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Abstract:

Acemoglu, Johnson, Robinson, and Yared (2008) demonstrate that estimation of the standard adjustment model with country-fixed and time-fixed effects removes the statistical significance of income as a causal factor of democracy. We argue that their empirical approach must produce insignificant income effects and that a small change in the estimation process immediately reveals the strong effect of income on democracy.

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1.   The Empirical Model

A central result in the political economy literature has been that higher income per capita causes democracy. This modernization hypothesis has been estimated for pure cross-country models and for panel estimates of adjustment models.[1] Both types of models have been found to predict about the same size of the long-run effect of income on democracy.

Acemoglu, Johnson, Robinson, and Yared (2008; hereafter AJRY) claim that the correlation between income and democracy is spurious, except in the very long run. AJRY demonstrate that estimation of the standard adjustment model with country-fixed and time-fixed effects removes the statistical significance of income as a causal factor of democracy. We argue that their empirical approach must produce insignificant income effects and that a small change in the estimation process immediately reveals the strong effect of income on democracy.

The empirical model of AJRY is:

$$d_{it} = \alpha d_{it-1} + \gamma y_{it-1} + \mu_i + \delta t_t + u_{it} \, , \tag{1}$$

where the dependent variable d_{it} is the democracy score of country i in time period t, and d_{it-1} is democracy lagged by one time interval. The main variable of interest is lagged income, y_{it-1}. The parameter γ identifies the presumed effect of income on democracy. The fixed effects μ_i and δt_t are represented by country and time dummies, and u_{it} is an error term, with $E(u_{it}) = 0$ for all i and t.

Equation (1) leaves very little of the variation in the democracy score to be explained by the variation in income.[2] The lagged democracy score captures the inertia, the country-fixed effect eliminates the cross-country variation, and the time-fixed effect eliminates the common element in the variation over time. Hence, income can only come to play in the country specific short-run movements in the democracy score. This variation will necessarily be small, especially if equation (1) is estimated for a short time interval of, say, five years.

If the two-fixed effects are proxies for income, equation (1) cannot be used to test the modernization hypothesis. Therefore, we estimate equation (1) with a two-step procedure that reveals the correlation between income and the unexplained variation in the democracy score.[3] Controlling for lagged democracy, the unexplained variation in the democracy score is given by the two fixed effects and the "true" error term. The first step is to exclude income from equation (1) and to estimate

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1. The present note only looks at empirical results. The literature and the empirical findings have been surveyed in Paldam and Gundlach (2008).

2 The democracy score is a step-variable that changes only occasionally, so it is difficult to explain by an (almost) continuous variable such as income.

3. The two-step procedure used is developed in the empirical literature on the relative productivity of multinational enterprises, see, e.g., Griffith and Simpson (2003) and Criscuolo and Martin (2005).

$$d_{it} = \alpha d_{it-1} + \mu_i + \delta t_t + u_{it}, \tag{2}$$

using the fixed-effects (within) estimator. From the estimate of (2) two alternative measures of the unexplained variation in the democracy score are calculated. The first is *the country-fixed effects residual*, z_{it}^c:

$$z_{it}^c = \hat{\mu}_i + \hat{u}_{it} = d_{it} - \alpha d_{it-1} - \hat{\delta} t_t,$$

which allows us to estimate

$$z_{it}^c = \beta^c + \gamma^c y_{it-1} + \varepsilon_{it}^c. \tag{3}$$

The second is *the time-fixed effects residual*, z_{it}^t:

$$z_{it}^t = \hat{\delta} t_t + \hat{u}_{it} = d_{it} - \alpha d_{it-1} - \hat{\mu}_i ,$$

which allows us to estimate

$$z_{it}^t = \beta^t + \gamma^t y_{it-1} + \varepsilon_{it}^t. \tag{4}$$

The second-step equations (3) and (4) give an estimate of the correlation between income and each of the two fixed effects. If income is closely correlated with one or both of the fixed effects residuals, estimation of equation (1) is likely to produce insignificant income effects, but cannot rule out a causal effect of income on democracy that may work through one or both of the two fixed effects.

To replicate the AJRY result, democracy is measured as the normalized [0,1] composite democracy index from the Polity IV data set (Marshall and Jaggers 2006), and income is measured as log GDP per capita.[4] The AJRY specifications with time intervals of 5-year, 10-year, and 20-year data are applied to an unbalanced base sample for 1960-2000, as in AJRY. In addition, we look at a sample with 50-year data.[5]

2.   Empirical Results

Tables 1-4 present estimates of equations (1) to (4) in columns (1) to (4), respectively. Column (1) in Table 1 replicates the main result of AJRY (see their Table 3, columns (2), (7), and (9)). Our estimated coefficients of lagged democracy and lagged income per capita are similar to the estimates

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4. We use the Maddison (2003) data, while AJRY use the PWT data, but this difference does not appear to affect the results.
5. The start data of the panel refers to the dependent variable. Hence, $t = 1960$ and $t-1 = 1955$ for the 5-year data sample; $t = 1960$ and $t-1 = 1950$ for the 10-year data sample; $t = 1980$ and $t-1 = 1960$ for the 20-year data sample; and $t = 1950$ and $t-1 = 1900$ for the 50-year data sample.

by AJRY. With lagged democracy and fixed effects for countries and time as explanatory variables, the coefficient of income is small in size and statistically insignificant.

Column (2) shows the estimation results for equation (2), where income is excluded. The parameter estimate for lagged democracy and the statistical variation explained by the model remain more or less unchanged.

The next two columns show the effect of log GDP per capita on our two alternative measures of the unexplained variation in the democracy score as defined by equations (3) and (4). Not surprisingly, we find that income is strongly correlated with the country-fixed residual. The estimated coefficient is statistically significant at the 1 percent level (column (3)). Income is more weakly correlated with the time-fixed effects residual (column (4)) due to the fact that part of the time series variation is already picked up by the lagged adjustment variable.[6] Consequently, the time-fixed effects are excluded to get the "within estimate":[7]

$$d_{it} = \alpha d_{it-1} + \gamma y_{it-1} + \mu_i + u_{it}, \tag{5}$$

Estimation of equation (5) produces a within-country effect of income on democracy that is even larger than the cross-country effect reported in column (3). We interpret these results as demonstrating that the country-fixed effects and the time-fixed effects are good proxies for the effect of income on democracy. If they are both included in an empirical model like equation (1), there appears to remain (almost) no variation to be explained by the income variable.

The results for the 10-year data sample and the 20-year data sample (Tables 2 and 3) show the same pattern One additional result emerges from comparisons across the samples. The estimated short-run effect of income on democracy rises with the chosen time interval of the data set. This can be seen by comparing the estimate for lagged per capita income in column (5) across Tables 1-3. The estimated short-run coefficient rises from 0.11 to 0.21, with no significant change in the implied steady state effect.[8] If income were unrelated to democracy as claimed by AJRY, we would not expect to find that the variation of the time dimension of the sample data should have a systematic effect on the short-run income coefficient.

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6. For the 5-year data sample of Table 1, the variance of the democracy score is 0.143. Controlling for lagged democracy reduces the variance to 0.061, additionally controlling for country-fixed and time-fixed effects further reduces the variance to 0.026.
7. The corresponding estimate without country-fixed effects gives an even stronger effect of income, but as the coefficient to the lagged endogenous variable falls, the implied steady state effect remains almost the same as for equation (5). These estimates are reported by AJRY.
8. The implied steady state effect appears to be quantitatively important. For instance, the difference in log GDP per capita between Togo and Thailand, which are countries that are close to the 25 percentile and the 75 percentile of the distribution in the 1960-2000 sample, is about 1.76 points. A steady state coefficient of 0.21 thus predicts a difference in the normalized democracy score of about 0.37. The actual difference in the normalized democracy score is 0.8, so our estimated effect accounts for almost half of the observed difference in the degree of democracy between the two countries.

Table 4 reports that this effect also shows up with 50-year interval data, where the estimated short-run income coefficient rises further to 0.36 and the steady state coefficient remains as before (column (5) of Table 4). We think that the robust long-run effect of income on democracy indicates that there is more to the modernization hypothesis than can be revealed by the AJRY approach.

Overall, our results appear to be much in line with previous results based on different model specifications and estimation techniques.[9] When estimating an adjustment model like equation (1), it is important not to include too many controls that will remove the long-run information from the data, and this is all the more so if at least part of the short-run information also is removed from the data by other controls. We conclude that the AJRY specification of the adjustment model is too restrictive by construction: it cannot produce a significant effect of income on democracy along with a lagged endogenous variable and both country-fixed and time-fixed effects.

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9. For more detailed estimation results on the effect of income on democracy, see Borooah and Paldam (2008) on the short to medium run, and Gundlach and Paldam (2008) on the medium to long run.

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Table 1. The effect of income on democracy, 5-year data interval

	AJRY rep.	Two-step procedure			Within
Equation (in text)	(1)	(2)	(3)	(4)	(5)
Dependent variable	d_{it}	d_{it}	z_{it}^c	z_{it}^t	d_{it}
Democracy lagged	0.453 (0.030)	0.453 (0.030)	-	-	0.545 (0.029)
Income lagged	0.016 (0.022)	-	0.067 (0.010)	0.009 (0.005)	0.107 (0.018)
Steady state effect of income	0.030 (0.041)	-	-	-	0.235 (0.040)
Fixed effects	Country and time	Country and time	No	No	Country
No. of countries	154	154	154	154	154
No. of observations	1069	1069	1069	1069	1069
R-squared within	0.400	0.400	0.003	0.043	0.311
R-squared between	0.900	0.894	0.277	0.004	0.845
R-squared overall	0.722	0.706	0.181	0.003	0.704

Note: OLS panel regressions. The implied cumulative effect of income is calculated as $\gamma/(1-\alpha)$. Base sample is an unbalanced panel, 1960-2000. Standard errors in parentheses.

Table 2. The effect of income on democracy, 10-year data interval

	AJRY rep.	Two-step procedure			Within
Equation (in text)	(1)	(2)	(3)	(4)	(5)
Dependent variable	d_{it}	d_{it}	z_{it}^c	z_{it}^t	d_{it}
Democracy lagged	0.154 (0.052)	0.155 (0.052)	-	-	0.232 (0.054)
Income lagged	0.025 (0.039)	-	0.094 (0.016)	0.016 (0.009)	0.178 (0.027)
Steady state effect of income	0.030 (0.047)	-	-	-	0.232 (0.037)
Fixed effects	Country and time	Country and time	No	No	Country
No. of countries	133	133	133	133	133
No. of observations	544	544	544	544	544
R-squared within	0.273	0.272	0.000	0.101	0.145
R-squared between	0.596	0.468	0.265	0.048	0.517
R-squared overall	0.383	0.302	0.236	0.006	0.474

Note: See Table 1.

Table 3. The effect of income on democracy, 20-year data interval

	AJRY rep.	Two-step procedure			Within
Equation (in text)	(1)	(2)	(3)	(4)	(5)
Dependent variable	d_{it}	d_{it}	z_{it}^c	z_{it}^t	d_{it}
Democracy lagged	-0.370 (0.103)	-0.372 (0.102)	-	-	0.437 (0.115)
Income lagged	-0.045 (0.082)	-	0.131 (0.029)	0.020 (0.012)	0.295 (0.056)
Steady state effect of income	-0.033 (0.060)	-	-	-	0.205 (0.043)
Fixed effects	Country and time	Country and time	No	No	Country
No. of countries	129	129	129	129	129
No. of observations	223	223	223	223	223
R-squared within	0.488	0.487	0.001	0.238	0.336
R-squared between	0.482	0.495	0.202	0.021	0.000
R-squared overall	0.083	0.053	0.234	0.012	0.032

Note: See Table 1.

Table 4. The effect of income on democracy, 50-year data interval

	AJRY rep.	Two-step procedure			Within
Equation (in text)	(1)	(2)	(3)	(4)	(5)
Dependent variable	d_{it}	d_{it}	z_{it}^c	z_{it}^t	d_{it}
Democracy lagged	-0.632 (0.166)	-0.646 (0.162)	-	-	-0.633 (0.211)
Income lagged	-0.063 (0.129)	-	0.221 (0.053)	0.005 (0.026)	0.356 (0.098)
Steady state effect of income	-0.039 (0.080)	-	-	-	0.218 (0.058)
Fixed effects	Country and time	Country and time	No	No	Country
No. of countries	68	68	68	68	68
No. of observations	95	95	95	95	95
R-squared within	0.650	0.646	0.003	0.369	0.413
R-squared between	0.214	0.195	0.380	0.146	0.006
R-squared overall	0.057	0.038	0.370	0.000	0.047

Note: See Table 1. Base sample is 1950-2000.