

Growth and Institutions I

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ABSTRACT:

Alternative conceptions of the link between social and political institutions and economic growth are explored theoretically and empirically. A number of plausible hypotheses found in the literature are found to have distinct implications for social steady state, including the possibility of low income steady state institutional traps. Empirical evidence suggests considerable heterogeneity between countries in the nature of the link between institutions and economic activity, throwing doubt on the validity of standard cross-sectional growth equations. The application of cointegration techniques of analysis identifies a number of countries that may prove fruitful as the object of more detailed clinical analysis.

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1 Introduction

The reemergence of interest in the determinants of growth, has focused attention on the puzzle of the apparent non-convergence of per-capita income between low and high income countries (see Romer 1994). One response to this dilemma has been what has come to be known as endogenous growth theory: which in various forms drops the assumptions of the exogeneity of technological change, and the homogeneity of investment opportunities across countries (seminal examples are Romer 1986, 1990 and Lucas 1988)¹.

The convergence prediction in Solow-Swan type growth models is of course conditional on homogeneity of the savings rate, the labour force growth rate, and the technology of production. The work of Romer and others has challenged the suggestion that the technology of production is homogenous across countries, either by positing the existence of knowledge spillover effects, or by emphasizing that knowledge has private as well as public good characteristics (see for instance Romer 1986, 1990, Lucas 1988). An alternative dismissal of homogeneity of technology across countries has argued that both fundamental structural “capacities” and the opportunities for the use of the most efficient technology may differ fundamentally between countries (see particularly Nelson and Wright 1992, but also Abramovitz 1986, 1993, and Fagerberg 1994).

Once the possibility of heterogeneity of countries in the relatively limited dimensions provided by Solow-Swan type growth models is recognized, the possibility that heterogeneity in other dimensions may be of significance to growth follows readily. Thus differences in the level of human capital (Barro 1991, Mankiw, Romer and Weil 1992), the depth of financial development (King and Levine 1993, Levine 1997, Levine and Zervos 1996, 1998), the nature and quality of government intervention in economic processes (Barro 1990, Fischer 1991, King and Levine 1993), to cite a few examples, have all been controlled for in growth equations. Yet even after correcting for a wide variety of additional explanatory variables, many growth equations struggle to account for cross country variation in growth, particularly in Africa and

¹Findings on convergence differ. Thus, for instance, Barro (1991) and Mankiw, Romer and Weil (1992) claim that once stocks of human capital are corrected for (Barro and Sala-i-Martin (1992) add government consumption expenditure), the convergence hypothesis is supported for a large sample of countries. However, Friedman (1992) and Quah (1993) have noted that the “Barro-regressions” on which such findings are based are subject to Galton’s fallacy, and do not constitute legitimate tests for convergence.

Latin America (see for example Barro 1991, and Easterly and Levine 1997). Such limitations to growth models has resulted in greater emphasis being paid to the interaction of economic growth with the wider social or institutional setting within which economic growth takes place².

Modernization theory postulates a link from economic development to democratization, such that “good things go together”. Political freedom is effectively viewed as a luxury good whose high income elasticity ensures emergence of democratization only at high levels of per capita income. The development of strong forms of associational life with economic growth is further held to reinforce the emergence and sustainability of democratic institutions. However, since the postulated causality runs from economic to political development, and since the link is viewed as existing between the levels of economic and political development, modernization theory in its initial format has little to say concerning the impact of political and social institutions on economic growth³. An extension to modernization theory is thus an investigation of the possibility of a link from political and social institutions to economic growth. One possibility might be that political freedoms might have positive externalities in reinforcing economic freedoms, strengthening both the demand for and the defensibility of the latter⁴. An alternative proposition might be that externalities are not positive but negative, particularly at low levels of development, since democracy is subject to populist pressure for redistributive policies, with negative consequences for savings rates, relative price distortions and uncertainty⁵. If institutions do matter

²A brief overview of some of the literature follows. For a more detailed discussion see Fedderke (1997).

³The seminal contribution is Lipset (1959). For further supporting evidence see Bilson (1982), Bollen (1979), Bollen and Jackman (1985), Burkhart and Lewis-Beck (1994), Cutright (1963), Helliwell (1992), Inglehart (1995), Theil (1979). Bilson (1982) indicates the possibility of a non-linearity. Sirowny and Inkeles (1990) and even more comprehensively Diamond (1992) provide reviews of the empirical evidence. Both Diamond (1992) and Burkhart and Lewis-Beck (1994) reject the possibility of political institutions influencing the level of economic development on the basis of empirical evidence.

⁴This might be termed the Hayek-Friedman perspective. Empirical evidence in support is provided by Grier and Tullock (1989) and Kormendi and Meguire (1985). The latter find political institutions impact on growth not directly, but also indirectly via the investment rate. Scully (1988, 1992) notes a positive association between political rights and economic growth, though it is subject to a threshold effect.

⁵See the discussion in Landes (1990). Barro (1994) provides some evidence of a potential negative impact of democracy on economic development at low levels of per capita GDP, as does Marsh (1979) with qualification, and Weede (1983).

in the determination of economic growth, it follows as corollary that their efficiency will also in turn come to matter for economic growth⁶.

A crucial question concerns the reason for the existence of a link from political institutions to long run economic performance - i.e. just why we might expect externalities to be present. One suggestion has been that the credibility of political dispensations is critical if political institutions are to avoid time-inconsistency problems, and that credibility is vital to maintaining private sector and foreign investor confidence (the argument is analogous to those surrounding the credibility of stabilization policy)⁷. Property rights are also frequently advanced as the institutions of greatest significance to economic growth, lowering uncertainty and transactions costs associated with economic activity⁸. An analogous but broader conception is that of social capital, viewed as consisting of a range of formal and informal cultural practices which increase the probability of cooperative solutions to problems of collective action, and again viewed as lowering transactions costs and uncertainty, and hence as beneficial to economic growth⁹.

The basic proposition of a possible link between economic and political development has also received a number of extensions. Thus for instance political instability has generally been viewed as lowering economic growth by raising uncertainty, and by reducing the quality of economic policy formulation¹⁰. However, where political instability disrupts rent-seeking activities it may have a positive impact on growth¹¹, and some authors have suggested the presence of simultaneity between growth and stability by pointing to the possibility that growth may disrupt traditional social forms¹². Some studies

⁶See Mauro (1995), but also Murphy, Schleifer and Vishny (1991, 1993), Rama (1993).

⁷See Borner, Brunetti and Weder (1995), who see credibility as of far greater significance than the level of political rights.

⁸See Knack and Keefer (1995), North and Thomas (1970, 1973), North (1981, 1990), Scully (1988, 1992).

⁹See Coleman (1988, 1990), Putnam (1995), Fukuyama (1995a, 1995b), and Fedderke, De Kadt and Luiz (1998).

¹⁰Alesina and Perotti (1993), Barro (1991), Londregan and Poole (1990), Knack and Keefer (1995), Venieris and Gupta (1986) all report empirical findings confirming both a direct and indirect (via the investment or savings rate) impact of political instability on growth. See Olson (1993) on the link between political stability and the quality of economic policy formulation. On the link between instability and excessive foreign debt burdens and capital flight see Alesina and Tabellini (1989) and Ozler and Tabellini (1991).

¹¹Olson (1982), who argues that (severe) political instability may disrupt the hold of rent-seeking interest groups on the state, thereby raising economic growth rates.

¹²See Olson (1963). Londregan and Poole (1990) confirm the presence of simultaneity

go further in identifying income inequality as a specific cause of the growth inhibiting political instability or redistributive policies noted in the preceding discussion¹³.

While the literature has gone some way toward introducing a number of distinct links between social and political institutions and economic growth, empirical evidence is as yet inconclusive in the sense that a number of the postulated, but alternative and occasionally contradictory links have found empirical support. Fedderke and Klitgaard (1998)¹⁴ demonstrate that the presence of strong webs of association amongst social indicators, makes an empirical distinction between the theoretical propositions outlined above difficult. Moreover, it is shown that simultaneity between institutional dimensions and economic growth finds empirical support, and carries significant implications for the reliability of standard statistical estimation results. The extent of our theoretical understanding of the link between institutions and economic growth is limited, such that the relative importance of the various institutional dimensions cited, their mutual interaction, the lags with which they may be said to operate, and the functional form in which they impact on growth are all as yet incompletely determined. Under such conditions both structural and reduced form statistical modeling is fraught with danger.

For this reason the present paper is concerned with the exploration of some simple propositions concerning the link between social and political institutions and economic growth. Our concern is the question of whether the process of institutional development can be endogenised into the economic growth process. In exploring the question we assume the link between social and political institutions and economic growth to be interactive, in the sense that while economic development may influence institutional development, the reverse direction of influence may be equally plausible.

The discussion will emphasise not only the possibility of endogenising institutional development into the process of economic growth, but also the impact of alternative conceptions of the link between growth and institutional

between economic growth and political instability, but find growth lowering instability.

¹³See Alesina and Perotti (1993) and Persson and Tabellini (1994). Clarke (1995) finds not only indirect effects of income inequality on economic growth (such as the investment channel noted above), but a direct negative effect of inequality on growth, for both democratic and autocratic regimes. However, some studies find no systematic relationship at all (see Papanek and Kyn 1986).

¹⁴For additional explorations of the link between social indicators and economic growth see Fedderke and Klitgaard (1996), and Klitgaard and Fedderke (1994, 1995).

development. We will see that alternative interpretations carry quite distinct implications for the nature of the endogeneity of institutional development. It is emphasised in advance that the links between institutional and economic development explored are not exhaustive. The objective here is ultimately methodological, in the sense of emphasising how “deep” the implications of relatively minor changes in specification are for steady state characteristics of economies. Given the sensitivity of cross-country regression results to changes in specification, this must add cautionary warnings to the usefulness of such results to those already known in the literature (Levine and Renelt 1992 for instance).

The discussion concludes with the presentation of some empirical results. We again add an important disclaimer at the outset. Data limitations prevent the exploration of institutions and their link to economic growth in general. Instead, the focus is on the Freedom House political rights measure frequently used in the growth literature. Inevitably, this limits the generality of conclusions that may be drawn from the discussion and of course we recognize that institutions are enormously varied and distinct across both time and space, and that different classes of institutions may have distinct impacts on economic growth. Fedderke and Klitgaard (1998) for instance identifies three distinct groupings of institutions, the level of rights, the instability of political institutions, and the efficiency of institutions, which may be distinguished conceptually and statistically, and for which there is prima facie evidence of a link to economic growth. On the other hand, Fedderke and Klitgaard (1998) also points to very high levels of correlation (rank correlations of 0.7 and above) between the three institutional dimensions, suggesting that institutional influences on growth potentially show strong indivisibilities. Good property rights, for instance, may be possible only where an efficient judiciary for the enforcement of those rights exists, and efficient judiciaries in turn may depend on the presence of a separation of executive and judicial powers most likely to occur under liberal democratic political dispensations. This suggests that representing the totality of a set of institutional structures in a single dimension is at least an acceptable starting point of analysis.

2 Alternative Steady State Growth Paths incorporating Institutions

2.1 Case 1: The Modernization Hypothesis - Social Institutions determined by Economic Development - a Bench-Mark

By way of providing a bench-mark for subsequent analysis, we begin with the proposition that institutional development depends on the level of economic development. The fundamental hypothesis here is that the level of economic development of a society carries implications for its social and political institutions - in line with original modernization theory. This might be justified on the grounds that the income elasticity of demand for political and social representation exceeds unity. Individual agents come to develop aspirations and demand possibilities for self-realization and expression which go beyond those offered by access to economic resources alone. Thus only after agents realize economic well-being, will their demand for additional civil liberty and political rights find expression. The view implies that there is a Maslowian hierarchy of human aspirations, such that once certain (basic) needs of survival are met, higher order needs such as political and social expression are pursued (see for instance Diamond, 1992:486-7). The point is that it is higher levels of individual economic well-being (rather than the systems requirements posed by efficient organization of economic activity), that drives aspirations for greater social and political rights, and hence institutional developments. It is the level of individual economic development that determines the aspirations for rights, thus affecting social institutions, rather than the absolute productive potential of the society¹⁵.

We represent the level of economic development by means of per capita

¹⁵Romer (1986) identifies a scale effect in labour in developing his model endogenising technological change through "learning by doing" effects. Similarly, Barro and Sala-i-Martin (1995:265-81) identify the possibility of scale effects in labour in a model of technological diffusion. Similar arguments might be advanced in connection with institutional development. For instance, if the absolute productive potential of the economy carries with it institutional requirements, which will have to be met if economic activity is to grow beyond certain threshold levels, rights might depend on the scale of absolute production rather than on per capita magnitudes. This issue is not further explored in the present paper - though see Kuznets (1965:181-2).

GDP¹⁶, and collapse social and political institutional development into a single dimension, which we will henceforth term “rights”, denoted R . For the sake of analytical convenience we further assume technology to be Cobb-Douglas, such that where Y denotes output, K capital stock, and L labour hours, we have:

$$Y = K^{\alpha} L^{1-\alpha} \quad (1)$$

and assuming homogeneity of degree 1, such that $\alpha + (1-\alpha) = 1$, in labour intensive form the production function becomes $y = k^{\alpha}$ (lower case notation denotes per-capita magnitudes throughout)¹⁷. On present specification of output, the economy’s growth path is unaffected by rights. Adding the assumption that savings and investment be proportional to output, we obtain the standard Solow-Swan type steady state growth path. Allowing s to denote the proportional savings rate, g_L the proportional growth rate of the labour force adjusted for the depreciation of the capital stock, and $\dot{x}$ the proportional growth rate of x , we have the standard result that:

$$\begin{aligned} \dot{k} &= s k^{\alpha-1} - g_L \\ \Rightarrow \frac{\dot{k}}{k} &= s (\alpha - 1) k^{\alpha-2} \end{aligned} \quad (2)$$

and since $y = k^{\alpha}$ the implication is of convergence to steady state values of k and y .

Again to aid analytical tractability we link rights to output in exponential form. Thus we have:

$$R = y^{\phi} = k^{\alpha\phi} \quad (3)$$

Given the presence of a steady state growth path under the technology of production assumed under equation 1, in the event of $\phi > 0$ rights will come to assume a steady state value determined by the steady state value of y .¹⁸

¹⁶Of course, this assumes away the impact of unequal distributions of income. The fact that income inequality appears to be deleterious to growth prospects (see for instance Lindert and Williamson 1985, Persson and Tabellini 1994, and Clarke 1995), might be taken to imply that the link between economic and institutional development is weakened. This becomes of particular importance in the context of Case 2 below.

¹⁷We will allow rights to be indivisible throughout, precluding the meaningfulness of per capita magnitudes in the rights dimension.

¹⁸Had rights depended instead on the absolute level of output, since output grows without bound in steady state, history would have been open-ended.

Where $\phi < 0$, rights come to be eroded over time, which might capture the experience of societies or polities which are sustainable only under ever increasing levels of repression (an example might be apartheid South Africa). Under $\phi = 0$ rights are not associated with economic development¹⁹.

Where institutional development is driven by the aspirations of individual agents, and such aspirations emerge from the consequences of improving economic welfare,

It now follows from equation 3 that:

$$\dot{R} = \phi \dot{Y} \quad (4)$$

which in steady state reduces to 0, such that rights will change only when the economy moves onto a new growth path. Transitional dynamics in the capital labour ratio for the growth rate of rights follows from equation 4:

$$\frac{\partial \dot{R}}{\partial k} = \phi \sigma (\alpha - 1) k^{\alpha-1} \quad (5)$$

$$\begin{aligned} &< 0 \text{ if } \phi > 0 \\ &> 0 \text{ if } \phi < 0 \end{aligned} \quad (6)$$

Declining growth rates of rights under $\phi > 0$ reflects the impact of the declining marginal product of capital and the declining growth rates of k , y in the approach to steady state. Where $\phi < 0$ the growth rate of rights is negative, though rising as $y \rightarrow 0$ in the approach to steady state. The two cases of $\phi > 0$, $\phi < 0$, are depicted in Figure 1.

In terms of transitional dynamics with respect to the growth rate of the labour force, we have:

$$\begin{aligned} \frac{\partial \dot{R}}{\partial g_L} &= -\phi \\ &< 0 \text{ if } \phi > 0 \\ &> 0 \text{ if } \phi < 0 \end{aligned} \quad (7)$$

¹⁹It is probable that the association between rights and the level of economic development is more complex than here postulated. By way of example, instead of the monotonic association employed for the discussion, it is plausible that with economic development rights first decrease, and transform into "take-off" only after some intermediate level of development. This would render ϕ dependent on Y by some non-linear association. For the purposes of the present analysis we abstract from such complexity.

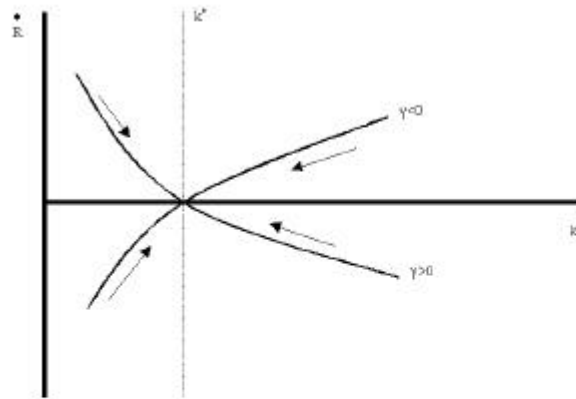


Figure 1: Modernization Theory: existence of steady state.

since higher labour force growth rates generate lower steady state equilibrium growth paths.

For modernization theory history is thus a closed process, in the sense that the economy will move to a steady state level of rights consistent with its level of economic development. Without economic development, institutions cannot evolve further. The growth rate of rights is determined by savings rates, technology of production, as well as the demographic characteristics of society.

2.2 Case 2: Interdependence between Institutional and Economic Development

The scenario investigated under Case 1 is a restrictive one. The suggestion is that economic development leads to institutional development. This accords an extraordinary primacy to economic activity, all the more so if one

considers economic activity as only one (admittedly vital) of many social activities and functions, which come to shape and influence the civil, political and indeed economic institutions of a society. It would seem at least equally plausible to suggest that while economic development may indeed inform and influence institutional change, institutional settings may themselves come to impact upon economic activity in various and diverse ways. Certainly at least some empirical evidence would seem to support such a hypothesis (see Fedderke and Klitgaard 1997), and modernization theory in its more sophisticated variants has accepted that it is not simply economic development which underlies institutional progress, but that the interaction is likely to be more complex (see Diamond 1992:488).

The introduction to the paper noted a number of alternative hypothesized impacts of institutions on economic activity. Property rights²⁰, the influence of special interest groupings (see Olson 1982), political instability²¹, deep seated values and cultural predispositions²², political credibility²³, political corruption and efficiency²⁴, and social capital²⁵ have all been identified as being of potential importance to economic performance.

While Case 1 thus examined the possibility that rights were dependent on the level of economic development, but that there existed no reverse influence, the second possibility is the case where rights and the level of economic development mutually determine one another. Consider:

$$Y = R^{(2)} Q^{(2)} \quad (8)$$

where $R^{(2)}$ denotes the impact of rights on output, $Q^{(2)}$ the impact of the technology of production on output. Again for the sake of analytical tractability, assume that the technology of production is Cobb-Douglas, and homogenous of degree 1, such that:

$$Q^{(2)} = K^{\alpha} L^{1-\alpha} \quad (9)$$

²⁰See North and Thomas (1973:1), Knack and Keefer (1995:207), and Scully (1988:653) as a limited sample.

²¹See Barro (1991), Londregan and Poole (1990) and Olson (1982).

²²The celebrated case is Weber's protestant work ethic, but note also Kuznets (1965a:104).

²³See Borner, Brunetti and Weder (1995).

²⁴See Mauro (1995).

²⁵See Putnam (1995), Coleman (1990), Fukuyama (1995a,b) and the World Development Report 1997.

There is a further distinction to be drawn. To specify that rights depend on the level of economic development could mean either that rights depend on the degree of development of the technology of production (that is, that rights depend on Q ⁽²⁾ in equation 8 above), or that rights depend on the level of economic development as measured by the output generated by the society (i.e. on Y in equation 8 above). In the latter case it is the actual or realized level of economic development which drives institutional development. In the former case, it is the productive potential inherent in the technology of production which is the determining factor. An impetus to such a formulation might come from the suggestion that the development of information technology makes the maintenance of repressive regimes increasingly difficult - ease of international information transfer simply lowers the cost of information sufficiently to render its control, and hence control of political aspirations increasingly difficult. The rival suggestion that improved information technology makes the control of populations easier for repressive regimes similarly posits a link between institutions and technology. Similarly, the industrial revolution might perhaps be argued to have produced a concentration of populations to a degree which rendered popular aspirations of control over political power inevitable, given the lowering of organizational and information costs of political organization in an urban environment, when compared with a dispersed rural population. It may also enable us to capture the intuition that developments such as Silicon Valley perhaps best thrive under conditions which allow space for unconventional patterns of behaviour, as a stimulus to the creative energy which appears to characterize such bursts of innovation. Once such patterns of production prove successful, they may well induce wider institutional change as other industries attempt to replicate the elements underlying the success.

Such intuitions are clearly of a different order from that which suggests that it is the realized level of economic welfare which generates aspirations to greater social and political means of self-expression. Case2.A will explore the suggestion that rights interact with the technology of production, while Case2.B allow rights to interact with the realized productive potential of society. It will become clear from our discussion that the distinction carries significant implications.

2.2.1 Case 2.A: Rights dependent on the per capita productive potential of the technology of production

The first possibility we examine is that the development of rights is determined by the per capita productive potential of the technology of production. The distinction from Case 1 is that output and rights are interdependent. Thus:

$$R = q^{\circ} = k^{\otimes^{\circ}} \quad (10)$$

so that per capita output is given by:

$$y = k^{\otimes(1+\circ)} \quad (11)$$

and the growth rate of per capita output would now be:

$$\dot{y} = \otimes(1+\circ) k^{\otimes(1+\circ)-1} \dot{k} \quad (12)$$

which increases in $\circ$ as long as the economy is not in steady state, and is capital deepening, since $\frac{\partial \dot{y}}{\partial \circ} = \otimes k^{\otimes(1+\circ)-1} \dot{k} > 0$ if $\dot{k} > 0$. Moreover the prospect for unbounded growth arises despite a technology of production which is not of increasing scale, since from:

$$\dot{k} = s k^{\otimes(1+\circ)-1} - g_L \quad (13)$$

such that:

$$\dot{y} = \otimes(1+\circ) s k^{\otimes(1+\circ)-1} - \otimes(1+\circ) g_L \quad (14)$$

implying the possibility of unbounded growth as long as rights increase in the technology of production sufficiently strongly²⁶. In particular, we have:

$$\begin{aligned} \frac{\partial \dot{y}}{\partial k} &= [\otimes(1+\circ) - 1] \otimes(1+\circ) s k^{\otimes(1+\circ)-2} \\ &> 0 \text{ if } \circ > \frac{1}{\otimes} - 1 \end{aligned} \quad (15)$$

²⁶This is the standard requirement that the increase in the capital stock is sufficient for capital deepening to occur. From (14), $\dot{y} > 0$ if $s k^{\otimes(1+\circ)-1} > g_L$; or $y > \frac{g_L}{s} k$, i.e. that actual per capita output exceed that required to maintain a constant capital-labour ratio.

The requirement is demanding. Unbounded growth in per capita output will follow only if the positive impact of improving rights outweighs the negative impact of the declining marginal product of capital on output. If $\alpha > 0.3$, the requirement is for $\phi > 2$ or greater.

The growth rate of rights follows as:

$$\frac{\dot{R}}{R} = \alpha \phi \frac{\dot{k}}{k} = \alpha \phi s k^{\alpha(1+\phi)-1} - (\alpha \phi) g_L \quad (16)$$

and hence:

$$\begin{aligned} \frac{\dot{R}}{R} &= \alpha \phi s [\alpha(1+\phi) - 1] k^{\alpha(1+\phi)-2} \\ &> 0 \text{ if } \phi > \frac{1}{\alpha} - 1 \text{ or } \phi < 0 \\ &< 0 \text{ else} \end{aligned} \quad (17)$$

For $\phi > \frac{1}{\alpha} - 1$ the positive impact of rights on output again outweighs the negative impact of the declining marginal product of capital. The growth rate of rights would be rising under such circumstances as per capita output increased indefinitely. Where $\phi < 0$ the growth rate of rights would be rising toward $-(\alpha \phi) g_L$. One possible interpretation of this possibility is that the political or social system is sustainable only under increasing erosion of rights, leading to higher levels of repression as output increases. Presumably there is some minimum level of rights beyond which the society or polity ceases to exist altogether if rights are decreased even further (say where agents no longer have a right to life), and rights can no longer change at all (and in this sense history would again be at an end point). Where $0 < \phi < \frac{1}{\alpha} - 1$ rights would be improving at a diminishing rate. These implications are represented in Figure 2.

2.2.2 Case 2.B: Rights dependent on the per capita level of output, or level of economic development

Consider the possibility that rights are determined by the per capita realized productive capacity of the economy, rather than the productive potential inherent in the technology of production. Thus:

$$R = y^\phi \quad (18)$$

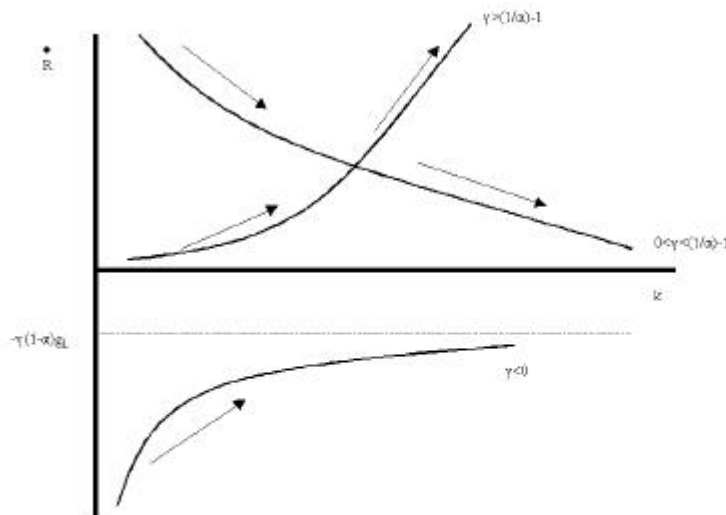


Figure 2: Rights dependent on Technology of Production

so that given equation 8:

$$y = k^{\frac{\alpha}{1-\alpha}} \quad (19)$$

and hence:

$$\dot{y} = \frac{\mu}{1-\alpha} k^{\frac{\alpha}{1-\alpha}} \quad (20)$$

Two important consequences follow on equation 20. The first is that unbounded growth in per capita output will emerge where the capital-labour ratio grows without bound, and since:

$$\dot{k} = s k^{\frac{\alpha}{1-\alpha}} - n k \quad (21)$$

it follows that:

$$\frac{\partial \dot{k}}{\partial k} = s \frac{\mu}{1-\alpha} k^{\frac{\alpha}{1-\alpha}-1} - n \quad (22)$$

$$\begin{aligned} &> 0 \text{ if } 1 - \beta < \alpha < 1 \\ &< 0 \text{ if } 1 - \beta > \alpha > 1 \end{aligned}$$

such that unbounded growth emerges where $1 - \beta < \alpha < 1$, which for the assumption of $\beta \geq 0.3$, implies $0.7 < \alpha < 1$, a considerably weaker requirement than under Case 2.A. Since from equation 18 $R = \alpha Y$, history may be either open or closed for Case 2.B, corresponding to $1 - \beta < \alpha < 1$ and $1 - \beta > \alpha > 1$ respectively.

The second consequence is the more intriguing. From equation 20 it follows immediately that for $0 < \alpha < 1$ the growth rate of per capita output is positive, as might be expected from the implied positive relationship between output and rights. However, where the association between output and rights becomes “strong”, in the sense that $\alpha > 1$ such that rights change more than proportionately with output, the growth rate of output becomes negative, an apparently counterintuitive result given the strong benevolent association implied by $\alpha > 1$. The explanation for this apparent anomaly lies in the existence of an unstable equilibrium for the society depicted in Figure 3. For $\alpha > 1$, the equilibrium point $R_e Y_e$ is unstable²⁷. For instance, with rights or institutions given by R_1 realized output is given by Y_1^0 , while output required to maintain that institutional capacity is given by Y_1 . At very low levels of institutional development, institutional deficiency may come to impair production. The consequence is that realized output is not sufficient to maintain existing institutions, and the society experiences both institutional and economic collapse. By contrast with institutions or rights given by R_2 , realized output Y_2^0 exceeds that required for the maintenance of institutions Y_2 , with the result that the society will experience both institutional and economic growth without bound. Effectively the strong association between economic and institutional development creates an institutional underdevelopment trap at low levels of institutional development. This may represent a particularly severe problem not only for countries at low levels of per capita GDP, but particularly for countries in which former colonial powers invested little in institutional development, simply superimposing administrative structures which came to subvert indigenous institutions. Withdrawal of the colonial power might then well issue in the sort of situation depicted by R_1 above. The appropriate policy response to such a trap in continued investment in factor inputs, despite apparent initial decreases in equilibrium output, until

²⁷ $\alpha = 1$ results in singularity.

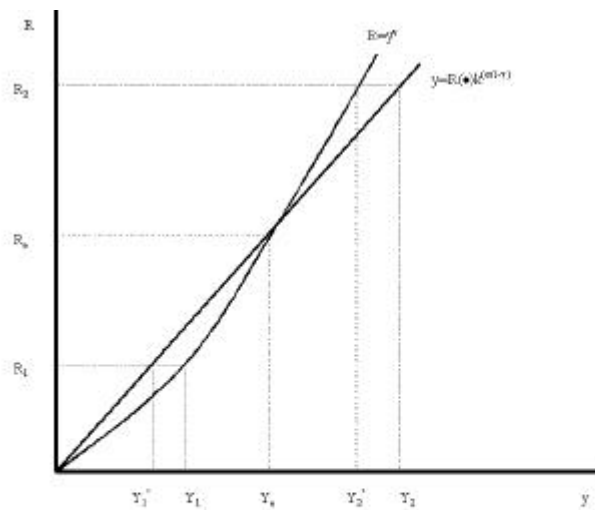


Figure 3: Low Equilibrium Institutional Trap

the society breaks the institutional underdevelopment trap.

Cases 2.A and 2.B thus differ profoundly in their implications. First, where it is realized productive potential, rather than the productive potential represented by the technology of production which determines rights, the possibility of a low level equilibrium institutional trap emerges. Second, the requirements for the emergence of endogenous growth are somewhat weaker under Case 2.B than under Case 2.A.

3 Some Empirical Results

Neither Case 1 nor Case 2 commits us to modernization theory. The positive association between economic development and rights implied by modernization theory in either Case requires that $\alpha > 0$, such that economic development issues in greater political and civil rights of citizens. But it is of course possible that rights are simply not influenced by the level of economic

development at all, $\phi = 0$, a proposition which is consistent with arguments that relatively authoritarian regimes have been capable of economic development without associated pressures for political and social liberalization. It is also logically feasible that there is a negative association between the state of economic and institutional development, $\phi < 0$. As already noted, this might capture cases of social and political forms which are sustainable only if they become increasingly repressive - which might represent the experience of polities of the apartheid South Africa variety. By implication then, it is conceivable that not all countries need be uniform, in the sense that the magnitude of ϕ , and perhaps even its sign could well differ between countries. The consequence is that universally quantified generalizations concerning the nature of socio-economic development may not be readily attainable. Instead more nuanced identification of alternative paths to development is required.

3.1 The Data and Econometric Methodology

We explore these possibilities on a data set compiled from a number of distinct sources, covering the period 1973-95:

- ² GDP at constant 1987 US\$ prices was obtained from World Bank national accounts data.
- ² Total physical capital, obtained from Nehru and Dhareshwa (1998)²⁸.
- ² Population figures were obtained from International Monetary Fund data.
- ² An index of political rights was obtained from the standard Freedom House Annual Survey of Political Rights and Civil Liberties.

Data was collected for 86 countries - the list can be found in the appendix. The present study departs from previous studies of the link between growth and institutions, in that estimation proceeds on a country-by-country approach, employing cointegration techniques of estimation.

²⁸The capital stock figures were available directly over the 1991-0 period. For 1991-5, the capital stock was imputed by $K_t = (1 - \delta) K_{t-1} + GDFI_t$, where K_t denotes capital stock, δ the average depreciation rate of capital stock over 1985-90 imputed from Nehru and Dhareshwa (199x), and GDFI denotes gross domestic fixed investment obtained from

Johansen²⁹ techniques of estimation are now standard, so that the discussion here can be brief. We employ a vector error-correction (VECM) framework, for which in the case of a set of k variables, we may have cointegrating relationships denoted r , such that $0 \leq r \leq k-1$. This gives us a k -dimensional VAR:

$$Z_t = A_1 Z_{t-1} + \dots + A_m Z_{t-m} + \epsilon_t + \epsilon_t \quad (23)$$

where m denotes lag length, and ϵ_t a Gaussian error term. While in general Z_t may contain $I(0)$ elements, given our bivariate association, as long as non-stationary variables are present we are exclusively restricted to $I(1)$ elements. Reparametrization provides the VECM specification:

$$\Phi Z_t = \sum_{i=1}^{k-1} \Phi_i Z_{t-i} + \beta Z_{t-k+1} + \epsilon_t + \epsilon_t \quad (24)$$

The existence of r cointegrating relationships amounts to the hypothesis that:

$$H_1(r) : \beta = \alpha^- \quad (25)$$

where β is $p \times p$, and α^- are $p \times r$ matrices of full rank. $H_1(r)$ is thus the hypothesis of reduced rank of β . Where $r > 1$, issues of identification arise³⁰. In our case this may arise where rights and output may interact (equations 10, 11; equations 18, 19). In this case we expect $r = 2$, and for the long run parameters:

$$\beta Z_{t-k+1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \end{bmatrix} \begin{bmatrix} y \\ k \\ r \end{bmatrix}_{t-k+1} \quad (26)$$

Cointegrating relationships are provided by $\pi_i = \alpha_{i1}y + \alpha_{i2}k + \alpha_{i3}r$ (where r denotes rights), with the α_{ij} providing the error correction terms. In the absence of a priori theory problems of identification attach to equation 26, since any linear combination of π_i will themselves be stationary and hence cointegrated. Exact identification requires r^2 restrictions, for the expectation that $r = 2$ thus 4. On the basis of the discussion above we specify:

$$\beta Z_{t-k+1} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \end{bmatrix} \begin{bmatrix} 1 & \alpha_{12} & 0 \\ 0 & \alpha_{22} & 1 \end{bmatrix} \begin{bmatrix} y \\ k \\ r \end{bmatrix}_{t-k+1} \quad (27)$$

²⁹See Johansen (1991) and Johansen and Juselius (1990).

³⁰See Wickens (1996), Johansen and Juselius (1990, 1992), Pesaran and Shin (1995a, 1995b), Pesaran, Shin and Smith (1996).

for both Case 2.A though the ρ parameter would have to be explicitly solved for from Γ_{12} and Γ_{22} . For Case 2.B, we specify:

$$\begin{matrix} & & \mathbf{2} & & \mathbf{3} & & \mathbf{2} & \mathbf{3} \\ & & \textcircled{R}_{11} & \textcircled{R}_{12} & & & & \\ \mathbf{1} & \mathbf{Z}_{t \mid k+1} = & \mathbf{4} & \textcircled{R}_{21} & \textcircled{R}_{22} & \mathbf{5} & \mathbf{1} & \mathbf{i} & \mathbf{12} & \mathbf{0} & \mathbf{1} & \mathbf{4} & \mathbf{y} & \mathbf{5} \\ & & & \textcircled{R}_{31} & \textcircled{R}_{32} & & \mathbf{i} & \mathbf{21} & \mathbf{0} & & & \mathbf{r} & & \\ & & & & & & & & & & & & & \mathbf{t \mid k+1} \end{matrix} \quad (28)$$

where Γ_{21} provides a direct estimate of the ρ parameter.

While our chief concern here is with the existence of cointegrating, hence the possibility of long-run equilibrium relationships contained in $\Gamma^0 \mathbf{Z}_t$, we are also interested in the possibility of heterogeneity between countries in terms of the nature of the link between economic activity and rights (i.e. whether Case 1, Case 2.A or Case 2.B is most likely to apply), and in terms of the strength of that link (as measured by ρ).

In all instances we test for the presence of a link by means of the standard reduced rank Johansen procedure, and verify the presence of the relevant link(s) between rights and output by means of both overidentifying restrictions, and in terms of tests for weak exogeneity.

3.2 Results

Case 1 presents few difficulties for estimation, with log transformation of equation 3 providing the means for direct estimation of ρ . Estimation of ρ for Case 2.A again follows readily from equations 10 and 11. Estimation of ρ for Case 2.B follows from equations 18 and 19.

Cointegration analysis proves useful in the current context. The bivariate associations implied by most of the the current relationships under investigation allows straightforward estimation where cointegration proves to be present. The one limitation to consider is that, given the simplicity of the relationship between economic activity and rights under consideration, the absence of cointegration cannot be held to be conclusive evidence of association between rights and economic activity, since the association may be subject to misspecification. The requirement here imposed for the presence of a long run equilibrium relationship is demanding, given the simplicity of the models under investigation. The conclusions drawn are thus not to be understood as a definitive identification of the nature of the link between economic activity and rights, but they do serve to support the methodological conclusions drawn in the text. These are strong and informative in their own right.

No a priori considerations suggest that all countries should share the same ρ -parameter. Indeed, that the world contains countries at vastly different levels of development, with different institutions, different historical paths of development, and different cultures, makes the suggestion that there may exist classes of countries with quite distinct ρ -coefficients, a natural one to explore.

Detailed results are provided in the appendix to the paper. Salient results are as follows:

1. There is significant cross-country variation in the ρ -parameter regardless of which model is estimated (Case 1, Case 2.A or Case 2.B).
2. There is significant cross-country variation in terms of the preferred model specification. Countries are spread across the Case 1, Case 2.A, and Case 2.B specifications, while most countries do not provide support for any of the three formulations here explored³¹.
3. Not all countries have a positive ρ -parameter - which we interpret as implying political structures sustainable only under conditions of increasing repression over time.
4. For most countries included in the study evidence either dismisses, or at best proves inconclusive on the presence of a link between output and the Freedom House political rights measure.

The implied country classification to emerge from estimation is as follows. For Case 1, we have the country classification given in Table 1. Three countries have a statistically significant but negative association between rights and output as outcome and independent variable respectively. Only three countries support the simple positive association between output and rights implied by early (Lipset) modernization theory. The Trinidad and Tobago classification seems somewhat counterintuitive. However, Trinidad and Tobago is the one country that fulfills the requirements of Case 1 that is also significant under Case 2. In the latter, it has a more plausible $\rho > 0$ parameter for Case 2.A (for Case 2.B we again have $\rho < 0$).

³¹This is generally for countries that show little or no variation in the Freedom House rights index - predominantly the industrialised countries. The implication might well be that the Freedom House index shows too little sensitivity to variations in rights structure at high levels of development in rights culture. Technically, of course, the absence of

Case 1	
$\phi < 0$	$\phi > 0$
Algeria, El Salvador Honduras, Nigeria Trinidad & Tobago	Cameroon Italy Malta

Table 1: Case 1: Country Classification

Case 2.A		
$\phi < 0$	$0 < \phi < \frac{1}{\theta} \wedge 1$	$\phi > \frac{1}{\theta} \wedge 1$
Malaysia	Cyprus, Dominican Republic, Ecuador, Iran, Japan, Mauritius, Trinidad & Tobago, Venezuela	Egypt Turkey

Table 2: Case 2.A: Country Classification

The country classification for Case 2.A is given by Table 2. The majority of countries fall into the $0 < \phi < \frac{1}{\theta} \wedge 1$ category, suggesting a positive association between output and rights, but not strong enough to facilitate unbounded growth. Some countries continue to generate the $\phi < 0$ parameter (suggesting political systems sustainable only under increasing repression), and three countries suggest that the association between rights and output is sufficiently strong $\phi > \frac{1}{\theta} \wedge 1$ to suggest the possibility of unbounded growth due to the link³².

The country classification for Case 2.B is given in Table 3. Our discussion noted that unbounded growth is possible for the $1 \wedge \theta < \phi < 1$ parameter values, while the $\phi > 1$ parameter value generates the possibility of low-level poverty traps (though also of unbounded growth if the trap is escaped). The $\phi < 0$ case carries the same interpretation as before, and $0 < \phi < 1 \wedge \theta$ represents the standard case of a positive association between per capita output and rights.

While some countries continue to have negative ϕ -coefficients, a number also have ϕ -coefficients consistent with institutional poverty-traps, and two, Iran and Japan have a ϕ -coefficient consistent with unbounded growth.

The majority of countries either conclusively show no statistical association in the rights index renders the variable stationary, making cointegration with per capita income (integrated of order 1) impossible.

³²The classification is insensitive to variation in the θ parameter over the 0.2 - 0.4 range.

Case 2.B			
$\rho < 0$	$0 < \rho < 1$ i ®	$1 \text{ i } \text{®} < \rho < 1$	$\rho > 1$
Dominican Republic, Egypt, Malaysia, Trinidad & Tobago, Turkey		Iran Japan	Cyprus, Ecuador, Mauritius, Venezuela

Table 3: Case 2.B: Country Classification

Conclusive Absence	Insufficient Evidence
Australia, Austria, Belgium, Brazil, Canada, Colombia, Costa Rica, Denmark, Finland, France, Iceland, Indonesia, Ireland, Israel, Jamaica, Korea, Luxemburg, Madagascar, Mexico, Mozambique, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Paraguay, Peru, Sierra Leone, South Africa, Sri Lanka, Sweden, Switzerland, Thailand Tunisia, Uganda, UK, USA, Uruguay, Zaire	Bangladesh, Bolivia, Chile, China, Cote D'Ivoire, Ghana, Greece, Guatemala, Haiti, India, Jordan, Kenya, Bolivia, Malawi, Mali, Morocco, Philippines, Portugal Rwanda, Senegal, Singapore, Spain Sudan, Zambia, Zimbabwe Insufficient Data: Angola, Ethiopia

Table 4: Countries with no statistically provable association between rights and output

caution between output and rights, or show inconclusive evidence of an association. We provide a listing in Table 4.

A number of important methodological implications follow from this evidence. First the evidence does not support the presence of a link between rights and economic activity for all countries - indeed the majority of countries report no systematic link for the simple cases here examined. Further, for those countries on which a systematic link emerges, the nature of the links established is diverse in terms of both their strength (magnitude of ρ) and the form of the link (i.e. which case applies). Last, but perhaps most important of all, changes in specification (between the various cases), results in dramatic shifts in the value of the ρ -parameter for the same country. The implication is the same as that already suggested in Fedderke and Klitgaard (1998) - that clear theoretical understanding of the nature of the link between rights and output is a necessary precondition to further empirical investigation.

The application of current time series techniques to this question has the advantage of offering a clear suggestion as to the way ahead. The application of cointegration techniques has allowed the isolation of a relatively small range of countries for which at least a necessary condition for an equilibrium relationship between rights and output is satisfied. In order to deepen our understanding of the general nature of this link, more detailed historical case studies may well be useful, in order to specify the reasons for the observed differences in the magnitude of the ϕ -parameter, and the specification in which it is most appropriately to be applied.

4 Conclusion

As in many previous studies, the existence of a link between economic and political development finds support from findings reported in this paper. Yet the main thrust of the argument emphasizes that even within the very simple hypothesized relationships between economic and political development here explored, many ambiguities lurk.

Even if one adheres to the simple modernization hypothesis, the suggestion that it is economic development that drives the development of social and political institutions, with no influence of social and political institutions on long run economic performance, the nature of the social steady state nevertheless differs depending on whether it is total or per capita economic development which drives political development. In one instance, we have an end-point to history in the sense that institutions cease to develop, in the other institutions continue to evolve even in steady state.

Where one accepts the possibility that social and political institutions may affect economic performance, the situation further complicates. We distinguished between the possibility that a link may exist either between the realized output of the society and the institutions of society, or between the technology of production and institutions. The nature of social steady state, and the conditions under which unbounded growth may arise differ markedly between the two cases, and where it is realized output which influences institutions, we noted the possibility of low-income institutional poverty traps, which may militate against the possibility of sustainable growth.

The implication is that the ambiguities implicit in even relatively simple hypothesized links between economic and institutional development of societies, potentially carry profoundly different implications both for our un-

derstanding of the link, and for the formulation of policy intervention. Given findings such as those of Fedderke and Klitgaard (1998), pointing to the fragility of growth equations incorporating measures of political and social institutions to alternative specification, the need for clarification of which link between institutional and economic development applies becomes all the more pressing.

Empirical results presented above suggest a further guideline to any examination of the link between institutions and economic growth. Time series results suggested that countries may well not share a single, common α -coefficient. The implication is that cross-sectional studies will lack robustness - given the absence of a homogenous underlying population. Indeed, it may well be the case that different countries may manifest different sorts of links between economic and institutional development - such that some adhere to Case 2.B, some to 2.A, others to Case 1, and some manifesting no link at all, say. Given the diversity of cultural, historical, and institutional settings to be found around the world, the suggestion that countries may form a heterogenous, rather than homogenous sample when it comes to the link between economic and institutional development, must surely be worthy of some credence.

In addition to further more detailed and general theoretical explorations of the link between economic and institutional development, more detailed clinical studies of individual country cases, paying due regard to the unique features of such countries, may well not be a fruitless line of further enquiry. By applying current time series techniques of estimation the current paper has suggested a number of countries that might provide useful leads in this regard.

5 Appendix³³

In all tests * denotes significance at the 5% level, z; y that tests for weak exogeneity confirm the direction of influence implied by the corresponding theoretical proposition at the 5% and 10% levels of significance respectively. The requirement is for both significance and appropriate weak exogeneity.

³³Since the Gastil measures have low scores representing good, high scores representing poor rights, a negative sign on GDP implies a positive association with rights. To aid the reader, the implied value of α corrected to reflect the intuitive sign of the association is reported.

We denote the absence of cointegration by $\beta = 0$, such that the case fails to fulfill a necessary condition for a long run equilibrium relationship, obviating the need for further investigation. Note that the absence of cointegration in Case 1 does not imply that cointegration cannot be present in either Case 2.A or 2.B.

The requirement here imposed for the presence of a long run equilibrium relationship is demanding, given the simplicity of the models under investigation. The conclusions drawn are thus not to be understood as a definitive identification of the nature of the link between economic activity and rights, but they do serve to support the methodological conclusions drawn in the text. These are strong and informative in their own right.

The scope for distinguishing between Case 2.A and 2.B is limited, since for 2.A direct determination of significance of the parameter is circumscribed. We therefore report countries for both cases in the text where weak exogeneity tests support the relevant link between rights and its determinants.

	JML _{Eq:3} for r=1	σ_1	JML _{Eqs:10; 11} Eqs:18; 19 for r=2	σ_{2A}	σ_{2B}
Algeria	16:75 [□] 22:16 [□]	-2.25 ^{□z}	21:67 [□] 21:70 [□]	1.30	-4.33 [□]
Angola	i	i	i	i	i
Argentina	i	i			
Australia	i	i	i	i	i
Austria	i	i	i	i	i
Bangladesh	16:92 [□] 17:59 [□]	+0.62 [□]	34:61 [□] 34:66 [□]	+0.52	+1.09 [□]
Belgium	i	i	i	i	i
Bolivia	25:02 [□] 28:79 [□]	-0.73 ^z	19:78 [□] 23:23 [□]	+1.14	-8.15 [□]
Brazil	i	i	r = 1	i	i
Cameroon	24:46 [□] 34:54 [□]	+7.73 ^{□z}	r = 1	i	i
Canada	i	i	i	i	i
Chile	35:39 [□] 35:87 [□]	+0.40 [□]	r = 1	i	i
China	17:91 [□] 18:25 [□]	-4.09 [□]	27:64 [□] 44:84 [□]	-0.07 ^y	-0.06 ^y
Colombia	i	i	i	i	i
Costa Rica	i	i	i	i	i
Cote d'Ivoire	i	i	22:54 [□] 24:71 [□]	+0.10	+0.11 [□]
Cyprus	i	i	23:01 [□] 27:92 [□]	+0.51 ^y	+1.02 ^{□y}
Denmark	i	i	i	i	i
Dominican Rep.	i	i	16:49 [□] 19:18 [□]	+1.18 ^z	-6.71 ^{□z}
Ecuador	11:00 18:10 [□]	+0.12	16:16 [□] 17:07 [□]	+0.90 ^z	+9.04 ^{□z}
Egypt	20:11 [□] 22:19 [□]	-0.84 ^z	15:69 [□] 16:33 [□]	+49.90 ^z	-1.02 ^{□z}

	JML _{Eq:3} r=1	° ₁	JML _{Eqs:10; 11} Eqs:18; 19 for r=2	° _{2A}	° _{2B}
El Salvador	46:81 [□] 60:82 [□]	-0.46 ^{□z}	27:27 [□] 21:28 [□]	+0.77 ^z	+3.27 ^z
Ethiopia	i	i	i	i	i
Finland	i	i	27:30 [□] 33:97 [□]	+0.68	+2.15 [□]
France	i	i	i	i	i
Ghana	17:73 [□] 25:57 [□]	-0.13 ^z	r = 1	i	i
Greece	i	i	16:98 [□] 30:46 [□]	+0.68 ^z	+2.19 ^z
Guatemala	15:70 [□] 25:08 [□]	-0.76 [□]	31:02 [□] 31:36 [□]	-1.05	-0.51 [□]
Haiti	23:15 [□] 23:35 [□]	-2.50 [□]	i	i	i
Honduras	20:46 [□] 26:51 [□]	-0.07 ^{□z}	r = 1	+0.95	62.45
Iceland	i	i	i	i	i
India	i	i	17:18 [□] 25:48 [□]	+0.23	+0.30 [□]
Indonesia	i	i	i	i	i
Iran	9:43 17:11 [□]	-5.43	34:35 [□] 36:21 [□]	+0.41 ^z	+0.70 ^{□z}
Ireland	i	i	i	i	i
Israel	i	i	i	i	i
Italy	18:03 [□] 19:53 [□]	+0.54 ^{□z}	r = 1	i	i
Jamaica	i	i	r = 1	i	i
Japan	i	i	15:96 [□] 20:67 [□]	+0.49 ^z	+0.97 ^{□z}
Jordan	18:63 [□] 19:57 [□]	-10.05 [□]	i	i	i
Kenya	i	i	21:30 [□] 27:34 [□]	+2.04	-1.97 [□]
Korea	i	i	r = 1	i	i

	JML _{Eq:3} r=1	° ₁	JML _{Eqs:10; 11} Eqs:18; 19 for r=2	° _{2A}	° _{2B}
Libya	25:75 [°] 34:06 [°]	+4.99	i	i	i
Luxembourg	i	i	i	i	i
Madagascar	i	i	r = 1	i	i
Malawi	i	i	21:97 [°] 28:38 [°]	-1.89	-0.65 [°]
Malaysia	34:63 [°] 45:26 [°]	+3.03	24:32 [°] 24:49 [°]	-2.39 ^z	-0.70 ^{°z}
Mali	24:39 [°] 25:20 [°]	-0.34 ^z	13:72 [°] 16:27 [°]	+4.02 ^z	-1.33 ^z
Malta	23:93 [°] 24:26 [°]	+0.79 ^{°z}	19:14 [°] 26:83 [°]	+0.57	+1.38 [°]
Mauritius	i	i	16:68 [°] 16:84 [°]	+0.64 ^z	+1.77 ^{°z}
Mexico	i	i	r = 1	i	i
Morocco	12:82 [°] 16:58 [°]	-0.54	17:60 [°] 21:60 [°]	+1.44 ^z	-3.26 ^z
Mozambique	i	i	i	i	i
Netherlands	i	i	i	i	i
New Zealand	i	i	i	i	i
Nicaragua	i	i	r = 1	i	i
Nigeria	13:29 [°] 18:13 [°]	-2.03 ^{°z}	17:11 [°] 17:43 [°]	+1.08	-13.66
Norway	i	i	i	i	i
Pakistan	i	i	r = 1	i	i
Panama	i	i	r = 1	i	i
Paraguay	i	i	r = 1	i	i
Peru	i	i	r = 1	i	i
Philippines	27:75 [°] 33:86 [°]	-12.42 [°]	30:27 [°] 37:38 [°]	+1.15	-7.82 [°]

	JML _{Eq:3} r=1	° ₁	JML _{Eqs:10;11} Eqs:18;19 for r=2	° _{2A}	° _{2B}
Portugal	35:62 [°] 50:04 [°]	-0.25	r = 1	i	i
Rwanda	23:16 [°] 31:79 [°]	+2.65 [°]	r = 1	i	i
Senegal	27:94 [°] 32:22 [°]	-39.65	r = 1	i	i
Sierra Leone	i	i	r = 1	i	i
Singapore	i	i	27:50 [°] 27:75 [°]	+0.15	+0.18 [°]
South Africa	i	i	r = 1	i	i
Spain	i	i	18:35 [°] 21:90 [°]	+0.84	+5.22 [°]
Sri Lanka	i	i	r = 1	i	i
Sudan	i	i	15:84 [°] 24:99 [°]	+1.67	-2.50 [°]
Sweden	i	i	i	i	i
Switzerland	i	i	i	i	i
Thailand	i	i	r = 1	i	i
Trinidad&Tobago	13:83 [°] 23:04 [°]	-0.69 ^{ay}	19:28 [°] 19:70 [°]	+1.25 ^z	-4.93 ^{az}
Tunisia	i	i	r = 1	i	i
Turkey	i	i	16:79 [°] 16:79 [°]	+2.08 ^z	-1.93 ^{az}
Uganda	i	i	i	i	i
UK	i	i	i	i	i
USA	i	i	i	i	i
Uruguay	i	i	r = 1	i	i
Venezuela	i	i	32:72 [°] 33:48 [°]	+0.89 ^z	+7.97 ^{az}
Zaire	i	i	r = 1	i	i
Zambia	i	i	16:59 [°] 20:38 [°]	-1.28	-0.56 [°]
Zimbabwe	10:89 [°] 19:62 [°]	+0.12	r = 1	i	i

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