Institutions and Economic Outcomes: A Dominance-Based Analysis of Causality and Multivariate Welfare with Discrete and Continuous Variables

Gordon Anderson
University of Toronto

Kinda Hachem
University of Toronto

This Draft: September 2009

Abstract

One of the central issues in welfare economics is the measurement of overall wellbeing and, to this end, the interaction between institutions (polity) and growth is paramount. Individual welfare depends on both economic and political factors but the continuous nature of economic variables combined with the discrete nature of political ones renders conventional multivariate techniques problematic. In this paper, we propose a multivariate dominance test based on the comparison of mixtures of continuous and discrete distributions to examine changes in welfare. Our results suggest that, while economic growth exerted a positive impact from 1960 to 2000, declines in polity over the earlier part of this period were sufficient to produce a decline in overall wellbeing until the mid-1970s. Subsequent increases in polity then reversed the trend and, ultimately, wellbeing in 2000 was higher than that in 1960. To be sure, economic and political variables are correlated and the dominance of polity in our multivariate results is consistent with the conjecture that this correlation is predominantly due to a causal link from polity to growth. While the development literature is rife with debates over whether it is institutions that cause growth or growth that causes institutions, we argue that the relevant question is not which hypothesis is correct but, rather, which hypothesis dominates. Since standard regression techniques have difficulty capturing non-linear dependence, especially when one of the variables is an index with limited variation, we propose a causality dominance test to examine this aspect of the growth-institutions nexus and indeed find evidence that the causal effects of polity on growth dominate those of growth on polity, particularly when the data are population weighted.

1. Introduction

The interaction between institutions and economic outcomes is a key issue in both welfare and development economics. While welfarists are more concerned with *intra-temporal* interactions between these variables, namely the extent to which they contribute to overall wellbeing, development economics has focused extensively on *inter-temporal* interactions between them, namely causality. In this paper, we argue that standard techniques are ill-suited for these questions and, instead, propose a dominance-based approach to address them.

There is no doubt that both political freedoms and material advancement promote welfare but the discrete nature of political variables combined with the continuous nature of economic ones encumbers the assessment of welfare changes. With respect to dynamic relationships, a positive correlation between institutions and economic outcomes has been readily established but causality has proven more contentious. Even theoretically, causality can run in both directions. To the extent that better institutions such as property rights, political freedoms, and government accountability provide better investment incentives, they can be expected to encourage economic activity. At the same time though, prolonged economic failure may compel agents to demand better institutions and any growth that makes them richer or more educated might also provide the extra bargaining power needed to make these demands credibly.[1]

On the empirical front, a key study that finds causality from institutions to economic outcomes is Acemoglu et al (2001). They argue that the institutions introduced by European colonizers varied according to their settlement objectives and show that the persistence of these institutions to the present day has had important income per capita implications for the ex-colonies. Using a growth

[1] Additional linkages are discussed in Sen (1999) and Friedman (2005).

accounting framework, Hall and Jones (1999) also argue for the primacy of institutions, finding that differences in social infrastructure help explain the large differences in capital accumulation and productivity that we observe across countries. More recent work by Gwartney et al (2006) confirms the importance of such an institutions-investment channel while Dawson (2003) identifies freedoms related to international finance as those which affect growth through investment and freedoms related to political, civil, and economic liberties as those which affect growth directly. Consistent with Calderon and Chong (2000) and Kaufmann and Kraay (2002), however, both Dawson (2003) and Gwartney et al (2006) also find evidence of reverse causality when certain institutional measures are used. The importance of disaggregating institutions is further established by the Heckelman (2000) result that an average measure of freedom along with its monetary, capital, and property rights components precedes growth but that growth likely precedes the extent of government intervention. A consistent conclusion is reached by Alvarez and Vega (2003) who find clear evidence of causality from institutions to growth when institutions are measured as economic freedoms but confounded evidence when they are measured as political freedoms.

Similar debates have also emerged in the financial development literature. Beck et al (2000), for example, argue that legal and accounting institutions are particularly important for an economy's growth because they determine the sophistication of its financial intermediaries. The results of King and Levine (1993) also suggest that the pre-determined component of financial development is a good predictor of long-term growth while Rajan and Zingales (1998) find that sectors in need of external finance develop more quickly in economies with better financial markets. Morris et al (2001), on the other hand, find evidence of reverse causality in some OECD countries and two-way causality in others but no decisive evidence that the link between financial development and economic performance runs strictly from the former to the latter. Using a Geweke decomposition to test for linear feedback between financial deepening and growth rather than the unidirectional Granger procedure typically employed, Calderon and Liu (2003) also find that causality runs in both directions with financial systems exerting a larger effect on growth in developing countries.

That the debate is far from settled is also reflected in several papers which have raised questions about the econometric methods used to investigate the relationship between growth and institutions. Levine and Renelt (1992), for example, demonstrate that slight changes in the list of explanatory variables can overturn the results of many empirical growth studies while De Haan et al (2006) also criticize the specification of certain growth models used in the literature. Perhaps the most searing criticism though is provided by Glaeser et al (2004) who argue that traditional methods for testing the relationship between institutions and economic outcomes are flawed and, once proper measures and valid instruments are employed, institutions only have a second-order effect on economic performance. The task of interpreting the literature is further complicated by the Doucouliagos (2005) finding of a publication bias towards the conclusion that economic freedoms have a positive impact on growth, suggesting that the lack of consensus may be even more pronounced than it appears.

In light of the preceding discussion, we abstract from conventional regression methods and analyze the relationship between institutions (polity) and economic outcomes in the context of inter-temporal dependence rather than just inter-temporal correlation. Given theoretical support for both the “polity causes growth” and “growth causes polity” hypotheses, we argue that they should not be treated as alternatives and instead focus on identifying the dominant hypothesis by adapting the overlap index proposed by Anderson et al (2009a, 2009b) for use with a mixture of discrete (polity) and continuous (growth) variables. The basic premise is that the joint density of two independent variables overlaps the product of their marginal densities at every point of support so, if institutions do indeed determine economic outcomes more than economic outcomes determine institutions, the joint density of earlier institutions and later outcomes should be systematically further away from independence than that of earlier outcomes and later institutions. Using this approach, we can admit non-linear relationships non-parametrically and bypass the error-term constraints that plague regression methods.[2] Dominance-based techniques are also germane because they are what we use to examine the other important aspect of the polity-growth interaction: the effect on overall welfare. Changes in economic and political variables have not always been in the same direction, making their net impact on wellbeing difficult to ascertain. Drawing from the multivariate stochastic dominance literature, however, we can compare the current distribution over growth-polity pairs to past distributions over these pairs and make qualitative statements about the progress of wellbeing.

The next section presents our methodology in more detail. Section 3 then discusses the data used while Section 4 reports our results. We find that economic growth exerted a positive impact on wellbeing from 1960 to 2000. Declines in polity over the earlier part of this period, however, were sufficient to produce a decline in overall wellbeing until the mid-1970s. Subsequent increases in polity then reversed the trend and, ultimately, wellbeing in 2000 was higher than that

[2] Further evidence of non-linearity in the development literature is provided by the Anand and Ravallion (1993) finding that GDP per capita loses its explanatory power for life expectancy when incomes of the poor are added as a separate variable. In addition to inflexibility in dealing with non-linear relationships, traditional regressions also have problems finding non-controversial instruments to address joint causality as well as problems dealing with mixtures of discrete and continuous variables.

in 1960. We also find evidence that the causal effects of polity on growth dominate those of growth on polity, particularly when the data are population weighted.

2. Methodology

Multivariate Wellbeing

With some modification, the multivariate stochastic dominance techniques presented in Anderson (2008) and Duclos, Sahn, and Younger (2006) can be used to assess changes in overall wellbeing. Although these techniques do not provide a complete ordering of states, when they do provide a ranking, the ordering is unambiguous. Suppose societal wellbeing in period *t* can be written as $U(y_t,x_t)$: a monotonic, non-decreasing function of the continuous variable economic wellbeing (y_t) and the discrete variable political freedoms (x_t). Further, let y_t and x_t be jointly distributed with potentially time-varying PDF $g_t(y,x)$ and corresponding CDF $G_t(y,x)$. If $D = G_t(y,x)-G_{t-i}(y,x) \leq 0$ for all pairs (y,x) with strict inequality for at least some, then $E(U(y_t,x_t)) \geq E(U(y_{t-i},x_{t-i}))$and, based on Atkinson and Bourguing (1982), the society at *t* can be considered a welfare improvement over the society at *t-i* for all wellbeing functions in the monotonic non-decreasing family. In fact, as long as *D* is significantly negative for some pairs (y,x) and not significantly positive for all other pairs, $E(U(y_t,x_t)) \geq E(U(y_{t-i},x_{t-i}))$ can be established and an approximately first order welfare improvement obtains.

In order to make quantitative statements about *D*, we use the Kolmogorov-Smirnov statistic for differences between distributions. The statistic is based on the maximum value of *D* over the support of the two distributions being compared and an estimate of this value can be obtained from sample-based estimates of the joint densities in two periods.[3] The formula used for $P(\sqrt{n}*D < \lambda)$ is $1\text{-}exp(-2\lambda^2)$ which is Rayleigh's formula for the univariate statistic ($K=1$). Although Kiefer and Wolfowitz (1958) establish the existence of a distribution function for D when $K>1$, they find that it generally depends on G. Later work by Kiefer (1961), however, suggests that the formula for the univariate case provides a conservative (i.e. larger) estimate of the true value when $K>1$.

Causality Dominance

Let x be an n-dimensional vector and $f_a(x)$ and $f_b(x)$ be two continuous multivariate distributions. The extent to which $f_a(x)$ and $f_b(x)$ overlap can be measured as:

$$OV = \int_{-\infty}^{\infty} \dots \int_{-\infty}^{\infty} \min\left\{f_a(x), f_b(x)\right\}\, dx_1 \dots dx_n$$

In recent work, Anderson, Linton, and Whang (2009b) show that the kernel estimator of $\theta = \int min\{f_a(x),f_b(x)\}dx$ is distributed as follows:

$$\begin{aligned}
&\sqrt{n}(\hat{\theta}-\theta)-\alpha_n \;\; \rightarrow \;\; N(0,v) \\
&where \\
&v = p_0\sigma_0^2 + p_a(1-p_a)+p_b(1-p_b) \\
&p_0 = P(X \in C_{f_a f_b}); \quad C_{f_a f_b} = \{x \in \mathbb{R}^n : f_a(x) = f_b(x) > 0\} \\
&p_a = P(X \in C_{f_a}); \quad C_{f_a} = \{x : f_a(x) < f_b(x)\} \\
&p_b = P(X \in C_{f_b}); \quad C_{f_b} = \{x : f_a(x) > f_b(x)\} \\
&\alpha_n \; and \; \sigma_0^2 \; are \; bias \; correction \;\; factors
\end{aligned}$$

[3] Although the joint distribution of polity and growth describes a mixture of discrete and continuous variables, this does not pose a problem since sample cumulants are easily calculated.

The slight wrinkle for the polity-growth application, however, is that x is a mixture of discrete and continuous variables. Denoting them by x_d and x_c respectively so that $x = (x_d, x_c)$, the appropriate overlap measure is:

$$OV_{mix} = \int_{-\infty}^{\infty} \sum_{x_d} \min\left\{f_a(x), f_b(x)\right\} dx_c$$

The discrete version of OV has been developed in Anderson, Ge, and Leo (2009a) so the properties of OV_{mix} can be derived as a mixture of the two cases. Moreover, OV_{mix} lends itself quite naturally to a measure of dependence. To see how, let y_t be a vector of economic variables in period t with joint distribution $f(y_t)$ and x_t be a vector of institutional indices in period t with joint density $p(x_t)$. The joint distribution of economic outcomes in period j and institutions in period k is denoted by $g(y_j,x_k)$. Under independence, $g(y_j,x_k) = f(y_j)p(x_k)$ and the following measure of their dependence can be constructed:

$$d(y_j, x_k) = 1 - \int_{y_j} \sum_{x_k} \min\left\{g(y_j, x_k), f(y_j)p(x_k)\right\} dy_j \in (0,1)$$

A greater degree of dependence between y_j and x_k implies less overlap between $g(y_j,x_k)$ and $f(y_j)p(x_k)$, leading to higher values of $d(y_j,x_k)$. To test for causality dominance, we thus focus on $d(y_{t-i},x_t)-d(y_t,x_{t-i})$ for $i=1,\ldots,n$. Consistently negative differences support the hypothesis that institutions promote growth more than growth promotes institutions while consistently positive differences support the reverse. Essentially, conditions like $d(y_{t-i},x_t)-d(y_t,x_{t-i}) \geq 0$ for all i or $d(y_{t-i},x_t)-d(y_t,x_{t-i}) \leq 0$ for all i are forms of dominance relationships and establishing them empirically would lend considerable support to one view or the other. Since these inequalities need to hold simultaneously, the simultaneous comparison techniques in Wolak (1989) and Stoline and Ury (1979) are appropriate.

3. Data

We consider a sample of 84 developed and developing countries over the period 1960 to 2000 and draw data on institutional quality and economic outcomes at 5 year intervals. A detailed description of the data is provided in Appendix I. Of all the standard measures of institutions, Glaeser et al (2004) suggest that constraints on the executive is the most defensible so we use the corresponding variable from the frequently cited Polity IV project.[4] We also use data on GDP per capita from the World Bank Development Indicators database to measure economic outcomes.

At this point, it is useful to address the often overlooked issue of population weighting. If the polity-growth nexus is viewed as a latent technological relationship, each country should be interpreted as a particular draw from that technology and given equal weight. If, on the other hand, we take a representative agent view, country-level observations should be population weighted so as to give each *individual* in the world sample equal weight. In what follows, we present the results of both approaches as well as a representative agent version that excludes the two most populous countries – China and India.

Summary statistics are reported in Tables 1a and 1b. When unweighted, average GDP per capita exhibited sustained growth throughout the period. Average polity, in contrast, declined over the first 15 years of our sample, returning to its initial level in the mid-1980s and rising to unprecedented levels thereafter. The 1980s also saw a reversal in the plight of the poorest nation with minimum GDP per capita transitioning from consistent improvements to substantial losses

---

[4] See, for example, Hanson (2004), Hausmann, Pritchett, and Rodrik (2005), and Klomp and De Haan (2009). Acemoglu et al (2001) also use the Polity IV data in their robustness checks.

late in the decade. With regard to dispersion, polity and GDP per capita seem to be driven by very different processes. Polity, in particular, appears to be a convergent measure whereas GDP per capita appears to be a divergent one. The population weighted statistics tell a similar story for the polity variable but not for GDP per capita which is characterized by greater dispersion and substantially lower means and medians.

4. Results

Multivariate Wellbeing

Tables 2a, 2b, and 2c report the Kolmogorov-Smirnov first order stochastic dominance comparisons for all possible pairs of years in the sample. The joint densities have been estimated using cumulants of the Epechinokov kernel in the continuous dimension and straightforward cumulation in the discrete dimension. An increase in overall wellbeing from year *B* to year *A* is declared if "H_0: Year A dominates Year B" is accepted and "H_0: Year B dominates Year A" is rejected. If both hypotheses are rejected or both hypotheses are accepted, an indeterminate change in welfare is reported.

In this application, the unweighted results are the clearest – out of the 36 possible year-to-year comparisons, the unweighted sample yields only 5 indeterminacies while the weighted samples with and without China and India yield 20 and 10 respectively. The unweighted results reflect the fact that declines in polity between 1960 and 1975 outweighed progress in incomes, leading to declines in overall wellbeing relative to initial conditions. By 1985, however, the drop in polity had been made up and further progress in such institutions meant that unambiguous increases in wellbeing were sustained through to 2000. The population weighted results tell a consistent story, particularly when China and India are excluded from the sample. In the latter case, the main difference relative to Table 2a is that a swifter recovery in polity under population weighting pulls the welfare declines in the earlier part of the observation period up to indeterminacy.

Causality Dominance

To avoid difficulties with joint density estimation at points with too few observations, we amalgamate polity categories 1 and 2 and polity categories 3 and 4 to form a new five-point polity scale. For all lags examined – 0 to 40 years in 5 year intervals – the dependence of GDP on past polity and the dependence of polity on past GDP are readily established. With causality in both directions, we now turn to the question of interest: does one direction dominate in the sense that the degree of dependence is always at least as great in that direction at every lag? Tables 3a, 3b, and 3c report the causality dominance results for the unweighted, population weighted, and population weighted excluding China and India data. We have used a discrete–continuous specification for the joint densities, employing a Gaussian kernel for the continuous component and Silverman's rule of thumb for the window width.[5]

With respect to the unweighted results, there is some indication that the causal nature of polity dominates that of GDP per capita but the differences are largely insignificant. The weighted results, on the other hand, exhibit a stronger level of dependency in all cases and a clearer pattern. At all lags where $d(y_{t-i},x_t)-d(y_t,x_{t-i})<0$, the hypothesis that the dependence of current outcomes on past institutions outweighs the dependence of current institutions on past outcomes is accepted under modest degrees of significance. In contrast, the reverse hypothesis is readily

[5] Silverman (1986) suggests a window width of $1.06\sigma n^{-1/(4+k)}$.

rejected at all lags where $d(y_{t-i},x_t)-d(y_t,x_{t-i})>0$. As previously noted, population weighting assigns extraordinary importance to the circumstances of China and India. If these countries are omitted from the weighted sample, the conclusion that "polity causes growth" dominates "growth causes polity" emerges more strongly.

5. Conclusion

There has been considerable debate over whether it is institutions that cause growth or growth that causes institutions and the discussion has, at least in part, been fomented by the fact that the two hypotheses are not mutually exclusive. In this paper, we argue that the relevant question is not which hypothesis is correct but, rather, which hypothesis dominates. Since conventional regression techniques have difficulty capturing non-linear dependence, especially when one of the variables is an index with limited variation, we propose a causality dominance test based on the overlap measure of Anderson et al (2009a, 2009b) to examine the growth-institutions nexus. When the data are not weighted by population size, consistent with a technological interpretation of the model, the results are inconclusive. In contrast, when a representative agent view is taken and the data are population weighted, we find evidence that institutions cause economic outcomes to a greater extent than economic outcomes cause institutions, particularly when China and India are excluded from the calculus. Another advantage of a dominance-based approach is its natural link to multivariate welfare comparisons. Our results on this front suggest that, while economic growth has had a positive impact on wellbeing over the past 40 years, early declines in polity were sufficient to produce a decline in overall welfare until the mid-1970s. Subsequent increases in polity then reversed the trend and, ultimately, wellbeing in 2000 was higher than that in 1960.

Table 1a: Summary Statistics, Unweighted Sample

	Polity Index					GDP per Capita				
	Mean	Median	StDev	Max	Min	Mean	Median	StDev	Max	Min
1960	4.0595	3	2.3865	7	1	2.8340	0.9360	3.8138	18.7110	0.0990
1965	3.9048	3	2.4079	7	1	3.4042	1.0250	4.6036	21.8770	0.1000
1970	3.5476	3	2.3867	7	1	4.1108	1.2265	5.4884	25.1250	0.1220
1975	3.4881	3	2.4909	7	1	4.7011	1.4135	6.1152	25.5950	0.1400
1980	3.7024	3	2.4971	7	1	5.2871	1.5490	6.9372	28.2060	0.1400
1985	4.0238	3	2.4690	7	1	5.6276	1.4660	7.6299	29.6870	0.1530
1990	4.6071	5	2.3593	7	1	6.2496	1.5100	8.6665	33.3690	0.1320
1995	5.0238	6	2.1055	7	1	6.7504	1.6780	9.2308	35.4390	0.0560
2000	5.2381	6	1.8860	7	1	7.7052	2.0165	10.572	37.4720	0.0850

Table 1b: Summary Statistics, Population Weighted Sample

	Polity Index			GDP per Capita		
	Mean	Median	StDev	Mean	Median	StDev
1960	4.3159	3	2.4045	2.6032	0.1880	4.3386
1965	4.1409	3	2.4693	3.0737	0.1930	5.1541
1970	3.9913	3	2.4946	3.6255	0.2280	6.0631
1975	3.7311	2	2.3118	3.9241	0.2200	6.6360
1980	4.3024	3	2.3210	4.3216	0.2500	7.4917
1985	4.5155	3	2.2116	4.6062	0.2820	8.1715
1990	4.6626	3	2.1532	5.0420	0.3730	9.2744
1995	4.8433	5	2.0778	5.3339	0.5960	9.6872
2000	5.1097	6	1.8967	5.8958	0.8440	10.6937

Table 2a: Multivariate Dominance Tests, Unweighted

Comparison Years B	Comparison Years A	Change in Wellbeing (↑=Increase, ↓=Decrease, n/d=Indeterminate)	P(A dominates B)	P(B dominates A)
1960	1965	↓	0.026095697	0.11850338
1960	1970	n/d	0.097916794	0.51465297
1960	1975	n/d	0.20874747	0.60711409
1960	1980	↓	0.0082932073	0.47699463
1960	1985	↓	0.023747494	0.11571586
1960	1990	↑	0.51823675	0.019935707
1960	1995	↑	0.82367753	5.7875176e-007
1960	2000	↑	0.91784705	0.0059285395
1965	1970	↓	0.031452497	0.26554788
1965	1975	n/d	0.12376443	0.45588410
1965	1980	↓	0.044379124	0.31831677
1965	1985	↑	0.10601742	0.026537624
1965	1990	↑	0.62963214	0.0061565362
1965	1995	↑	0.91564586	1.6200814e-007
1965	2000	↑	0.97356939	0.00062529422
1970	1975	↓	0.048017103	0.13007599
1970	1980	n/d	0.11957484	0.058384074
1970	1985	↑	0.38634246	0.017977451
1970	1990	↑	0.90266393	0.0056174308
1970	1995	↑	0.98590375	8.7398894e-006
1970	2000	↑	0.99679388	2.2803319e-006
1975	1980	↑	0.11010568	1.0208946e-008
1975	1985	↑	0.46673230	0.00071125766
1975	1990	↑	0.87021908	7.7727105e-005
1975	1995	↑	0.98095379	3.5621253e-005
1975	2000	↑	0.99526916	2.1558126e-006
1980	1985	↑	0.19299481	0.0013534198
1980	1990	↑	0.75971296	7.4649073e-005
1980	1995	↑	0.95623359	1.0352316e-006
1980	2000	↑	0.98800982	6.4344415e-005
1985	1990	↑	0.44568735	5.7465243e-007
1985	1995	↑	0.84905464	2.1653034e-006
1985	2000	↑	0.94348564	6.8788149e-005
1990	1995	↑	0.30718239	5.1650570e-006
1990	2000	↑	0.55811598	2.6561361e-008
1995	2000	n/d	0.16173100	0.056415134

Table 2b: Multivariate Dominance Tests, Population Weighted, China and India Included

Comparison Years B	Comparison Years A	Change in Wellbeing (↑=Increase, ↓=Decrease, n/d=Indeterminate)	P(A dominates B)	P(B dominates A)
1960	1965	↓	0.012311067	0.10479906
1960	1970	↓	0.016197666	0.36370992
1960	1975	↓	0.00090649030	0.86721410
1960	1980	n/d	0.059709774	0.69177442
1960	1985	n/d	0.062985155	0.79529069
1960	1990	n/d	0.11624084	0.95983110
1960	1995	n/d	0.69358022	0.76415276
1960	2000	n/d	0.55154715	0.95972809
1965	1970	↓	0.035547872	0.20920414
1965	1975	↓	0.011977133	0.83354021
1965	1980	↓	0.041373940	0.42731053
1965	1985	n/d	0.11601445	0.64891922
1965	1990	n/d	0.24593613	0.94230165
1965	1995	n/d	0.68335991	0.76361940
1965	2000	n/d	0.67281329	0.95025659
1970	1975	↓	6.6152341e-006	0.55386816
1970	1980	n/d	0.099397583	0.15205695
1970	1985	n/d	0.32242648	0.48926328
1970	1990	n/d	0.45951041	0.90200906
1970	1995	n/d	0.91483171	0.61934480
1970	2000	n/d	0.89461235	0.89305615
1975	1980	↑	0.22337623	0.047758204
1975	1985	n/d	0.51059764	0.33271108
1975	1990	n/d	0.66370882	0.83829950
1975	1995	n/d	0.97629449	0.48470411
1975	2000	n/d	0.96875965	0.81907182
1980	1985	n/d	0.13344319	0.15206811
1980	1990	n/d	0.26213185	0.31874794
1980	1995	↑	0.64443631	2.1820664e-006
1980	2000	↑	0.68587293	1.3710790e-005
1985	1990	↑	0.030367266	0.049145457
1985	1995	↑	0.58521921	3.0951799e-006
1985	2000	↑	0.75671521	2.1950087e-005
1990	1995	↑	0.38950613	3.4595414e-007
1990	2000	↑	0.69725946	0.035595225
1995	2000	↑	0.34233381	0.0017220562

Table 2c: Multivariate Dominance Tests, Population Weighted, China and India Excluded

Comparison Years B	A	Change in Wellbeing (↑=Increase, ↓=Decrease, n/d=Indeterminate)	P(A dominates B)	P(B dominates A)
1960	1965	n/d	0.063238664	0.39408100
1960	1970	n/d	0.20254125	0.63036076
1960	1975	n/d	0.26718915	0.81810162
1960	1980	↓	0.0074026734	0.77089334
1960	1985	↓	0.047936564	0.26337816
1960	1990	n/d	0.51987356	0.13901535
1960	1995	↑	0.69308651	0.00014329966
1960	2000	↑	0.85077586	0.039237850
1965	1970	n/d	0.11239711	0.26011478
1965	1975	n/d	0.087104918	0.50830041
1965	1980	n/d	0.099218213	0.43648797
1965	1985	n/d	0.35005223	0.096537349
1965	1990	↑	0.62676388	0.045879373
1965	1995	↑	0.82788121	5.9325521e-005
1965	2000	↑	0.96331337	0.0015408809
1970	1975	n/d	0.0076207032	0.085633244
1970	1980	↓	0.010915308	0.063602252
1970	1985	↑	0.41551074	0.041262914
1970	1990	↑	0.68134139	0.015871029
1970	1995	↑	0.89700057	0.00018287109
1970	2000	↑	0.98747463	1.8514816e-006
1975	1980	↑	0.054535959	0.0014700837
1975	1985	↑	0.58623719	0.00029843225
1975	1990	↑	0.79959322	0.034869126
1975	1995	↑	0.95917695	0.00020264293
1975	2000	↑	0.98987974	3.0430335e-005
1980	1985	↑	0.40807978	0.00043506019
1980	1990	↑	0.66971880	1.3204289e-006
1980	1995	↑	0.91247128	7.1326197e-006
1980	2000	↑	0.98321602	5.0665324e-005
1985	1990	↑	0.10522856	8.7281870e-007
1985	1995	↑	0.56006106	1.1273375e-005
1985	2000	↑	0.87632965	7.9859118e-005
1990	1995	↑	0.23469919	0.00013157124
1990	2000	↑	0.80855281	3.5060235e-006
1995	2000	n/d	0.61916063	0.056347152

Table 3a: Causality Dominance Tests, Unweighted (y=incomes, x=institutions)

Lag Length	No Bias Adjustment				Bias Adjusted			
(years)	$d(y_{t-i},x_t)$	$d(y_t,x_{t-i})$	“t(diff)”	P(T>"t")	$d(y_{t-I},x_t)$	$d(y_t,x_{t-i})$	“t(diff)”	P(T>"t")
0	0.4282	0.4291	-0.0139	0.4945	0.1485	0.2465	-0.9296	0.1763
5	0.4256	0.4342	-0.1943	0.4230	0.1754	0.2397	-0.8672	0.1929
10	0.4207	0.4216	-0.0235	0.4906	0.2043	0.2390	-0.5769	0.2820
15	0.4200	0.4162	0.1251	0.5498	0.2260	0.2411	-0.2855	0.3876
20	0.4286	0.4145	0.5233	0.6996	0.2482	0.2486	-0.0066	0.4974
25	0.4299	0.4203	0.3850	0.6499	0.2631	0.2597	0.0790	0.5315
30	0.4254	0.4237	0.0766	0.5305	0.2674	0.2699	-0.0606	0.4758
35	0.4169	0.4135	0.1730	0.5687	0.2671	0.2666	0.0126	0.5050
40	0.4242	0.4242	0.0000	0.5000	0.2819	0.2819	0.0000	0.5000

Table 3b: Causality Dominance Tests, Population Weighted, China and India Included

Lag Length	No Bias Adjustment				Bias Adjusted			
(years)	$d(y_{t-i},x_t)$	$d(y_t,x_{t-i})$	“t(diff)”	P(T>"t")	$d(y_{t-I},x_t)$	$d(y_t,x_{t-i})$	“t(diff)”	P(T>"t")
0	0.4608	0.4443	0.2787	0.6098	0.2765	0.3087	-0.3026	0.3811
5	0.4509	0.4582	-0.1665	0.4339	0.2983	0.3312	-0.4411	0.3296
10	0.4346	0.4682	-0.9411	0.1733	0.2890	0.3595	-1.1777	0.1195
15	0.4434	0.4640	-0.6857	0.2464	0.3125	0.3560	-0.8374	0.2012
20	0.4492	0.4709	-0.8188	0.2064	0.3343	0.3730	-0.8418	0.2000
25	0.4562	0.4757	-0.8129	0.2081	0.3533	0.3854	-0.7642	0.2224
30	0.4636	0.4601	0.1601	0.5636	0.3702	0.3747	-0.1159	0.4539
35	0.4584	0.4542	0.2129	0.5843	0.3705	0.3708	-0.0101	0.4960
40	0.4513	0.4513	0.0000	0.5000	0.3689	0.3689	0.0000	0.5000

Table 3c: Causality Dominance Tests, Population Weighted, China and India Excluded

Lag Length	No Bias Adjustment				Bias Adjusted			
(years)	$d(y_{t-i},x_t)$	$d(y_t,x_{t-i})$	“t(diff)”	P(T>"t")	$d(y_{t-i},x_t)$	$d(y_t,x_{t-i})$	“t(diff)”	P(T>"t")
0	0.4748	0.4724	0.0410	0.5163	0.3364	0.3458	-0.0873	0.4652
5	0.4554	0.4784	-0.5301	0.2980	0.3278	0.3798	-0.6922	0.2444
10	0.4436	0.4890	-1.2918	0.0982	0.3165	0.4005	-1.3924	0.0819
15	0.4454	0.4879	-1.4217	0.0776	0.3321	0.3961	-1.2303	0.1093
20	0.4546	0.4940	-1.4913	0.0679	0.3529	0.4053	-1.1296	0.1293
25	0.4629	0.4923	-1.2363	0.1082	0.3682	0.4058	-0.8906	0.1866
30	0.4713	0.4761	-0.2247	0.4111	0.3840	0.3940	-0.2550	0.3994
35	0.4663	0.4673	-0.0541	0.4784	0.3841	0.3888	-0.1271	0.4494
40	0.4655	0.4655	0.0000	0.5000	0.3879	0.3879	0.0000	0.5000

References

Acemoglu, D., S. Johnson, and J. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review*, 91(5), 1369-1401.

Anand, S. and M. Ravallion. 1993. "Human Development in Poor Countries: On the Role of Private Incomes and Public Services." *Journal of Economic Perspectives*, 7(1), 133-150.

Alvarez-Arce, J. and M. Vega-Gordillo. 2003. "Economic Growth and Freedom: A Causality Study." *Cato Journal*, 23(2), 199-215.

Anderson, G.J. 2008. "The Empirical Assessment of Multidimensional Welfare, Inequality and Poverty: Sample Weighted Multivariate Generalizations of the Kolmogorov-Smirnov Two Sample Test for Stochastic Dominance." *Journal of Economic Inequality*, 6(1), 73-87.

Anderson, G.J., Y. Ge, and T. Leo. 2009a. "Distributional Overlap: Simple Multivariate, Parametric and Non-Parametric Tests for Alienation, Convergence and General Distributional Differences." Forthcoming in *Econometric Reviews*.

Anderson, G.J., O. Linton, and Y.J. Whang. 2009b. "Non Parametric Estimation of a Polarization Measure." University of Toronto Mimeo.

Atkinson, A.B. and F. Bourguignon. 1982. "The Comparison of Multidimensional Distributions of Economic Status." *Review of Economic Studies*, 49(2), 183-201.

Beck, T., R. Levine, and N. Loayza. 2000. "Financial Intermediation and Growth: Causality and Causes." *Journal of Monetary Economics*, 46(1), 31-77.

Calderon, C. and A. Chong. 2000. "Causality and Feedback between Institutional Measures and Economic Growth." *Economics and Politics*, 12(1), 69-81.

Calderon, C. and L. Liu. 2003. "The Direction of Causality between Financial Development and Economic Growth." *Journal of Development Economics*, 72(1), 321-334.

Dawson, J. 2003. "Causality in the Freedom–Growth Relationship." *European Journal of Political Economy*, 19(3), 479-495.

De Haan, J., S. Lundstrom, and J. Sturm. 2006. "Market-Oriented Institutions and Policies and Economic Growth: A Critical Survey." *Journal of Economic Surveys*, 20(2), 157-191.

Doucouliagos, C. 2005. "Publication Bias in the Economic Freedom and Economic Growth Literature." *Journal of Economic Surveys*, 19(3), 367-387.

Duclos, J.Y., D. Sahn, and S.D. Younger. 2006. "Robust Multidimensional Poverty Comparisons." *Economic Journal*, 116(514), 943-968.

Freidman, B.M. 2005. *The Moral Consequences of Economic Growth*. Random House.

Glaeser, E., R. La Porta, F. Lopez-de-Silanes, and A. Shleifer. 2004. "Do Institutions Cause Growth?" *Journal of Economic Growth*, 9(3), 271-303.

Gwartney, J., R. Holcombe, and R. Lawson. 2006. "Institutions and the Impact of Investment on Growth." *Kyklos*, 59(2), 255-273.

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

Hanson, J. 2004. "Growth States and Development: Political Institutions and Their Conditional Effects." University of Michigan Mimeo.

Hausmann, R., L. Pritchett, and D. Rodrik. 2005. "Growth Accelerations." *Journal of Economic Growth*, 10(4), 303-329.

Heckelman, J. 2000. "Economic Freedom and Economic Growth: A Short-Run Causal Investigation." *Journal of Applied Economics*, 3(1), 71-91.

Jaggers, K. and M. Marshall. 2007. "Polity IV Project: Political Regime Characteristics and Transitions, 1800-2006." Center for Systemic Peace Data Manual.

Kaufmann, D. and A. Kraay. 2002. "Growth without Governance." *Economia*, 3(1), 169-229.

Kiefer, J. 1961. "On Large Deviations of the Empiric D.F. of Vector Chance Variables and a Law of the Iterated Logarithm." *Pacific Journal of Mathematics*, 11(2), 649 - 660.

Kiefer, J. and J. Wolfowitz. 1958. "On the Deviations of the Empiric Distribution Function of Vector Chance Variables." *Transactions of the American Mathematical Society*, 87(1), 173-186.

King, R. and R. Levine. 1993. "Finance and Growth: Schumpeter Might Be Right." *Quarterly Journal of Economics*, 108(3), 717-737.

Klomp, J. and J. De Haan. 2009. "Political Institutions and Economic Volatility." *European Journal of Political Economy*, 25(3), 311-326.

Levine, R. and D. Renelt. 1992. "A Sensitivity Analysis of Cross-Country Growth Regressions." *American Economic Review*, 82(4), 942-963.

Morris, A., J. Shan, and F. Sun. 2001. "Financial Development and Economic Growth: An Egg-and-Chicken Problem?" *Review of International Economics*, 9(3), 443-454.

Rajan, R. and L. Zingales. 1998. "Financial Dependence and Growth." *American Economic Review*, 88(3), 559-586.

Sen, A.K. 1999. *Development as Freedom*. Random House.

Silverman, B. 1986. *Density Estimation for Statistics and Data Analysis*. Chapman & Hall.

Stoline, M.R. and H.K. Ury. 1979. "Tables of the Studentized Maximum Modulus Distribution and an Application to Multiple Comparisons Among Means." *Technometrics*, 21(1), 87-93.

Wolak, F.A. 1989. "Testing Inequality Constraints in Linear Econometric Models." *Journal of Econometrics*, 41(2), 205-235.

Appendix I: Data Sources

Institutions

- Constraints on the executive measured on a scale of 1 to 7. Higher values reflect better institutions with 1 representing *unlimited authority* and 7 *executive subordination*.

- Data from Polity IV Project (www.systemicpeace.org/inscr/inscr.htm). See Jaggers and Marshall (2007) for a description.

- The Polity IV dataset does not report measures of executive constraints for transition years. This was an issue for a few of the observations used here and, to circumvent it, the closest available data point – usually within one or two years of the missing one – was used.

Economic Outcomes

- Real GDP per capita measured in thousands of constant 2000 US$.

- Data from the World Bank's World Development Indicators database.

Population

- Data from the World Bank's World Development Indicators database.

Countries

- The following were chosen based on data availability for the period 1960–2000:

  Algeria, Argentina, Australia, Austria, Belgium, Benin, Bolivia, Brazil, Burkina Faso, Cameroon, Canada, Central African Rep, Chad, Chile, China, Colombia, Congo Brazzaville, Congo Kinshasa, Costa Rica, Denmark, Dominican Rep, Ecuador, Egypt, El Salvador, Finland, France, Gabon, Ghana, Greece, Guatemala, Haiti, Honduras, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Ivory Coast, Japan, Kenya, Liberia, Madagascar, Malawi, Malaysia, Mauritania, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, Singapore, South Africa, South Korea, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Thailand, Togo, Trinidad, Tunisia, United Kingdom, United States, Uruguay, Venezuela, Zambia.