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Income, Growth, and Democracy

Looking for the main causal directions in the nexus

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Abstract:

The development of the political system of countries is noisy, but in the longer run a strong relation to the economy emerges in the cross-country data for income, growth, and the main democracy indices. Two main theories explain the causal directions in the nexus of these variables: (α) starts from the strong correlation between income and democracy, seeing income as the causal variable. It is the democratic transition. (β) starts from the much weaker correlation between democracy and economic growth, seeing democracy as the causal variable. This is a part of the primacy-of-institutions theory. The discussion needs (λ) a link-relation between growth and income. It connects the (α) and (β) theories, so that one may explain the other. The analysis looks at all six possible univariate relations between the three variables using kernel regressions on a large, unified data set. This method gives a clear picture. The strong α-relation can indeed explain the weak β-relation as spurious, but the weak β-relation predicts that the α-relation is very weak. Thus, (α) encompasses (β), but not vice versa.

Keywords: Democratic transition, primacy-of-institutions

Jel: O10, O47, O57

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The reader will know the large discussion about replicability and data mining in economics. The data for this paper are downloaded from four open sources (part 1 of references). The analysis uses the same small set of tools, and no ad hoc control variables. Thus, everything is transparent and easy to replicate.

1. Two alternative theories

It would be great if we could advise poor countries that if they turned into democracies, they would grow faster to become wealthy as well. Democracy is surely a good in itself, but the growth premium may be wishful thinking.

The paper studies the relation between the annual observations for three variables: Two are calculated from the *gdp*, the GDP/GNI per capita. *Income*, $\boldsymbol{y} = \ln(gdp)$, and *growth*, $\boldsymbol{g} = gdp/gdp_{-1} - 1$. $\boldsymbol{X}$ is the political system measured by a democracy index, where three are used, see Table 1 below. The structure of the relations between these variables has been much analyzed, with mixed results. Two basic theories with the reverse causal structure have emerged from the literature.

The α-theory is the ***democratic transition***, where the key relation is $X = X(y)$. It is the political part of the grand transition, where development is the change from the traditional steady state to the modern one. First, the economy diverges from the traditional steady state. Much later, it converges to the modern steady state. It gives the characteristic transition path to many variables. It looks as  or  , where the horizontal axis is income. Whether the transition variable increases or decreases depends on the scale. In the first difference, the figures become hump-shaped such as  or  . Transitions are non-linear relations – they move slowly, but they are strong in the longer run.

The β-theory about the ***primacy-of-institutions***, where the political system is an important institution explaining growth. Thus, the key relation is $g = g(X)$. We like to believe that democracy causes better decisions (for the population), but the decisions are made after a complex process, and it takes some time before higher growth may result. When democracy causes growth, democratic countries become wealthier, and income and democracy become positively correlated.

The two theories are connected by (λ) a ***link-relation*** between *g* and *y*. It may either be a transition in the growth rate, $g(y)$, or a relation where *y* is accumulated growth.

Both theories deal with fuzzy relations that are supposed to be ***general*** and may be strong in the ***longer run*** only, i.e., they are 'underlying' relations with long variable lags. They give a description of the development of the average country, but each country has a complex political history that gives fuzzy movements around the pattern, and long spells of a constant political regime.

As explained in section 2 the nature of the relations calls for careful choice of analytical

technique: The paper uses kernel regressions on large, unified data sets. This is a new way to use the tool of kernel regressions.

Section 3 is a survey of the literature and shows the basic stylized facts about the relations: The democracy indices and income are correlated due to one strong common factor.

The next three sections look at the two possible relations between each correlation. Section 4 shows how the two democracy-income relation looks, while section 5 looks at the two democracy-growth relations. The two growth-income relations are analyzed in section 6.

This allows an analysis of the causal structure in sections 7 and 8. The conclusion from the analysis is that the strong transition relation $X(y)$ dominates, and together with the weak transition in the growth rate $g(y)$ it generates a spurious relation between g and X.

Reporting the robustness of a relation is bulky, and articles must be terse. However, the key relations – $X(y)$ and $g(y)$ – have been extensively analyzed in other papers, surveyed in two notes. An Appendix (*App*) is available on the net documenting the robustness of the relations that have not been covered elsewhere.

Finally, a note about the causality terminology used. Macro relations connect variables that aggregate many indicators, which may have complex interactions. In addition, political systems have seemingly random quirks. Thus, the relations discussed are unlikely to have a simple one-way causal structure. Still, one ***causal direction*** may dominate – the purpose of the paper is to find that structure. Table 1 defines the variable and the data for easy references.

Table 1. Variables and data samples – all data are annual

Part 1: Variables		
Variable	Definition, *d* is first difference operator	Sources, see references
	gdp is the real GDP per capita, in international 2011 US$	Maddison project
y	Income, the natural logarithm to gdp	Calculated from *gdp*
g	Growth, $g = (gdp/gdp_{-1} - 1)$. Recall the approximation $g \approx dy$	Calculated from *gdp*
	X is an index for the political system, *X* = *F*, *P*, *V*	
F	FH index, average of civil liberties and Political rights	Freedom House
P	Polity2 index	Polity project
V	Polyarchy index	V-Dem project
Part 2: Data samples. Present and former OPEC countries are omitted (incl Bahrain and Oman)		
Main sample	*N* = 5,668. All observations where the five variables are available	
gT sample	*N* = 5,471. Extreme growth omitted. Thus, *g* is in interval [-10, 12]	
yT sample	*N* = 4,436. Modern steady state omitted. Thus, *y* is < 10	

Bahrain and Oman follow the OPEC pattern and are thus taken to be OPEC neighbors Table 3 converts the three democracy indices to the same C-scale. As $g \approx dy$, a set of calculations have looked at the three *dX* variables as well, but they proved to be weakly connected to the main story, so they are confined to *App*. The obverse/reverse division is made in sections 4 to 6 as mentioned. By a crude assessment, \$2023 ≈ 1.4\$2011. The data are downloaded in the early fall 2022 from four net-sites; see references part 1.

2. Method: kernel regressions on unified data sets

2.1 The fuzziness and long, uncertain lags of the relations studied

Economic theory normally assumes that relations between variables are sharp and have well-defined lags. This is surely not the case for the relations analyzed:

(a) Political systems are big cumbersome institutions that are hard to change. Most power holders try to consolidate their system. Thus, systems are often in temporary *status quo* equilibrium. The distribution of the democracy indices shows that systems have long spells of stability, see *App*. The average duration of a system is more than a decade, but the spells are of a highly variable length. Except at the steady states in both income ends where they are stable.

(b) When political regimes change, they do so in *jumps* set into motion by random *triggering events*. Reform processes may last a few years, but then they add up to a larger change.[2]

(c) Political decisions that affect the growth rate are normally made after a complex process that takes time. Often, reforms require a crisis to be accepted. Reforms rarely work immediately but have long lags that are difficult to predict. Many reforms are investments: A reform improving education will affect development, but it takes at least a decade before the positive effect appears. In the meantime, it is a cost. Liberalizations require a large and often painful restructuring of business that takes time. Other reforms have other time profiles.

Political systems are heavily influenced by history and have large spatial components. The correlation/factor analysis in section 3.3 shows that the data have a clear pattern with one strong common factor. That factor proves to be non-linear in sections 4 and 6.

Consequently, the analysis looks for non-linear underlying relations that are overlaid by a great deal of fuzziness. The tool used allows the relations to have long, variable lags, but still the relations are found to be strong in the average country and in the long run. Poor countries are authoritarian, and wealthy countries are democracies.

2.2 Tools to find an underlying relation with a soft lag structure

The relations examined are supposed to generalize. Hence, they are analyzed on unified annual data, where the data panels are stacked, so that each variable becomes one column. The seven columns are: country, year, income, growth and three democracy indices. With 137 countries and 46 years the data should have 6,302 rows, but some are missing. The dataset is a (7 *x* 5,668)

[2] Part II of Paldam (2021a) contains a study of this process using the Polity index. It shows that triggering events are very different and largely random in the perspective of economics. It also shows that the transition path is an attractor for the resulting jumps.

matrix with seven columns and 5,668 rows. This is the *Main* sample. It is analyzed with univariate kernel regressions. The relation $g(X)$ is analyzed, on the g and X column in the dataset, by the kernel $g = K^g(X, bw)$, where the only choice involved is the bandwidth, bw, where a simple pattern makes the choice robust.

The 5,668 rows in the Main sample have no 'natural' order, but each kernel regression sorts the rows by the explanatory variable. Thus, $g = K^g(X, bw)$ sorts the matrix by X. The sorting scrambles the remaining six variables – not only g but also countries and time. Thus, it analyzes the average country (within the bandwidth) and a wide range of lags.

Kernel regression is a common technique in many fields,[3] but not in the political economy of growth and development. Thus, a brief introduction to the way it is used may be useful. A kernel curve can be understood as a smoothed moving average with a fixed bandwidth, bw. If bw is chosen too small, the curve becomes too wobbly to interpret, and if bw is too large, the non-linearities vanish, but there normally is a wide range of bw's giving the same picture, see *App* for examples. The command (lpoly in stata) used provides a first estimate of a good bw, and 95% confidence intervals around the kernel-curve. The intervals are often amazingly narrow, like 1-2 percentage points. In this case the curve found generalizes the data well. Consequently, the unification of the panel is justified.

2.3 Tests of theories

The classical method to test a theory is to turn it into a formal model, operationalize and run regressions on that model. A recent count of the methods used in economics found that as of now about 60% of papers in economic journals are empirical. Of those, about 75% relies on the classical method that has the great virtue of producing results, see Paldam (2021b). However, it is a problem that the method is too flexible, not least as there is tradition to add ad hoc control variables to the estimating model. It is common to experiment with a dozen such variables giving very many possible model variants, of which a good many are tried. If economists behave as predicted by economic theory, they will surely publish the best estimates. Such datamining/overfitting often leads to exaggeration, see Paldam (2018).[4] Thus, in studies where it is possible, it is worth trying an alternative method.

Kernel regressions provide a best average curve surrounded by confidence intervals.

[3] Google scholar gave 1.9 million hits to 'kernel regression' in August 2023.

[4] It is a part of the large discussion of the replication crisis in the social and medical sciences. In August 2023 the term replication crisis had almost 600,000 hits in Google scholar, about 1/3 of the hits was to economics. An introduction to this literature is to look at the distribution (funnel diagram) of all published results in studies pertaining to estimate the same parameter. They are normally amazingly wide, see Ioannidis et al. (2017).

The kernel estimate is fully independent of the theory tested. If the theory predicts that the relation has a certain functional form, it is a test of the theory if a curve with the predicted form can be drawn within the confidence interval. The test is strong under two conditions: (i) the prediction is distinct, notably it is non-linear, and (ii) the confidence intervals are narrow.

Ad (i): (α) transition theory makes a distinct prediction as mentioned in section 1. (β) primacy-of-institutions theory makes vaguer predictions, as it only predicts that the slope is positive. However, it is important to see if the curve bends.

2.4 The kernel pair $K^x(y, bw)$ and $K^y(x, bw)$ may provide causal evidence

The relation (1) $x = x(y)$ assumes that y causes x, and the relation (2) $y = y(x)$ assumes that x causes y. The correlation $r(x, y)$ provides no help to choose between (1) and (2). Neither do the two regressions (2) $x = a + by$ and (3) $y = c + dy$, even when the estimates of b and $1/d$ look different. However, when the two variables are lagged, it gives causal information if the lags are sharp. This is the base for Granger-causal testing.

The pair of kernel regressions (4) $x = K^x(y, bw)$ and (5) $K^y(x, bw)$ are substantially different as the data are sorted by y in (4) and by x in (5). If the data are highly correlated, the two kernels will be similar. If the correlation is small, the two kernels will be almost orthogonal, and the data may contain both relations.

For a moderately high correlation (like 0.4 to 0.7), the two curves are often amazingly different, as the two sides of a coin; see e.g., Figures 1 and 2 below. If one looks as it should, while the other does not make sense, the first one is termed the *obverse* and the other the *reverse*. Here the obverse confirms its theory, and hereby the causality implied by the theory.

If the two variables are simultaneous, or explained by a third variable, it is likely that it is unclear which of the pair is the obverse. Thus, the kernel pair may give an unclear causal message, but so do other causality tests. However, the pair may also give clear evidence. This paper finds such cases.

3. Literature, data and a first look

3.1 Literature

It is a well-known fact that countries in the traditional steady state are/were authoritarian and countries in the modern steady state are democracies. An early explanation of the fact was Lipset (1959). His discussion is complex, but in the end his explanation is in line with the α-

theory and the relation, $X(y)$. For long, nobody disputed that the main causal direction is from y to X, but cases with alternative interpretations keep happening.[5]

However, Acemoglu *et al.* (2008) rejected the relation from *income* to X using panel regression on an L2FE-model explaining X by X lagged, fixed effects for countries and time, and income. The result is that the coefficient to income is zero.[6] It follows from sections 2 and 8.2 below that the L2FE-model is the wrong tool to catch transitions.

The β-relation, $g(X)$, is both politically important and weak, and thus an alluring prize for researchers trying to finally find a nice effect of X on g. Consequently, about two hundred papers exist. Two meta-studies cover this literature. Doucouliagos and Ulubaşoğlu (2008) survey the first 84 studies, concluding that β is small and of dubious significance. Colagrossi *et al.* (2018) cover 188 studies. They also find that β is small, but due to the increased sample, it is now significant. One of the most careful studies giving this result is Acemoglu *et al.* (2019).

In standard textbooks on economic growth such as Jones and Vollrath (2013) or Barro and Sala-i-Martin (2004), X plays no role. However, Acemoglu *at al.* (2005) survey the primacy-of-institutions theory. The main message of the survey seems to be that the economic system is important for development, and that the power structure determines what economic and political system a country gets or perhaps even chooses.

3.2 Variables, data and the six relations that may explain the three correlations

Table 1 above listed the variables X, y, and g and the data samples. OPEC countries have a different transition, and hence they are excluded. As F only starts in 1972, the data covers the 47 years from 1972 to 2018, but one year is used to give all first differences. The data in the main sample covers 137 countries. For every year and country included, the data matrix includes one observation for the five variables. The political indices F and P have no observations for colonies, and P is zero or blank when countries are in constitutional chaos or occupied. Potentially each of the eight level-variables has 46 x 137 = 6,302 observations, but 634 observations are missing, mostly because of countries that started after 1972. The biggest group of new countries are the old member-states of the Soviet Union and Yugoslavia that became independent 1990/91. The number of observations in the ***Main*** sample is N = 5,668.

[5] Sometimes a dictator has reformed the economy for the better or worse. The reader may think of generals Pinochet in Chile and Peron in Argentina. Similarly, democratic politicians such as Margaret Thatcher and Boris Johnson (from the same party) have had different effects on the economy of the UK.

[6] The author can confirm that this is indeed the case. The L2FE-model also rejects other transitions, e.g., it shows that there is no agricultural transition and no demographic transition; see Gundlach and Paldam (2010).

Table 2 surveys the relations studied below. It has a row for each of the three possible correlations between the variables α = cor(X, y), ß = cor(X, g), and λ = cor(y, g), giving the kernel pair that may provide an explanation. In the data set analyzed, kernel regressions give different pictures of the two relations of the pair, where one is assessed to be the obverse, while the poor relative is the reverse as indicated by an 'r' and a gray shading.

Table 2. The six relations that may explain the three correlations

Each row gives one of the three correlation and the pair of potentially explanatory relations						
Correlation	Obverse of the pair			Reverse of the pair		
	Relation	Kernel	Section	Relation	Kernel	Section
α = $r(X, y) \approx 0.67$	(α) $X = X(y)$	$K^X(y, bw)$	4.1	(αr) $y = y(X)$	$K^y(X, bw)$	4.2
ß = $r(X, g) \approx 0.07$	(β) $g = g(X)$	$K^g(X, bw)$	5.1	(βr) $X = X(g)$	$K^X(g, bw)$	5.2
λ = $r(g, y) \approx 0.12$	(λ) $g = g(y)$	$K^g(y, bw)$	6.1	(λr) $y = y(g)$	$K^y(g, bw)$	6.2

The correlations reported are from Table 4. Recall that X is a democracy index, y is income, and g is growth.

The two theories deal with the long run, but long time series are rare, while cross-country data are plentiful. The ***equivalence hypothesis*** claims that wide cross-country and long time series samples show the same picture. In the present case, it has been confirmed for the P- and V-index in a 2-century perspective; see *App*. [7] The three democracy indices aggregate different indicators and are conceptually different. They also use different scales, so they are converted to the C-scale that is in percent of the range of the index, as described in Table 3. The figures below show the relations for the three converted indices.

Table 3. The C-scale adjusting the three democracy indices to the same range and level

Index	Original	The two adjustments for the C-scale			Original	C-scaled
X	Range	Range adjustment	Level adjustment	Final	Av (std)	Av (std)
F	F_0: 7 to 1	$F_1 = 100(7 - F_0)/6$	$L^F = \text{Av}(P) - \text{Av}(F_1)$	$F = F_1 - L^F$	4.29 (2.02)	62.6 (33.7)
P	P_0: −10 to 10	$P_1 = 100(P_0 + 10)/20$	0	$P = P_1$	2.31 (7.24)	62.6 (35.8)
V	V_0: 0 to 1	$V_1 = 100V_0$	$L^V = \text{Av}(P) - \text{Av}(V_1)$	$V = V_1 - L^V$	0.479 (0.29)	62.6 (28.9)

The three democracy indices F, P, and V are the Freedom House index, Polity, and Polyarchy, respectively. The original indices are F_0, P_0, and V_0. After the range conversion, they become F_1, P_1, and V_1. After the level adjustment, they become F, P, and V used in the paper. Av is the arithmetic average. Both F and P score many countries as perfect democracies or autocracies, while *Polyarchy* does not use the extremes. Thus, the highest score reached is 0.926, indicating that full democracy is an ideal that has not been (cannot be) reached. The indices are not linear when they are used to explain each other, but for simplicity linear conversions are used. This causes a small fraction of the F and V scores to be slightly over 100. The paper disregards this problem.

[7] In all cases examined where that data allowed a check, equivalence holds, thus, it may be taken as the default when data does not allow a confirmation.

3.3 The basic structure in the data: two tables

Table 4 reports two correlation matrices of the five variables. The usual correlation, r, assumes normality, but the series are far from normal; see *App*. Hence, the correlations are also calculated with the Spearman rank correlation, ρ. In large samples of normally distributed data, it gives the same result. This is the case for most of the correlations, but $\rho(y, P)$ fits better into the pattern than $r(y, P)$. The table also shows that the correlations between the three democracy indices are above 0.9. Thus, they can be expected to tell the same story, as indeed they do.

Table 4. The correlations of the five unified series

Main sample		**Panel *r*:** Pearson's correlation					**Panel *ρ*:** Spearman's rank correlation				
N = 5,668		F	P	V	y	g	F	P	V	y	g
(1)	F	1					1				
(2)	P	0.898	1				0.916	1			
(3)	V	0.930	0.902	1			0.921	0.925	1		
(4)	y	0.671	0.569	0.682	1		0.688	0.653	0.674	1	
(5)	g	0.079	0.081	0.065	0.122	1	0.059	0.068	0.053	0.122	1

App reports correlations between country and within countries, and for the gT and yT samples. Recall that the three democracy indices are $X = F$, P, and V, while y is income and g growth.

The table gives three main correlations: $\alpha = r(X, y) \approx 0.67$, $\beta = r(X, g) \approx 0.07$, and $\lambda = r(y, g) \approx 0.12$. The product $\alpha\lambda \approx \beta$, while the product $\beta\lambda << \alpha$. This suggests that the α-relation and the λ-link may explain the β-relation, while (ii) the β-relation and the λr-link cannot explain the α-relation. The analysis below supports both suggestions.

Table 5. A factor analysis of the five variables

Main sample	Factor1	Factor2
Eigenvalue	3.171	0.108
Variable	Factor loadings	
F	0.959	-0.015
P	0.917	-0.160
V	0.965	-0.019
y	0.688	0.239
g	0.094	0.157

Table 5 is a factor analysis of the Main sample. It is, of course, closely related to the correlation analysis, but it adds one key point: The data contains one – and only one –

substantial common factor. It is Factor1, which has an eigenvalue of 3.17. The three democracy indices load highly to that factor. Income has a substantial load to Factor1 as well, but growth has not. The statistics for Factor2 are shaded in gray to indicate that it is of no consequence.

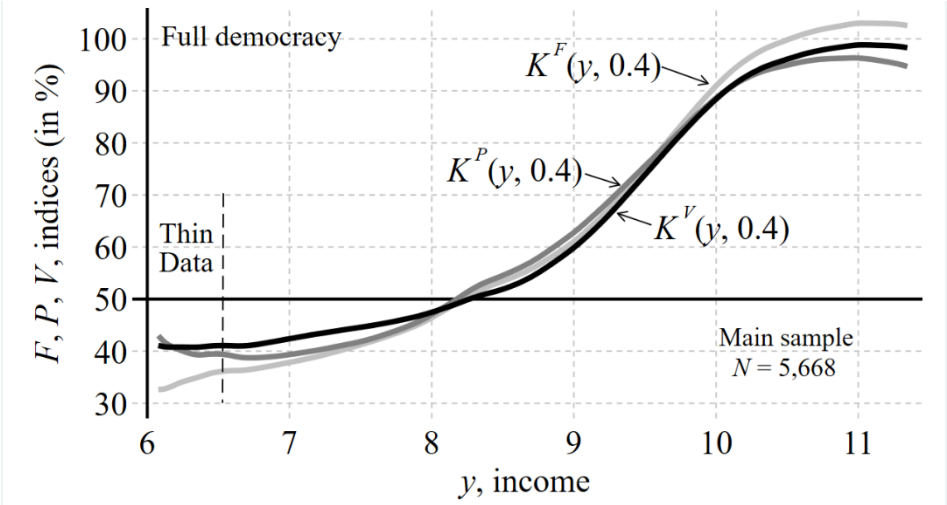
The next section turns to the relation between X and y. Table 5 predicts that one strong common factor should be found, and this is precisely what happens.

4. Relations (α) and (αr) that may explain the correlation α ≈ 0.67

4.1 (α) The transition relation, $X = X(y) \approx K^X(y, bw)$

The α-relation aims at explaining α = 0.67 from Table 4. Figure 1 shows the democratic transition estimated for $X = F$, P, and V. The F kernel is drawn in light gray, P is in dark gray, and V is in black. This color scheme is used throughout the paper. The three curves look similar, and precisely as transition curves should;[8] see also Table 6. Confidence intervals are shown in the *App*. They are typically 2-3 percentage points, widening at the ends, where the data are thin. Prior studies show that the curve is remarkably robust.[9]

Figure 1. (α) The democratic transition, $X(y)$



[8] The differences between the three curves at the top and the bottom on Figure 1 are due to the different ways the indices deviate from linearity; see the note to Table 3.

[9] The robustness of the democratic transition has been tested on eight democracy indices, see Paldam (2021a). It generalizes for 5-year periods and for country averages. The P and V data contain long time series, which confirms the pattern, see *App* and Paldam (2023). It has been estimated independently on the data for five decades and for the five main country groups. As far as the data allow the pattern generalizes; see Paldam (2021 and 2023). The only exception is the group of OPEC countries that became wealthy without a transition. OPEC countries have the reverse transition, as they get rich first. Then they do not need to change the socio-economic structure of society, and in most cases they do not. They use the new wealth to consolidate the old system, see Paldam (2024b).

Table 6. Descriptive regressions for Figures 1 and 2

	Panel (α): Figure 1 Regression: $X = ay + b$				**Panel (αr):** Figure 2 Regression: $y = aX + b$			
Sample	Variable	*F*	*P*	*V*	Variable	*F*	*P*	*V*
Main	*y*	18.98 (68)	17.10 (52)	16.52 (70)	*X*	0.02 (68)	0.02 (52)	0.03 (70)
N = 5,668	Con	-102.53 (-42)	-86.21 (-30)	-81.10 (-39)	Con	7.22 (291)	7.51 (287)	6.94 (251)
	R^2	0.450	0.324	0.465	R^2	0.450	0.324	0.465
gT	*y*	19.01 (68)	17.07 (52)	16.52 (69)	*X*	0.02 (68)	0.02 (52)	0.03 (69)
N = 5,471	Con	-102.45 (-41)	-85.63 (-29)	-80.93 (-39)	Con	7.20 (284)	7.50 (278)	6.93 (244)
	R^2	0.455	0.328	0.468	R^2	0.455	0.328	0.468
yT	*y*	15.96 (40)	15.19 (31)	13.27 (39)	*X*	0.02 (40)	0.01 (31)	0.02 (39)
N = 4,436	Con	-78.62 (-23)	-71.02 (-17)	-55.45 (-20)	Con	7.44 (289)	7.67 (308)	7.26 (242)
	R^2	0.261	0.181	0.257	R^2	0.261	0.181	0.257

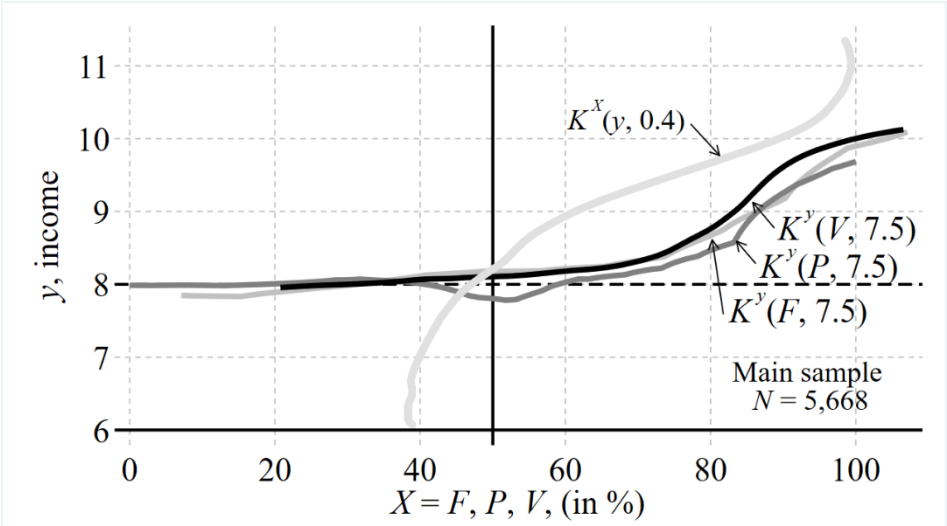
The regressions are linear approximations to the curves on the figures. Con means Constant. The parentheses hold t-ratios. Section 7.2 uses $X = 16y - 80$ as a good linear approximation for the α-relation.

All (non-OPEC) high-income countries are democracies. The only real exception is Singapore, due to the long rule of the (largely benevolent) autocrat, Lee Kuan Yew.

4.2 (αr) The reverse transition relation, $y = y(X) \approx K^y(X, bw)$

Figure 2 shows the three αr-curves. They are much flatter than the α-curves in Figure 1. For an easy comparison, the graph includes the average α-curve, using the axes of the αr-curves.

Figure 2. (αr) The reverse transition, *y*(*X*). Including (α), *X*(*y*)



The thin light gray α-curve is $K^X(y, 0.4)$, which is the average of the three curves from Figure 1.

As the $\alpha = r(y, X) \approx 0.67$, the α- and αr-curves have some relation. However, the three αr-curves are flat until X reaches 75. Hence, the $y(X)$-curves show nothing for most of the X-range. It makes little sense to find that most political systems give an income of 8 (which is 4,000 US$). Thus, the αr-curves are weak reflections of the α-curves, not the other way around. Hence, (α) is the obverse relation, while (αr) is its poor reverse relation. The αr-relation appears when (β) is inserted in (λr) $y = y(g(X)) = y(X)$; see Table 9. Thus, the αr-curves illustrate that the β-theory cannot explain the α-theory, as further discussed in section 7.

4.3 The timing of the transition

Another way to view the evidence is to consider the timing of the democratization in the process of the grand transition. Figure 1 shows that democratization happens late in the grand transition. It starts softly and becomes significant after the income level of 8 [$ 4,000] is reached. The transition curve is steepest in the y-interval from 9 to 10 [$ 11,000, $ 30,000].[10] This is the income level that was reached by countries like Chile, South Korea, Taiwan, Spain, and Portugal, when they democratized. They had been democracies before, but it did not last. However, it seems that at present democracy in these countries has consolidated.

In addition, Figure 2 shows that the possible effect on growth from the political system only happens at the end of the democratization. Thus, it appears that first countries develop, and when they have reached a substantial income level, they turn into democracies. This is evidence in support of the α-theory and against the β-theory.

Finally, it should be mentioned that previous work studies the relation between income and democracy by the formal ***DP-causality test*** and finds significant long-run causality from income to democracy, while causality the other way is dubious.[11]

5. Relations (β) and (βr) that may explain the correlation ß ≈ 0.07

5.1 (β) The primacy-of-institutions relation, $g = g(X) \approx K^g(X, bw)$

The three curves on Figure 3a have positive slopes that look linear, but the confidence intervals are wide. Figure 3b uses the *gT* sample, without extreme growth observations. It has narrower confidence intervals. See *App* for additional calculations.

[10] The Maddison data used 2010 international US$. By a crude assessment one 2011 $ equals 1.4 2023 $, which is used in the examples.

[11] It is a TSIV-test (for a two-stage instrument variable) using a set of DP-variables that show the development potential of countries long before the grand transition started. The test is run for annual data every year from 1820 to 2016. The DP-causality test is joint work with Erich Gundlach; see Paldam (2021a).

Figure 3. (β). Growth explained by democracy, $g(X)$

Figure 3a. Main sample

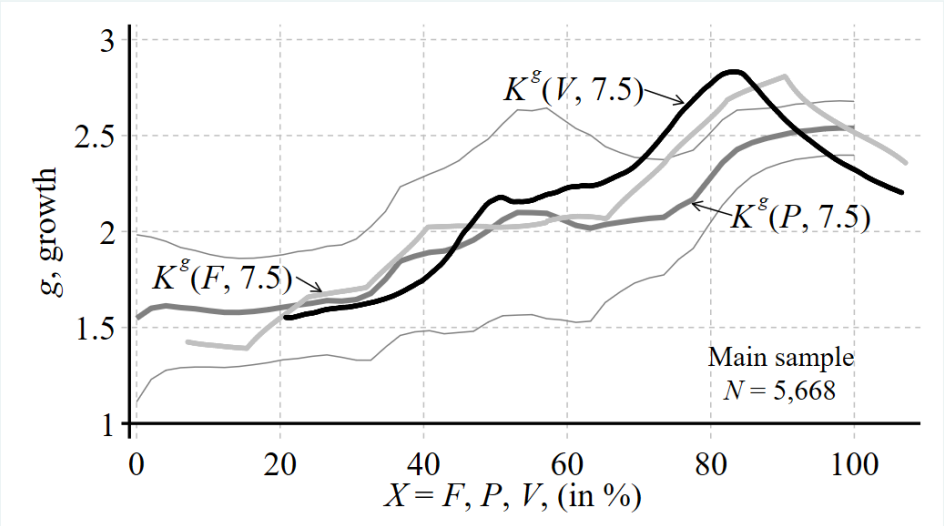
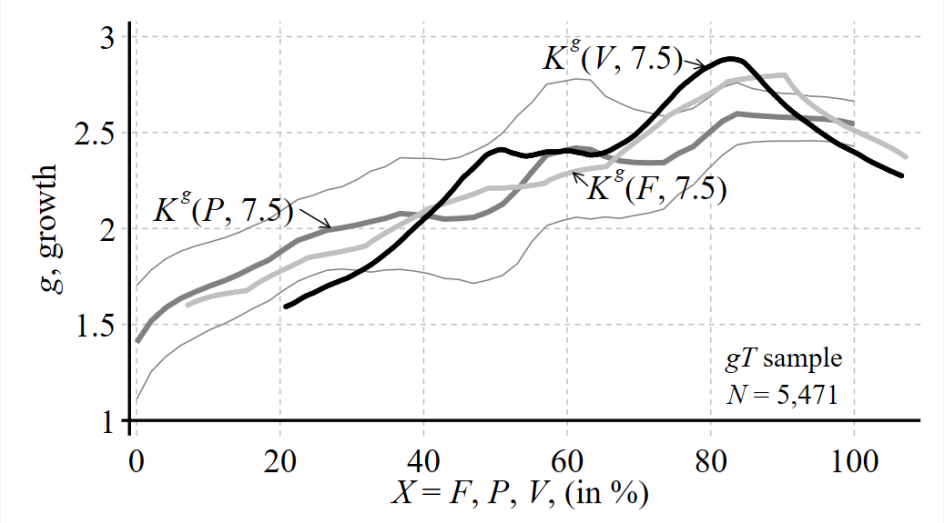


Figure 3b. gT sample (growth truncated to [-10, 12])



The 95% confidence intervals are for the $g(P)$ curve.

The curves on Figure 3 bend at the top, for $X > 80$. The bend is significant for both the F and the V-indices, but not for the P-index. Thus, it is a bit dubious if Figure 3 confirms the bend. In Table 7, the coefficients to the Xs are significant but small, and so are the R^2-scores.

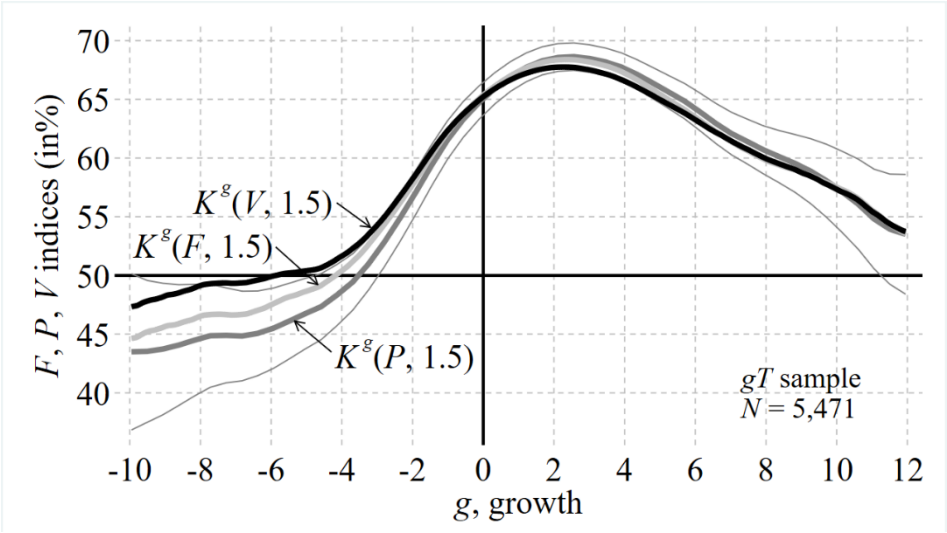
The small coefficient to the indices and the poor fit of the regressions in Table 7 are well in accordance with the literature, as summarized in section 3.1.

Table 7. Descriptive regressions for Figures 3 and 4

	Panel β: Figure 3 Regression: $g = aX + b$				**Panel βr:** Figure 4 Regression: $X = ag + b$			
Sample	Variable	*F*	*P*	*V*	Variable	*F*	*P*	*V*
Main	*g*	0.011 (6.0)	0.011 (6.1)	0.011 (4.9)	*X*	0.55 (6.6)	0.60 (6.1)	0.39 (4.9)
N = 5,668	Con	1.40 (10)	1.43 (11)	1.43 (9)	Con	61.44 (126)	61.34 (119)	61.79 (148)
	R^2	0.006	0.007	0.004	R^2	0.006	0.007	0.004
gT	*g*	0.009 (5.9)	0.01 (7.0)	0.01 (5.7)	*X*	0.73 (5.9)	0.91 (7.0)	0.60 (5.7)
N = 5,471	Con	1.69 (16)	1.62 (16)	1.63 (14)	Con	61.58 (116)	61.11 (109)	61.78 (136)
	R^2	0.006	0.009	0.006	R^2	0.006	0.009	0.006
yT	*g*	0.016 (8.5)	0.01 (8.9)	0.02 (8.5)	*X*	0.98 (8.5)	1.18 (8.9)	0.83 (8.5)
N = 4,436	Con	1.40 (12)	1.45 (13)	1.21 (8.7)	Con	52.07 (99)	52.83 (88)	53.20 (121)
	R^2	0.016	0.018	0.016	R^2	0.016	0.018	0.016

See note to Table 6. Section 7.2 uses $g \approx 0.01X + 1.7$ as a good linear approximation for the β-relation. *App* for the *gT* sample shows that a squared term increases the R^2-score to 0.035.

Figure 4. (βr) Democracy explained by growth, *X*(*g*)



Confidence intervals are for the *P*-curve. The curves for the Main sample are in *App*.

5.2 (βr) The reverse primacy-of-institutions relation, X = X(g) ≈ K^X(g, bw)

The βr-relation also aims at explaining (β) = 0.07 from Table 5. Figure 4 shows the curve for the *gT* interval, where the curve has a clear hump shape that points to a first difference transition curve. Thus, instead of *y* at the axis that would give the transition curves of Figure 1, Figure 4 has $dy \approx g$ on the axis. This makes the *X*(*g*)-curve hump-shaped. However, note the large fall in the R^2 when the corresponding cells in Tables 6 and 7 are compared.

The *App* shows the βr-curve for all observations. Outside the *gT* range [-10, 12] the confidence intervals become wider, and the curve shows big fluctuations. It also shows that the

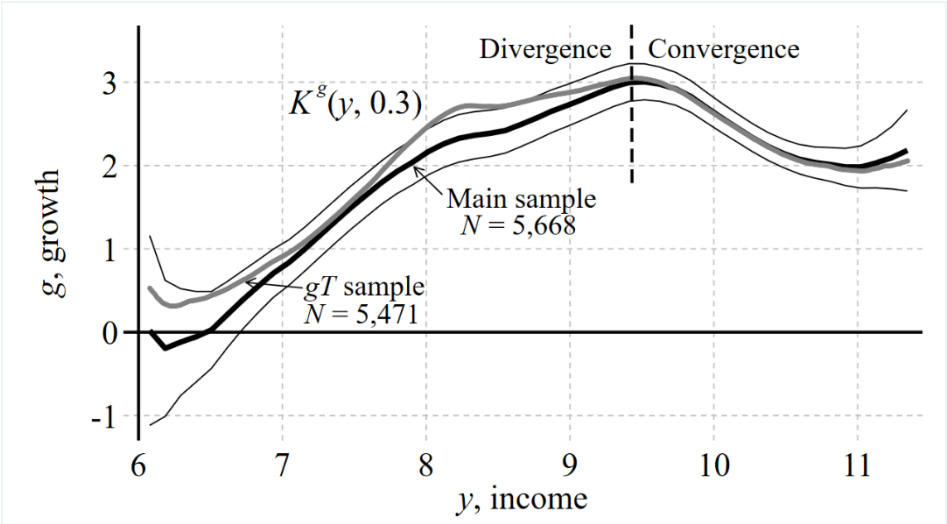
B- and Br-curves are almost orthogonal, so they are almost independent. While Figure 4 can be explained as secondary consequence of the α-theory, it is not likely to be a primary relation. Consequently, (β) is the obverse and (βr) the reverse relation that is fully explained by the transition in Figure 1.

6. Relations (λ) and (λr) that may explain the correlation λ ≈ 0.12

6.1 (λ) The link, g = g(y) ≈ K^g(y, bw)

The *g*(*y*) curve is a typical (first difference) transition curve, with the characteristic hump shape of such curves.[12] Figure 5 shows how it looks in the data sample used. It is a fine example of this transition curve. Figure 5 includes the curve for the *gT* sample, where growth is truncated for 197 extreme growth rates. It is (almost) within the 95% confidence interval. Table 8 also shows the linear curve for the *yT* sample, where *y* < 10. Here the slope is higher, as the countries included are diverging.

Figure 5. (λ) The transition in the growth rate, *g*(*y*)



The grand transition moves production from less productive traditional sectors to more productive modern sectors. The good old two-sector model of development neatly formalizes this process. The process is slow at the start, as the modern sector is small and has a low

[12] The robustness of the transition in the growth rate is analyzed in Gundlach and Paldam (2022). It holds both in cross-country samples and long time series. It is robust for different country groups and time units.

absorptive capacity.[13] At the end, the process slows down too, as the traditional sector becomes so small that it can only deliver little to the modern sector. Income is exogenous for the transition as it is for the democratic one.

Table 8. Descriptive regressions for Figures 5 and 6

		Panel λ: Figure 5		**Panel λr:** Figure 6
Sample	Variable	Reg: $g = ay + b$	Variable	Reg: $y = ag + b$
Main	y	0.494 (9.2)	g	0.030 (9.2
N = 5,732	Con	-2.192 (-4.7)	Con	8.637 (504)
	R^2	0.015	R^2	0.015
gT	y	0.417 (10)	g	0.044 (10)
N = 5,528	Con	-1.394 (-3.8)	Con	8.619 (460)
	R^2	0.018	R^2	0.018
yT	y	0.863 (15)	G	0.053 (15)
N = 4,461	Con	-4.910 (-9.9)	Con	8.207 (496)
	R^2	0.046	R^2	0.046

See note to Table 6. Section 7.2 uses $g = 0.45y - 1.5$ as a good linear approximation for the λ-relation.

The relation is also known as the absolute convergence relation in cross-country growth regression literature; see, e.g., Chapters 11 and 12 in Barro and Sala-i-Martin (2004). This literature is keen on estimating and discussing the top part of the curve – in the interval [9.5, 11] for y – where the countries do converge. However, countries diverge in the interval [6, 9.5].

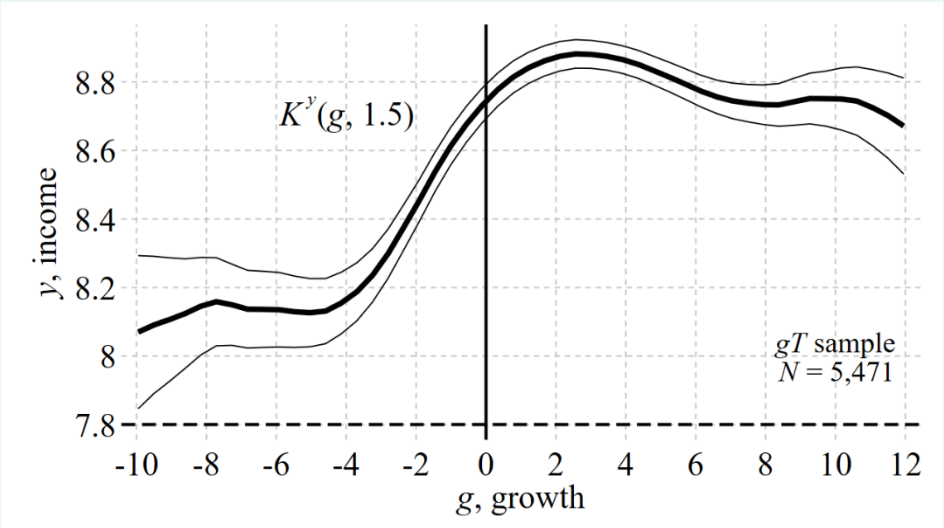
6.2 (λr) The reverse link, $y = y(g) \approx K^y(g, bw)$

Income, y, is accumulated growth. As y is the natural logarithm to GDP per capita, $g \approx dy$ is a fine approximation. Hence, $y \approx y_{-1} + g \approx y_{-2} + g + g_{-1} \approx \sum_{i=0}^{-\infty} g_i$, so that Lr is the start of an accumulation relation. Thus, the relation $y = y(g)$ should have a good fit.

However, when economic fluctuations are added, things get more complicated, as it makes the λr relation less easy to explain as a simple accumulation process, especially as the autocorrelation in the growth rate quickly dies out, see *App*. Thus, it is not so surprising that the λr-relation has a poor fit.

[13] The newest version of the model is Lucas (2007). Gundlach and Paldam (2020) contains a set of simulations with that model. It appears that it always gives a hump-shaped $g(y)$-relation. The model leads to large structural changes that are always painful, and much may go awry, so the explanatory power of the relation is small.

Figure 6. (λr) Income explained by growth



The curve for all growth rates is in App.

When the full sample is used the picture becomes wilder and the confidence intervals widen substantially, see *App*. It is still not a straight line, but it does have a positive slope, as it should. However, it is strange that the curve on Figure 6 and in *App* has a negative slope for $g > 1$. It suggests that high growth rates are mostly associated with low ones in the neighboring years. In addition, the autocorrelation in the growth rate is modest, as already said.

Furthermore, it is a problem for the $y(g)$-relation that the range of the y-values explained by the growth rate is from 8 to 9, which are *gdp* levels from $ 4,000 to $ 11,000. Thus, the curve in Figure 6 makes little sense.

The *App* shows that the curves on Figures 5 and 6 are almost orthogonal, so they are almost independent. When (λ) and (λr) are compared, the empirical fit of (λ) is better, and gives a graph that makes sense. In addition, the confidence intervals are satisfactory on Figure 5, and the figure is robust to growth outliers. It is concluded that (λ) is the obverse relation.

7. The structure of the six relations

This section has two aims. Section 7.1 summarizes the structure of the relations suggested by the classification into obverse and reverse relations in the three pairs. Section 7.2 assesses that the α-theory can explain the β correlation, and section 7.3 assesses that the β-theory cannot explain the α correlation.

Table 9. Two equations giving the third, and one variable is exogenous

Correlation		**Panel I**: Equation (e1) inserted in (e2)							**Panel II:** One exogenous				
from Table 3		Eqs	(e1)		(e2)		Gives (e3)		Eqs	Exg	(e1)		(sp)
Part 1: Relations related to the α-theory, i.e., relations with A													
α	0.67	(1a)	(α)	$X(y)$	(β)	$g(X)$	(λ)	$g(y)$	(1c)	y	(α)	$X(y)$	(β)
λ	0.12	(1b)	(λ)	$g(y)$	(βr)	$X(g)$	(α)	$X(y)$			(λ)	$g(y)$	
Part 2: Relations related to the β-theory, i.e., relations with B													
α	0.67	(2a)	(αr)	$y(X)$	(λ)	$g(y)$	(β)	$g(X)$	(2c)	X	(αr)	$y(X)$	(α)
β	0.07	(2b)	(β)	$g(X)$	(λr)	$y(g)$	(αr)	$y(X)$			(β)	$g(X)$	

Recall the correlation α is $r(X, y)$ between democracy and income, β is $r(X, g)$ between democracy and growth. and λ is $r(y, g)$ between income and growth. The obverse relations are un-shaded, while the reverse relations are shaded as in Table 2. (sp) indicates a spurious correlation.

7.1 The four parts of Table 9

Table 9 lists six univariate relations. It has two panels to the left and right, and two parts at the top and bottom. Each line 'Eqs' is an equation system that suggests a causal structure.

Panel I: Reports four equation systems (1a), (1b), (2a), and (2b), which consist of three equations (e1), (e2), and (e3). In each system, (e1) is inserted in (e2) to give (e3). If two equations are estimated, a third can be calculated. If it is estimated too, it gives a consistency check. When the estimates are consistent, it suggests a causal structure. The suggestion is strengthened when the relations are supported by economic theory.

Panel II: Reports two equation systems (1c) and (2c), where one variable is exogenous. Here the system becomes two equations with two variables. The third relation is (sp), i.e., a spurious correlation that can be checked for consistency.

Part 1 for *y* primarily considers the α-theory. Transition theory suggests (1a) and (1c), where (α) and (λ) are the key relations. (1a) suggests that both (α) and (β) are true; this generates (λ). (1c) suggests that both (α) and (λ) are transitions; here B is spurious. (1b) has the reverse causal structure than (1a), and (2b) relies on (βr) to reach (α). This is not supported by economic theory, and (βr) is a weak relation. Thus, (1b) is ruled out.

Part 2 for *X* primarily considers the β-theory. The primacy-of-institutions theory is (2b) or (2c). (2b) relies on (λr) to generate (αr), while (2c) relies on (αr) to explain *y*. Neither (λr) nor (αr) obtained much empirical support, so the β-theory has a problem, which is discussed in section 7.3. A third part making *g* primary was excluded as unreasonable.

Eqs (1a) and (1c) are straightforward and seem reasonable. Thus, only two of the interpretations work well to give all three variables: Eqs (1a) where (α) and (β) are two causal relations, and (λ) follows. Eqs (1c) where *y* is exogenous, so (α) and (λ) are causal relations, and then (β) is spurious. The estimate of (β) is less convincing than the estimate of (λ).

Furthermore, (λ) has a stronger foundation in economic theory than (β). It follows that Eqs (1c) is the preferable system; it is easy to interpret and well in accordance with the empirics.

Consequently, the α-theory sees *y* as primary relative to *g* and *X*. This idea comes from the theory of economic growth that explains trends in growth and income by the predetermined investments in human and physical capital and technology.[14] Endogenous growth theory explains technology by research budgets and human capital. This means that the trend in income is exogenous relative to the transition path.

The β-theory sees the political system as primary relative to *y* and *g*. It is due to political decisions that in the last resort are due to an unobserved variable: the ***power structure*** in society. However, to get to the last variable, *y*, requires (αr) or (λr), which are problematic, as shown in section 4.2 and 5.2, respectively.

7.2 Can (α) and (λ) explain the correlation β = 0.07?

The two relations from (1c) are:

(α) $X = X(y)$ from Figure 1 is flat at the two ends but has a positive slope in-between

(λ) $g = g(y)$ from Figure 4 also has a positive slope for most of its range, though it bends a bit backward at the top range.

When relations (α) and (λ) are seen together, one gets a spurious (*g, X*)-relation that is positive over most of its range, but it bends downwards at the top, just as Figure 3.

The linear approximations to the two equations are two equations with two unknowns:

(1) $X = a + b\,y$, where $b > 0$. It follows that $y = (X - a)/b$

(2) $g = c + d\,y$, where $d > 0$. Inserting *y* in (2) yields $g = c + (X - a)\,(d/b)$, thus *g* becomes:

(2b) $g = (d/b)\,X + (c - ad/b)$, which is a linear relation with a positive slope (d/b)

The linear estimates from Table 6 are approximately $X = 16y - 80$, and from Table 8 yields $g = 0.45y - 1.5$. Inserting in (3) yields $g = 0.03y - 9.6$. This differs a bit from the estimate in Table 7, $g \approx 0.01X + 1.7$. However, the fit of (2) is poor, and it is hump-shaped, so the linear approximation is poor too. Note that the R^2 of (1) is about 0.4, while it is about 0.015 in (2), so the product is 0.006 as in the β-relation. Consequently, the α-relation is consistent with the β-relation. In this interpretation the β-relation is a spurious consequence of the democratic

[14] Technology is a broad concept. The analysis assumes that it does not include the political system.

transition and the transition in the growth rate. Thus, the β-relation is a typical consequence of the general confluence of time series caused by the grand transition.[15]

7.3 Can (β) and (λr) explain the correlation α = 0.67?

The two relations from (2c) are:

(i) (β) $g = g(X)$ from Figure 3 is now seen as causal. It has a positive slope.

(ii) (λr) $y = y(g)$ from Figure 5 has a positive slope as well, but it is not a convincing model as just discussed.

When (i) is inserted in (ii), it becomes the reduced form relation $y = y(g) = y(g(X)) = y(X)$ estimated in section 4.2. Both relations (i) and (ii) have a positive slope and so has A. Once again, the linear approximations to the two equations allow a solution for the two unknowns:

(3) $g = aX + b$, where $a > 0$, so

(4) $y = cg + d$, where $c > 0$. When (3) is inserted into (4), it gives $y = c\,(aX + b) + d$ so that

(5) $X = y/(ca) - (b/a) - d/(ca)$, which is the α-relation. It has a positive slope.

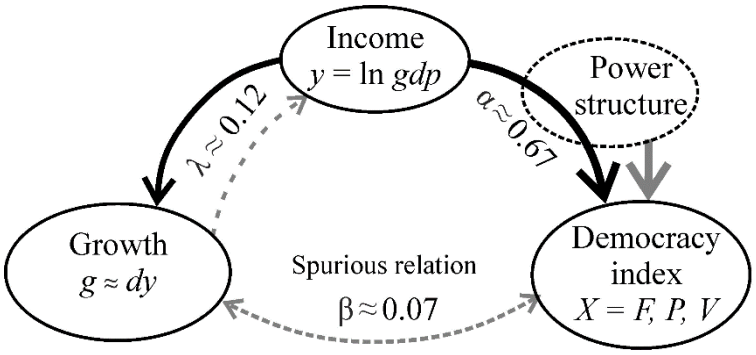
It is a problem that the R^2 for (i) is about 0.006, as seen from Table 6, and R^2 for (ii) is about 0.017 in Table 7. If the two R^2's are combined, the result is $0.006 \times 0.017 = 0.0001 \approx 0$. Thus, there is no way to get to the powerful α-relation from the weak β-relation and the dubious λr-relation. It means that if (β) is taken to be a causal relation, neither (λ) nor (λr) is enough to get to (α). Thus, the strong correlation, α, requires another explanation. The α-theory is the leading theory to do that.

8. The main causal direction: explaining the transition path

Figure 7 summarizes the empirical inquiry. The α-theory is the black arrows. Income explains X (a democracy index) and g (the growth rate) as transitions. Thus, $\beta = r(g, X) \approx 0.07$ is spurious. The β-theory is the gray arrows of the primacy-of-institutions theory. It sees X as causal for g and explains income as accumulated growth. Thus, the $\alpha = r(y, X) \approx$ is spurious. However, the two weak relations can only carry a small fraction of the strong α-correlation.

[15] Further work has studied the effect of the relative democracy $X - K^X(y, bw)$ and has shown that it has virtually no effect on the growth rate; see Paldam (2024a).

Figure 7. Summary of the causal structure



The spurious (g, X)-relation leaves very little to a relation from X to g. Recall that $\alpha = \text{Cor}(y, X)$, $\beta = \text{cor}(g, X)$, and $\lambda = \text{cor}(y, g)$ are the three correlations.

Thus, the analysis rests on two transition relations: $g = g(y)$ and $X = X(y)$. They are underlying relations overlaid with a great deal of fuzziness. Both relations were stable in the traditional steady state, where growth rates were 10-20% per century. And it is stable in the modern steady state as well, where countries converge to a growth rate of about 2% per year (though growth has recently been a little lower).

The transition in the growth rate, $g(y)$, follows from the good old two-sector model of development. The mechanism can be sketched as follows: The modern sector starts as small islands of modern technology. Development means that the islands grow to eventually absorb the whole economy. In the beginning the islands could not absorb much. At the end, the traditional sector is so small that it cannot provide much to absorb. But in the middle the change that gives extra growth may be large.

The democratic transition $X(y)$ is much stronger. To explain why it (always) happens requires a general mechanism: the grand transition should reduce the basis of the old power structure in a systematic way, so that it collapses, and generate a new basis that gives a mass political system. These mechanisms are the subject of Paldam (2023). A well-known model of the traditional political system is the three pillars model, where the pillars are a hereditary king, a hereditary nobility, and a national Church. The economic basis for these pillars was a *feudal* structure, including the tithe, and as regards the power of the Church, strong religiosity. Both the king and the Church were big landowners.

Two strong transitions are the agricultural transition that reduces the share of agriculture in the economy from over 50% to less than 5%, and the religious transition that reduces religiosity between three and five times. Thus, the power structure in society changed dramatically and *in the same way* in all countries going through the grand transition.

Part of the modernization was the creation of a large middle-class that became the main recipient of the huge increase in human capital. The middle-class lives in towns, so it can exercise strong political pressures. It demanded mass representation, making democracy the logical outcome.

These mechanisms are at work everywhere, but old power holders often tried to hold on to the old system, so the changes happened in bounds and leaps. However, in the longer run they will always work. The transition path is an average that is a function of income. Part II in Paldam (2021a) shows that the path acts as an attractor for jumps that happen due to random triggering events. It is a philosophical question if this process can be termed causal, but the author thinks that it should!

These processes lead to an econometric point: Income increases around almost linear lines, while the democracy indices are defined within limited intervals. The system jumps happen at random intervals, and the transition is a non-linear process. It depends upon the initial situation which way the system jumps. A hazard model may be developed for this process, but it is not easy to catch with a standard panel regression, such as the L2FE-model; see section 3.1. Thus, it is no wonder that such panel regressions work poorly, as already mentioned.

9. Conclusions. A clear result from a special method

The paper studies the causal connections between income, growth, and the political system. They are explained by two theories: (α) the democratic transition and (β) the primacy-of-institutions. They give the reverse explanation of the connection between income and democracy.

The analysis uses the unusual technique of univariate kernel regression on large, unified data sets. When kernel regressions are run for a causal pair, such as $y(X)$ and $X(y)$,[16] they often look different. It is frequently easy to see that one of the pairs is the ***obverse***, while the other is the ***reverse***. The obverse is chosen by two criteria: (i) it has a stronger foundation in economic theory, and (hence?) (ii) it has a better fit. That is, the curve looks as it should according to a theory, and the confidence intervals are narrow, while the reverse looks like a poor reflection. The analysis of kernel pairs may give unclear results, like other methods to study causality, but when the results are clear, it is evidence that helps the researcher identify the main causal direction between the two variables.

The pair $X = X(y)$ and $y = y(X)$ is analyzed by Figures 1 and 2. Here $X(y)$ yields the

[16] Recall from Table 1 that y is income, g is growth, and X is one of the three leading democracy indices.

same perfect transition curve for all three democracy indices. It is surely the obverse, while $y(X)$ is the poor reverse. From this finding, the analysis goes on to show that the α-theory fully explains the B-finding as spurious, while the β-theory can only explain a small fraction of the A-finding. Thus, the technique gives a clear result in the case analyzed. This is surely not all available information on the relation between income, growth, and democracy, but hopefully the reader will agree that it is a solid piece of evidence.

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