-0.009
		(0.07)		(0.07)
R^2	0.06	0.09	0.08	0.12
Obs.	149	149	149	149

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 4: Property Rights Institution II: Property Security

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.34**	0.34**	0.57**	0.52**
	(0.11)	(0.10)	(0.10)	(0.09)
log(inst)	-0.05	-0.31	-0.38	-0.52
	(0.49)	(0.45)	(0.53)	(0.47)
log(scale)*inst	-0.10**	-0.09**	-0.11**	-0.08**
	(0.03)	(0.02)	(0.03)	(0.03)
log(govt share)		-0.42**		-0.24*
		(0.17)		(0.15)
log(openness)		0.15		0.42**
		(0.14)		(0.12)
log(xrat)		-0.12**		-0.10**
		(0.02)		(0.02)
R^2	0.47	0.56	0.56	0.67
Obs.	130	130	130	130

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.81**	1.03**	0.80**	0.82**
	(0.21)	(0.21)	(0.22)	(0.22)
log(inst)	-1.52	-2.00**	-2.11*	-2.02*
	(0.95)	(0.94)	(1.14)	(1.12)
log(scale)*inst	-0.16**	-0.17**	-0.16**	-0.13**
	(0.05)	(0.05)	(0.06)	(0.06)
log(govt share)		0.25		0.31
		(0.34)		(0.35)
log(openness)		0.94**		0.70**
		(0.29)		(0.28)
log(xrat)		-0.02		0.03
		(0.06)		(0.05)
R^2	0.17	0.24	0.17	0.22
Obs.	130	130	130	130

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 5: Property Rights Institution III: Expropriation Protection

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.42**	0.37**	0.67**	0.63**
	(0.16)	(0.15)	(0.16)	(0.14)
log(inst)	0.32	0.19	-0.46	-0.78
	(0.80)	(0.74)	(0.88)	(0.79)
log(scale)*inst	-0.07**	-0.06**	-0.07**	-0.06**
	(0.02)	(0.02)	(0.02)	(0.02)
log(govt share)		-0.40**		-0.25
		(0.17)		(0.16)
log(openness)		-0.13**		0.28**
		(0.15)		(0.14)
log(xrat)		-0.13**		-0.11**
		(0.03)		(0.02)
R^2	0.53	0.63	0.58	0.68
Obs.	116	116	116	116

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.80**	1.08**	0.92**	0.96**
	(0.35)	(0.35)	(0.35)	(0.34)
log(inst)	0.07	-1.11	-1.62	-1.86
	(1.71)	(1.72)	(1.96)	(1.92)
log(scale)*inst	-0.07	-0.08*	-0.08*	-0.06
	(0.04)	(0.04)	(0.05)	(0.05)
log(govt share)		0.17		0.32
		(0.40)		(0.40)
log(openness)		1.01**		0.94**
		(0.35)		(0.34)
log(xrat)		-0.002		0.06
		(0.06)		(0.06)
R^2	0.22	0.27	0.25	0.30
Obs.	116	116	116	116

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 6: Property Rights Institution IV: Repudiation

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.14	-0.02	0.44**	0.35**
	(0.13)	(0.13)	(0.15)	(0.14)
log(inst)	1.83**	2.28**	0.67	0.92
	(0.71)	(0.65)	(0.84)	(0.81)
log(scale)*inst	-0.03*	-0.02	-0.06**	-0.04**
	(0.02)	(0.02)	(0.02)	(0.02)
log(govt share)		-0.37**		-0.24
		(0.16)		(0.17)
log(openness)		-0.34**		-0.01
		(0.13)		(0.14)
log(xrat)		-0.09**		-0.09
		(0.02)		(0.02)
R^2	0.73	0.80	0.74	0.79
Obs.	87	87	87	87

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.44	0.76*	0.99**	1.28**
	(0.36)	(0.38)	(0.40)	(0.40)
log(inst)	1.06	-0.04	-2.47	-3.86*
	(1.94)	(1.97)	(2.29)	(2.28)
log(scale)*inst	-0.05	-0.06	-0.12**	-0.13**
	(0.05)	(0.05)	(0.06)	(0.05)
log(govt share)		0.41		0.60
		(0.49)		(0.48)
log(openness)		0.89*		1.06**
		(0.39)		(0.39)
log(xrat)		-0.06		-0.009
		(0.07)		(0.06)
R^2	0.25	0.30	0.29	0.36
Obs.	87	87	87	87

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 7: Property Rights Institution V: Corruption

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.05	0.07	0.39**	0.38**
	(0.08)	(0.08)	(0.08)	(0.07)
log(inst)	0.34	0.42	0.16	0.06
	(0.30)	(0.27)	(0.34)	(0.28)
log(scale)*inst	-0.03**	-0.02**	-0.03**	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)
log(govt share)		-0.66**		-0.38**
		(0.20)		(0.18)
log(openness)		0.21		0.58**
		(0.15)		(0.12)
log(xrat)		-0.15**		-0.12**
		(10.03)		(0.02)
R^2	0.32	0.51	0.40	0.63
Obs.	121	121	121	121

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.30*	0.60**	0.34**	0.53**
	(0.15)	(0.16)	(0.15)	(0.16)
log(inst)	1.36**	0.93*	1.12**	0.67
	(0.56)	(0.54)	(0.65)	(0.63)
log(scale)*inst	-0.003	-0.006	0.002	0.003
	(0.02)	(0.02)	(0.02)	(0.02)
log(govt share)		0.11		0.46
		(0.40)		(0.40)
log(openness)		1.28**		1.10**
		(0.31)		(0.28)
log(xrat)		-0.02		0.07
		(0.06)		(0.06)
R^2	0.19	0.30	0.24	0.33
Obs.	121	121	121	121

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 8: Contracting Institution I: Formalism

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	-0.04	-0.01	0.15	0.20*
	(0.15)	(0.15)	(0.13)	(0.11)
log(inst)	-1.51	-0.70	-0.83	0.04
	(0.94)	(0.88)	(0.79)	(0.66)
log(scale)*inst	-0.03	-0.01	0.006	0.02
	(0.04)	(0.04)	(0.04)	(0.03)
log(govt share)		-0.51**		-0.22
		(0.23)		(0.21)
log(openness)		0.27		0.77**
		(0.19)		(0.15)
log(xrat)		-0.16**		-0.14**
		(0.03)		(-0.03)
R^2	0.16	0.34	0.18	0.49
Obs.	111	111	111	111

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	-0.09	0.05	-0.07	0.04
	(0.27)	(0.27)	(0.23)	(0.24)
log(inst)	0.02	0.79	0.43	0.96
	(1.64)	(1.65)	(1.38)	(1.42)
log(scale)*inst	0.05	0.07	0.07	0.08
	(0.08)	(0.08)	(0.06)	(0.06)
log(govt share)		0.002		0.11
		(0.44)		(0.45)
log(openness)		1.08**		0.97**
		(0.36)		(0.33)
log(xrat)		-0.03		0.02
		(0.06)		(0.06)
R^2	0.05	0.12	0.07	0.14
Obs.	111	111	111	111

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 9: Contracting Institution II: Number of Procedures

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	-0.01	0.10	0.44**	0.56**
	(0.14)	(0.13)	(0.09)	(0.08)
log(inst)	-1.78**	-1.16	-0.40	-0.92*
	(0.82)	(0.70)	(0.62)	(0.48)
log(scale)*inst	-0.005	-0.003	-0.001	-0.005**
	(0.004)	(0.004)	(0.003)	(0.002)
log(govt share)		-0.57**		-0.22
		(0.20)		(0.15)
log(openness)		0.44**		0.82**
		(0.18)		(0.12)
log(xrat)		-0.18**		-0.12**
		(0.03)		(0.02)
R^2	0.12	0.40	0.38	0.66
Obs.	121	121	121	121

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.17	0.62**	0.09	0.31
	(0.24)	(-2.09)	(0.19)	(0.21)
log(inst)	-1.81	1.42	0.02	-0.69
	(1.45)	(-0.006)	(1.29)	(1.29)
log(scale)*inst	-0.002	-0.007	0.006	0.001
	(0.008)	(0.008)	(0.006)	(0.006)
log(govt share)		-0.09		0.02
		(0.41)		(0.42)
log(openness)		1.30**		0.96**
		(0.37)		(0.33)
log(xrat)		-0.07		-0.01
		(0.06)		(0.06)
R^2	0.10	0.21	0.14	0.20
Obs.	121	121	121	121

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 10: Contracting Institution III: Procedural Complexity

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.07	0.26	0.51**	0.51**
	(0.28)	(0.25)	(0.17)	(0.13)
log(inst)	-1.99	-1.57	-1.06	-0.70
	(1.66)	(1.41)	(1.05)	(0.81)
log(scale)*inst	-0.03	-0.03	-0.02	-0.02
	(0.05)	(0.04)	(0.03)	(0.02)
log(govt share)		-0.54**		-0.27*
		(0.21)		(0.0.16)
log(openness)		0.55**		0.75**
		(0.18)		(0.12)
log(xrat)		-0.19**		-0.12**
		(0.03)		(0.02)
R^2	0.07	0.37	0.39	0.0.65
Obs.	121	121	121	121

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	-0.06	0.54	0.28	0.43
	(0.51)	(0.50)	(0.36)	(0.36)
log(inst)	0.94	-0.13	0.05	-0.12
	(2.97)	(2.83)	(2.26)	(2.19)
log(scale)*inst	0.05	0.005	0.01	-0.000
	(0.08)	(0.08)	(0.06)	(0.06)
log(govt share)		-0.14		0.09
		(0.42)		(0.42)
log(openness)		1.42**		1.08**
		(0.36)		(0.32)
log(xrat)		-0.10		-0.01
		(0.06)		(0.06)
R^2	0.03	0.18	0.09	0.18
Obs.	121	121	121	121

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 11: Contracting Institution IV: Debt Efficiency

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.14**	0.07	0.28**	0.27**
	(0.07)	(0.08)	(0.06)	(0.07)
log(inst)	-0.04	0.06	0.11	0.11
	(0.28)	(0.29)	(0.27)	(0.28)
log(scale)*inst	-0.003**	-0.002**	-0.002**	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
log(govt share)		-0.50**		-0.36*
		(0.19)		(0.18)
log(openness)		-0.11		0.21
		(0.14)		(0.13)
log(xrat)		-0.02**		-0.03
		(0.03)		(0.03)
R^2	0.37	0.43	0.45	0.50
Obs.	85	85	85	85

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.32	0.42*	0.34	0.34
	(0.20)	(0.23)	(0.20)	(0.23)
log(inst)	0.13	0.46	-0.48	-0.11
	(0.80)	(0.84)	(0.84)	(0.89)
log(scale)*inst	-0.004	-0.003	-0.007	-0.006
	(0.003)	(0.003)	(0.004)	(0.004)
log(govt share)		0.01		-0.02
		(0.56)		(0.57)
log(openness)		0.79*		0.46
		(0.41)		(0.41)
log(xrat)		0.09		0.10
		(0.08)		(0.08)
R^2	0.15	0.20	0.17	0.20
Obs.	85	85	85	85

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 12: Contracting Institution V: Debt Cost

Panel A: Dep. var. = Log real GDP per capita

	Scale = Pop		Scale = GDP	
log(scale)	0.02	0.01	0.21	0.25**
	(0.06)	(0.07)	(0.05)	(0.05)
log(inst)	-0.49**	-0.38**	-0.44	-0.34**
	(0.17)	(0.17)	(0.14)	(0.14)
log(scale)*inst	-0.20	-0.16	-0.19	-0.14
	(0.25)	(0.23)	(0.21)	(0.20)
log(govt share)		-0.62**		-0.34*
		(0.20)		(0.19)
log(openness)		0.05		0.35**
		(0.15)		(0.13)
log(xrat)		-0.06		-0.06**
		(0.03)		(0.02)
R^2	0.19	0.0.31	0.33	0.46
Obs.	85	85	85	85

Panel B: Dep. var. = GDP per capita growth

	Scale = Pop		Scale = GDP	
log(scale)	0.002	0.21	0.02	0.14
	(0.18)	(0.21)	(0.16)	(0.18)
log(inst)	0.06	0.14	-0.02	0.14
	(0.47)	(0.47)	(0.44)	(0.44)
log(scale)*inst	0.47	0.54	0.30	0.44
	(0.68)	(0.67)	(0.65)	(0.64)
log(govt share)		-0.43		-0.37
		(0.58)		(0.61)
log(openness)		1.06**		0.93**
		(0.43)		(0.41)
log(xrat)		-0.007		0.009
		(0.08)		(0.08)
R^2	0.02	0.10	0.01	0.08
Obs.	85	85	85	85

N.B. ** and * denote significance at 5 and 10% respectively. All regressions include an unreported constant term. Variable descriptions and data sources are given in the Appendix (Table 13). Pop is country population as a proportion of world population; GDP is country real GDP as a proportion of world real GDP.

Table 13: List of Variables and Sources

Variable	Description	Source
Expropriation protection	A score of the risk of expropriation of a private foreign investments, between 0 (highest risk) and 10 (lowest risk)	Used in Knack and Keefer (1995), data from International Country Risk Guide (ICRG).
Repudiation	The modification of a contract (repudiation, postponement or scaling down) due to government pressure. Scored 0-10, with lower scores for higher risks, averaged over 1982-95.	Knack and Keefer (1995), using data from ICRG.
Private property	A score indicating the extent of protection of private property from 1(very low) to 5 (very high)	Gwartney and Lawson (1997)
Corruption	An score from 0 to 10 of corruption in government, where lower scores indicate higher likelihood of a bureaucrat to demand illegal payments in relation to trade licenses, exchange controls, tax assessment, policy protection, or loans.	La Porta et al. (1999)
Legal formalism	An updated version of the legal formalism index, indicating the formality of legal procedures for collecting on a bounced cheque	Djankov et al. (2003)
Number of procedures	Number of procedures involved in collecting a commercial debt of 50% of per capita income	World Bank (2004)
Procedural complexity	Index of the procedural complexity involved in collecting a commercial debt of 50% of per capita income (on a scale from 0 to 10 as in AJ)	World Bank (2004)
Openness	1985-2004 average of exports plus imports as a ratio of GDP in constant (2000) prices. Deleted countries with fewer than 10 growth observations for the period (Angola, Armenia, Azerbaijan, Belarus, Guyana, Kyrgyzstan, Libya, Seychelles).	Heston et al. (2006)
Growth	1985-2004 average of growth rate of real GDP per capita. Same deleted countries.	Heston et al. (2006)
Exchange rate	1985-2004 average of exchange rate relative to US. Same deleted countries.	Heston et al. (2006)
GDP per capita	1985-2004 averages of real (2000 prices) GDP per capita. Same deleted countries as above.	Heston et al. (2006)
Level of GDP	Authors calculations using 1985-2004 averages of real (2000 prices) GDP per capita and population. Same deleted countries as above.	Heston et al. (2006)
Population	1985-2004 average population. Same deleted countries.	Heston et al. (2006)
Government share of GDP	1985-2004 average government spending share of real (2000 prices) GDP per capita Same deleted countries.	Heston et al. (2006)
Executive constraints	1985-2004 average for constraint on executive. Treating flags for interregnums, transitions and foreign 'interruptions' as missing values	Polity IV (2006)
Debt Efficiency	The present value of the net worth of Mirage using data for the cost, time to resolution and the rate of interest on private debt in each country	Djankov et al. (2008)
Debt Cost	The estimated cost of the insolvency proceeding for Mirage, reported as a percentage of the value of the insolvency estate, borne by all parties	Djankov et al. (2008)

ABOUT THE CDMA

The **Centre for Dynamic Macroeconomic Analysis** was established by a direct grant from the University of St Andrews in 2003. The Centre funds PhD students and facilitates a programme of research centred on macroeconomic theory and policy. The Centre has research interests in areas such as: characterising the key stylised facts of the business cycle; constructing theoretical models that can match these business cycles; using theoretical models to understand the normative and positive aspects of the macroeconomic policymakers' stabilisation problem, in both open and closed economies; understanding the conduct of monetary/macroeconomic policy in the UK and other countries; analyzing the impact of globalization and policy reform on the macroeconomy; and analyzing the impact of financial factors on the long-run growth of the UK economy, from both an historical and a theoretical perspective. The Centre also has interests in developing numerical techniques for analyzing dynamic stochastic general equilibrium models. Its affiliated members are Faculty members at St Andrews and elsewhere with interests in the broad area of dynamic macroeconomics. Its international Advisory Board comprises a group of leading macroeconomists and, ex officio, the University's Principal.

RECENT WORKING PAPERS FROM THE CENTRE FOR DYNAMIC MACROECONOMIC ANALYSIS

Number	Title	Author(s)
CDMA07/14	Regulation of Reserves and Interest Rates in a Model of Bank Runs	Geethanjali Selvaretnam (St Andrews).
CDMA07/15	Interest Rate Rules and Welfare in Open Economies	Ozge Senay (St Andrews).
CDMA07/16	Arbitrage and Simple Financial Market Efficiency during the South Sea Bubble: A Comparative Study of the Royal African and South Sea Companies Subscription Share Issues	Gary S. Shea (St Andrews).
CDMA07/17	Anticipated Fiscal Policy and Adaptive Learning	George Evans (Oregon and St Andrews), Seppo Honkapohja (Cambridge) and Kaushik Mitra (St Andrews)
CDMA07/18	The Millennium Development Goals and Sovereign Debt Write-downs	Sayantan Ghosal (Warwick), Kannika Thampanishvong (St Andrews)
CDMA07/19	Robust Learning Stability with Operational Monetary Policy Rules	George Evans (Oregon and St Andrews), Seppo Honkapohja (Cambridge)
CDMA07/20	Can macroeconomic variables explain long term stock market movements? A comparison of the US and Japan	Andreas Humpe (St Andrews) and Peter Macmillan (St Andrews)
CDMA07/21	Unconditionally Optimal Monetary Policy	Tatiana Damjanovic (St Andrews), Vladislav Damjanovic (St Andrews) and Charles Nolan (St Andrews)
CDMA07/22	Estimating DSGE Models under Partial Information	Paul Levine (Surrey), Joseph Pearlman (London Metropolitan) and George Perendia (London Metropolitan)
CDMA08/01	Simple Monetary-Fiscal Targeting Rules	Michal Horvath (St Andrews)
CDMA08/02	Expectations, Learning and Monetary Policy: An Overview of Recent Research	George Evans (Oregon and St Andrews), Seppo Honkapohja (Bank of Finland and Cambridge)
CDMA08/03	Exchange rate dynamics, asset market structure and the role of the trade elasticity	Christoph Thoenissen (St Andrews)

CDMA08/04	Linear-Quadratic Approximation to Unconditionally Optimal Policy: The Distorted Steady-State	Tatiana Damjanovic (St Andrews), Vladislav Damjanovic (St Andrews) and Charles Nolan (St Andrews)
CDMA08/05	Does Government Spending Optimally Crowd in Private Consumption?	Michal Horvath (St Andrews)
CDMA08/06	Long-Term Growth and Short-Term Volatility: The Labour Market Nexus	Barbara Annicchiarico (Rome), Luisa Corrado (Cambridge and Rome) and Alessandra Pelloni (Rome)
CDMA08/07	Seigniorage-maximizing inflation	Tatiana Damjanovic (St Andrews) and Charles Nolan (St Andrews)
CDMA08/08	Productivity, Preferences and UIP deviations in an Open Economy Business Cycle Model	Arnab Bhattacharjee (St Andrews), Jagjit S. Chadha (Canterbury) and Qi Sun (St Andrews)
CDMA08/09	Infrastructure Finance and Industrial Takeoff in the United Kingdom	Alex Trew (St Andrews)
CDMA08/10	Financial Shocks and the US Business Cycle	Charles Nolan (St Andrews) and Christoph Thoenissen (St Andrews)
CDMA09/01	Technological Change and the Roaring Twenties: A Neoclassical Perspective	Sharon Harrison (Columbia) Mark Weder (Adeleide)
CDMA09/02	A Model of Near-Rational Exuberance	George Evans (Oregon and St Andrews), Seppo Honkapohja (Bank of Finland and Cambridge) and James Bullard (St Louis Fed)
CDMA09/03	Shocks, Monetary Policy and Institutions: Explaining Unemployment Persistence in "Europe" and the United States	Ansgar Rannenberg (St Andrews)
CDMA09/04	Contracting Institutions and Growth	Alex Trew (St Andrews)
CDMA09/05	International Business Cycles and the Relative Price of Investment Goods	Parantap Basu (Durham) and Christoph Thoenissen (St Andrews)

For information or copies of working papers in this series, or to subscribe to email notification, contact:

Jinyu Chen
Castlecliffe, School of Economics and Finance
University of St Andrews
Fife, UK, KY16 9AL

Email: jc736@at-andrews.ac.uk; Phone: +44 (0)1334 462445; Fax: +44 (0)1334 462444.