A Reassessment of the Relationship Between Inequality and Growth: Comment

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December 2000

1 Introduction

It is often that the most basic questions in economics turn out to be the hardest to answer and the most provocative answers end up being the bravest and the most suspect. Thus it is with the empirical literature on the effect of inequality on growth. Many have felt compelled to try to say something about this very important question, despite the lack of reliable data and the obvious problems with identification. Benabou (1999) lists twelve studies over the previous decade that report cross-country ordinary least squares (OLS) estimates of the following relationship:

$$\frac{(y_{it+a} - y_{it})}{a} = \alpha y_{it} + X_{it}\beta + \delta g_{it} + v_i + \epsilon_{it} \ , \quad (1)$$

where y_{it} is the logarithm of GDP in country i at date t and a is the length of the time period chosen for measuring growth ($(y_{it+a} - y_{it})/a$ is therefore the growth rate of GDP). X_{it} is a set of control variables, g_{it} is the Gini coefficient in country i at date t and v_i is a country fixed effect.

The broad consensus of this literature until recently (see the reviews in Benabou (1999) and Forbes (2000)) was that there is a negative relationship between inequality and growth, which is usually, but not always, significant. This conclusion has been recently challenged in a new paper by Forbes (2000) who argues that these estimates may be biased because of the potential

*Department of Economics, MIT, and Department of Economics, MIT and NBER, respectively. We thank Alberto Alesina, Oriana Bandiera, Robert Barro, Roland Benabou, Olivier Blanchard, Steve Durlauf, Kristin Forbes, Michael Kremer, Debraj Ray, and Emmanuel Saez for useful conversations.

correlation between g_{it} and v_i in the above equation.[1] She therefore re-estimates the equation with a country fixed effect, using panel data on inequality that have recently been made available by Deininger and Squire (1996). The result is a dramatic reversal of sign—she concludes that "results suggest that in the short and medium term, an increase in a country's level of inequality has a significant positive relationship with subsequent economic growth" (Forbes (2000), p. 885).

Potentially this is a very important result. Unfortunately it is false, being based on a simple misinterpretation of the data that arises because the author imposes a linear structure on highly non-linear data. In the data, increases in inequality are not followed by an increase in the growth rate: on the contrary, they seem to be followed by a reduction in the growth rate. The problem is that decreases in inequality *are also followed by a reduction in the growth rate* and it is this relationship, (mistakenly) linearly extrapolated, which is the basis of Forbes' result.

The next section lays out a set of brief arguments aimed at explaining why the relationship between *changes* in inequality and *changes* in growth, which is the relationship that Forbes (2000) estimates (Forbes (2000), equation 4) might be strongly non-linear. The goal of this section is not to argue that the relationship is *necessarily* non-linear, but to remind the reader that neither the data nor the models underlying this relationship have simple predictions. The empirical evidence for non-linearity is presented in section 3.

2 Reasons for Non-linearity

2.1 Measurement Error

Inequality is not easy to measure, and while the Deininger and Squire data is a considerable improvement over the data that was previously available, substantial scope for error remains. Atkinson and Brandolini (1999) carefully discuss the Deininger and Squire data for the OECD countries, and find that even the "high quality" subset has important problems. Most worrisome is the fact the data may be especially ill-suited for comparison over time and within countries. For example, the Deininger and Squire data for France shows a sharp drop in inequality from 1975-1980. Atkinson and Brandolini (1999) demonstrate that this is due to a rupture in the series

[1] Li and Zou (1998) had also shown that the relationship between inequality and growth is positive once fixed effects are introduced in the regression. We focus on Forbes (2000), who presents both fixed effects and GMM estimates.

rather than to a genuine change in the underlying inequality. Table 1 gives the list of all countries and periods where, according to the Deininger and Squire data, the Gini coefficient changed by more than three percentage points over a five-year period. It contains several countries where a large increase in inequality is immediately followed (or preceded) with a large decrease in inequality. It seems likely that some of these changes are due to measurement error.[2]

To see why this matters, assume that all apparent changes in inequality arise from mismeasurement by the statistical agency. Assume also that the statistical agency is more likely to mismeasure when the society as a whole is under stress, because of an economic or a political crisis, or a war. These are also times when the growth rate is likely to fall. We will therefore expect an inverted U-shaped relation between measured changes in inequality and changes in the growth rate—measured changes in inequality in any direction will be associated with a subsequent fall in the growth rate.

2.2 Political Economy

Consider an economy that has two groups, rich and poor. The economy has a potential growth rate of $\Delta y/y$ in every period, but if there is a distributional conflict, growth is below its potential rate. Distributional conflict can be initiated by either one of the two groups and they initiate it only when they are quite sure that they will manage to increase their share of total output in the process. When there is no distributional conflict, the distribution does not change.

This is a very stylized model, but the ideas are familiar. The basic notion is that in the typical case, the distribution of wealth changes relatively slowly. Large changes in the distribution of income over a relatively short period of time often involve one group imposing its will upon the other, and this typically involves going through a period of turmoil.[3] The immediate impact of

[2]For example, in Bulgaria, the Gini coefficient went down by 3.7 percentage points between 1975 and 1980, and up by 7.2 percentage points between 1980 and 85. In Brazil, it went up by 4.3 percentage points between 1970 and 75, down by 4.2 percentage points between 1975 and 1980, and up again by 4 percentage points between 1980 and 1985. Colombia, Hong Kong, Sri Lanka, Sweden, and Venezuela also show consecutive increases and decreases in the Gini coefficient of more than 3 percentage points.

[3]Some of the large changes in table 1 took place right after a rapid change in regime from democracy to autocracy or from autocracy to democracy (e.g. Chile (1975-1980), Spain (1975-1980), Portugal (1975-1980)). Rodrik (1999) shows that such rapid regime shifts are often associated with large shifts in the income distribution in favor of or against wage earners.

the distributional changes is therefore likely to be a slowing down of growth, though it is entirely possible that the long run effect is an acceleration of growth.[4]

The idea that distributional conflicts hurt growth is in many models, including Benhabib and Rustichini (1998), Tornell and Velasco (1992), and Perotti (1996). The idea that changing the income distribution reduces the growth rate is also at the heart of the influential political economy models of Persson and Tabellini (1991), Alesina and Rodrik (1994), and Saint-Paul and Verdier (1993). However, in their models, the only cost of redistribution arises from distortionary taxation, and therefore, only redistribution from the poor to the rich hurts growth. Redistribution in the opposite direction is actually good for growth. By contrast, we emphasize that the process of getting all sides to agree to the redistribution may be an important source of waste in itself, at least in the very short run.

The immediate implication of this model is that periods when there are changes in inequality in either direction are followed by periods of lower than average growth. Suppose now that there are only two possible levels of growth, high and low. Then, in any period during which there are changes in inequality, growth is either lower or the same as in the previous period —either there was a change in inequality in the previous period, in which case growth does not change, or there was no change in the previous period in which case growth is now lower. This generates an inverted U-shaped relation between changes in inequality and changes in growth with a peak at zero change.

2.3 Wealth Effects

To summarize the ideas underlying the most simple wealth effects models, assume that there is an increasing, concave relationship between the current wealth (w_t) and the future wealth (w_{t+1}) of an individual, as illustrated in figure 1. Such a concave relationship could be due to credit market imperfections. Intuitively, the poor underinvest because credit markets are imperfect and as a result earn higher average returns on their wealth than the rich, who invest more (see for example Benabou (1996), and Bardhan, Bowles and Gintis (2000)).

An implication of the shape of the $w_{t+1}(w_t)$ curve is that a mean-preserving spread in wealth

[4]There are several possible reasons why this may be the case: For example, the change in the distribution may make the distribution less skewed towards the rich, and therefore reduce the possibility that there will be a damaging political conflict (say a revolution) in the future.

reduces growth. Moreover, the shape of the $w_{t+1}(w_t)$ function has the immediate implication that there is convergence—in the long run, wealth converges to w^*. This implies that if everyone starts out below w^*, growth will tend to slow down over time. It also implies that if everyone in the economy shares the same $w_{t+1}(w_t)$ curve, there will be no inequality in the long run. Together, these two observations tell us that if we follow the same economy over time and we started with most people below w^*, *reductions in inequality* will be correlated with *reductions in the growth rate*. This is a pure convergence effect— as already noted, the *causal* effect of an exogenous reduction in inequality in this model would be to *increase* the growth rate. If we could perfectly control for convergence, this correlation would disappear. However, it is clear from figure 1 that convergence is slowing down as countries get closer to w^*. A linear control for past growth will therefore not fully control for convergence.

How about the effect of increases in inequality? In this model, all increases in inequality are exogeneous. Because the $w_{t+1}(w_t)$ curve is concave, the causal effect of an exogenous mean-preserving spread is to reduce the growth rate. The correlation between increases in inequality and changes in growth will therefore tend to be negative, unless the source of the increase in inequality has an independent effect on growth.[5]

In summary, even the simplest possible wealth effects model predicts that in the data, the correlation between changes in inequality and changes in growth may depend on the direction of the change. Increases in inequality will be associated with reductions in the growth rate (unless they have a direct positive impact on growth), but so will decreases in inequality, if most of the observed changes in inequality are endogenous changes due to the convergence process.

Measurement errors, political economy arguments, and the convergence properties in wealth effects models all suggest that the assumption of linearity between change in growth and changes in measured inequality, which is critical to the interpretation of the results of Forbes, cannot be taken for granted. We now turn to examining whether this is empirically a serious concern.

[5] For example, new technologies could increase both inequality and the growth rate simultaneously (Galor and Tsiddon (1997)), while hyperinflations could increase inequality and reduce the growth rate.

3 Non-linearity—Empirical Evidence and Implications

Forbes first estimates equation 1 (for a period a of five years), using fixed effects and random effects. A Hausman test rejects the equality of the random effects and the fixed effect estimates, which indicates that the country specific error term v_i is correlated with the regressors, and that the random effect estimator is inconsistent. The fixed effects estimate is positive and significant (Forbes (2000), table 3).

She points out, however, that both fixed effects and random effects estimates are biased in short panels due to the presence of a lagged endogenous regressor. To correct the random effects estimator for this bias, she implements the Chamberlain π-matrix estimator. However, she rejects the assumption of exogeneity of the right-hand-side variables, and concludes that this estimator is biased as well.

She therefore implements a GMM estimator suggested by Arellano and Bond (1991), which is consistent in the presence of a country fixed effect and a lagged endogenous regressor. In practice, she writes equation 1 in first-differences form and rearranges terms to obtain the following relationship between changes in inequality and changes in growth:

$$(y_{it+a} - y_{it})/a = (1 + \alpha a)(y_{it} - y_{it-a})/a + (X_{it} - X_{it-a})\beta + \delta(g_{it} - g_{it-a}) + \epsilon_{it} - \epsilon_{it-a}. \quad (2)$$

Under the assumption that y_{it-a}, X_{it-a} and g_{it-a} are predetermined and ϵ_{it} is not serially correlated, Arellano and Bond (1991) showed that y_{it-a}, g_{it-a}, X_{it-a} and further lags of these variables are valid instruments for the differences on the right-hand-side of equation 2.

The previous section suggests, however, that there are good reasons to question the linearity that is being imposed here. A more general form that nests the linear case is:

$$(y_{it+a} - y_{it})/a = (1 + \alpha a)(y_{it} - y_{it-a})/a + (X_{it} - X_{it-a})\beta + k(g_{it} - g_{it-a}) + \epsilon_{it} - \epsilon_{it-a,}. \quad (3)$$

where $k()$ can be any function. We have also argued that there are good reasons why $k()$ may be inverted U-shaped with a peak at zero.

We begin by estimating equation 3 using a kernel estimator for partially linear models developed by Robinson (1988) and applied in Hausman and Newey (1995).[6] We use the same sample

[6] This is implemented by first regressing all the control variables and the dependent variable $\Delta y_{it+a} = y_{it+a} - y_{it}$ non-parametrically on $\Delta g_{it} = g_{it} - g_{it-a}$ and forming the residuals of this non-parametric regression. Esti-

and the same control variables as Forbes (2000) (female and male education and purchasing power parity of investment goods).

The estimate of the function $k(.)$ is shown in figure 2. It certainly does not appear to be linear, and it seems have an inverted U-shape. In other words, both increases and reductions in inequality seem to be correlated with reductions in the growth rate. To explore this pattern further, we show in table 2 the results of estimating equation 3, using different functional forms for the function $k(.)$. Column 1 has no control variable (except lagged growth), column 2 uses the same control as Forbes.[7] In the first panel, we use a linear form for $k(.)$ (in other words, we simply estimate equation 2 using OLS), and we find a positive coefficient. In the second panel, we use a quadratic form. The quadratic term is negative and significant. In the third panel, we use a quartic form (which, as shown in figure 1, captures the shape of the kernel regression) and show the F test for the significance of the non linear term. The quartic term is significant at 6% without controls, and at 10% with the controls. This polynomial is maximized when the changes in the Gini coefficient is equal to 0.0074, very close to zero.

These estimates are, however, potentially inconsistent, since we have a lagged endogenous variable on the right hand side of the equation. We are not aware of a generalization of the Arellano and Bond estimator in a semi-parametric setting. However, our main objective is to test for the linearity of equation 2. We will therefore test for linearity *starting from the assumption that the model was correctly estimated in Forbes' paper.* Using the Arellano and Bond estimates that she reports for equation 2, we construct:

$$(y_{it+a} - y_{it})^*/a = (y_{it+a} - y_{it})/a - (1 + \hat{\alpha} a)(y_{it} - y_{it-a})/a - (X_{it} - X_{it-a})\hat{\beta}.$$

We then estimate the relationship:

$$(y_{it} - y_{it-a})^*/a = k(g_{it} - g_{it-a}) + \omega_{it}.$$

Under the hypothesis of linearity, the parameters estimated using the Arellano and Bond method are consistent, and we can therefore directly test for the linearity of $k(.)$. The kernel estimator

mates of the parameters α and β are then obtained from the OLS regression of the residual of the dependent variables on the residuals of the control variables. Finally, the function $ak(.)$ is estimated by estimating non-parametrically the functions $\hat{E}(\Delta y_{+a}|\Delta g)$, $\hat{E}(\Delta y|\Delta g)$, and $\hat{E}(\Delta X|\Delta g)\hat{\beta}$ and forming the difference $\hat{E}(\Delta y_{+a}|\Delta g) - (a\hat{\alpha} + 1)\hat{E}(\Delta y|\Delta g) - a\hat{E}(\Delta X|\Delta g)\hat{\beta}$.

[7]We also estimated the same relationship using a much larger set of control variables (that of Barro (2000)), and find the same U-shaped pattern.

is shown in figure 3, along with the quartic polynomial. The estimates of different forms for the function $k(.)$ are shown in table 1 (column 3). The results are very similar to those we obtained in column 1. In particular, there is evidence of a non-monotonicity in the relationship between changes in inequality and changes in growth. The non-linear terms are significant in the quadratic and the quartic specifications. The quartic polynomial is maximized for a value of changes in inequality of 0.0059.

Clearly, these results do not support the conclusion that increases in inequality are followed with increases in growth. Indeed, increases in inequality, like reductions in inequality, seem to be associated with a fall in growth. Forbes' positive estimate is a result of averaging the positive coefficient that one gets by looking at reductions in inequality with the negative coefficient that one gets by looking at increases in inequality.[8] The shape of the curves in figures 2 and 3 (the increasing part is steeper than the decreasing part) and the fact that there is more variance within decreases in inequality than within increases in inequality explains why the average is positive.

Besides the non-linearity of the effect of inequality, a feature of the data helps explain why the Arellano and Bond estimator is positive. Lagged levels of inequality are used to instrument for changes in inequality. In table 3, we regress changes in inequality on lagged inequality, controlling for lags of the other regressors. Lagged inequality is negatively correlated with changes in inequality. However, this negative correlation is entirely driven by the tendency for inequality to decline when it is high. In column 2 we regress reductions in inequality on lagged inequality. The coefficient is negative, indicating that higher inequality is associated with larger declines in inequality. Column 3 repeats this exercise with increases in inequality, and the contrast is striking: Increases in inequality are not correlated with lagged levels. Therefore, the Arellano and Bond estimator captures only the negative effect of decreases in inequality, which explains why it is positive.

[8] The fixed effect estimator differences the mean out of each variable in equation 1. Clearly, since the relationship is non-linear in first differences, this procedure is not valid: if the relationship were linear once the means are differenced out, it would also be linear in first differences.

4 Conclusion

This comment is primarily an attempt to forestall a potentially influential misinterpretation of the data on inequality and growth. If it serves any purpose beyond that, it is to serve as a broader warning against the automatic use of linear models in settings where the theory does not necessarily predict a linear or even a monotonic relationship.

References

Alesina, Alberto, and Dani Rodrik (1994) 'Distributive politics and economic growth.' *Quarterly Journal of Economics* 109(2), 465–490

Arellano, Manuel, and Stephen Bond (1991) 'Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations.' *Review of Economic Studies* 58, 277–297

Atkinson, A.B., and A. Brandolini (1999) 'Promise and pitfalls in the use of "secondary" datasets: Income inequality in OECD countries.' Mimeo, Nuffield College, Oxford

Bardhan, Pranab, Samuel Bowles, and Herbert Gintis (2000) 'Wealth inequality, wealth constraints and economic performance.' In *Handbook of Income Distribution,* ed. A.B. Atkinson and F. Bourguignon

Barro, Robert J. (2000) 'Inequality and growth in a panel of countries.' *Journal of Economic Growth* 5(1), 5–32

Benabou, Roland (1996) 'Inequality and growth.' In *NBER Macroeconomics Annual 1996,* ed. Ben Bernanke and Julio J. Rotemberg (MIT Press) pp. 11–73

—— (1999) 'Unequal socities: Income distribution and the social contract.' Mimeo, forthcoming *American Economic Review*

Benhabib, Jess, and A. Rustichini (1998) 'Social conflict and growth.' *Journal of Economic Growth* 1(1), 143–158

Deininger, Klaus, and Lyn Squire (1996) 'A new data set measuring income inequality.' *World Bank Economic Review* 10, 565–591

Forbes, Kristin J. (2000) 'A reassessment of the relationship between inequality and growth.' *American Economic Review* 90(4), 869–887

Galor, Oded, and Daniel Tsiddon (1997) 'Technological progress, mobility, and economic growth.' *American Economic Review* 87(3), 363–382

Hausman, Jerry A., and Whitney Newey (1995) 'Nonparametric estimation of exact consumers surplus and deadweight loss.' *Econometrica* 63(6), 1445–1476

Li, Hongyi, and Heng-fu Zou (1998) 'Income inequality is not harmful for growth: Theory and evidence.' *Review of Development Economics* 2(3), 318–334

Perotti, Roberto (1996) 'Growth, income distribution and democracy.' *Journal of Economic Growth* 1, 149–187

Persson, Torsten, and Guido Tabellini (1991) 'Is inequality harmful for growth? Theory and evidence.' *American Economic Review* 48, 600–621

Robinson, Peter (1988) 'Root-n consistent semiparametric regressions.' *Econometrica* 56, 931–954

Rodrik, Dani (1999) 'Democracies pay higher wages.' *Quarterly Journal of Economics* 114(3), 707–738

Saint-Paul, Gilles, and Thierry Verdier (1993) 'Education, democracy and growth.' *Journal of Development Economics* 42(2), 399–407

Tornell, Aaron, and Andes Velasco (1992) 'The tragedy of the commons and economic growth: Why does capital flow from rich to poor countries?' *Journal of Political Economy* 100(6), 1208–1231

Table 1

Countries with large changes in Gini coefficients

Decrease in Gini coefficient larger than 3 percentage points				Increase in Gini coefficient larger than 3 percentage points			
Country	Period	Begining of period Gini (in %)	Change in Gini (percentage points)	Country	Period	Begining of period Gini (in %)	Change in Gini (percentage points)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bangladesh	65-70	37.3	-3.1	Australia	85-90	37.6	4.1
Bulgaria	70-75	21.5	-3.7	Bulgaria	75-80	17.8	7.2
Brazil	75-80	61.9	-4.2	Brazil	80-85	57.8	4.0
Canada	85-90	32.8	-5.3	Brazil	70-75	57.6	4.3
Colombia	70-75	52.0	-6.0	Chile	75-80	46.0	7.2
Spain	75-80	37.1	-3.7	China	85-90	31.4	3.2
Finland	70-75	31.8	-4.8	Colombia	75-80	46.0	8.5
Finland	85-90	30.8	-4.7	Germany	65-70	28.1	5.4
France	75-80	43.0	-8.1	Dominican Republic	85-90	43.3	7.2
Hong Kong	85-90	45.2	-3.2	Finland	75-80	27.0	3.9
Hungary	65-70	25.9	-3.0	United Kingdom	85-90	27.1	5.2
Indonesia	80-85	42.2	-3.2	Hong Kong	80-85	37.3	7.9
Ireland	75-80	38.7	-3.0	Sri Lanka	75-80	35.3	6.7
Italy	75-80	39.0	-4.7	Sri Lanka	80-85	42.0	3.3
Korea, Republic of	80-85	38.6	-4.1	Mexico	85-90	50.6	4.4
Sri Lanka	85-90	45.3	-8.6	New Zealand	85-90	35.8	4.4
Sri Lanka	65-70	47.0	-9.3	New Zealand	75-80	30.0	4.8
Mexico	75-80	57.9	-7.9	Sweden	75-80	27.3	5.1
Norway	75-80	37.5	-6.3	Thailand	85-90	43.1	5.7
Portugal	75-80	40.6	-3.8	Venezuela	80-85	39.4	3.4
Sweden	70-75	0.4	-6.1	Venezuela	85-90	42.8	11.0
Trinidad and Tobago	75-80	51.0	-4.9				
Trinidad and Tobago	80-85	46.1	-4.4				
Turkey	70-75	56.0	-5.0				
Venezuela	75-80	47.7	-8.2				

Deininger and Squire high quality sample

Table 2: Relationship between changes in growth and changes in inequality

	Dependent variable		
	y(t+1)-y(t)		(y(t+1)-y(t))*
	First differenced equation		Partialling out
	No controls	Perotti controls	Forbes estimates
Panel A: difference			
g(t)-g(t-1)	0.0020	0.0029	0.0049
	(0.0018)	(0.0017)	(0.0020)
Panel B: quadratic specification			
g(t)-g(t-1)	0.0019	0.0029	0.0049
	(0.0018)	(0.0017)	(0.0020)
g(t)-g(t-1)^2	-0.074	-0.057	-0.054
	(0.030)	(0.028)	(0.035)
Panel C: quartic specification			
F test, non linear terms significant	2.57	2.08	2.84
(p. value)	(0.057)	(0.10)	(0.041)
Number of countries	45	45	45
Number of observations	132	132	132
Controls: y(t)-y(t-1)	Yes	Yes	Yes
Med(t)-Med(t-1), fed(t)-fed(t-1), pppi(t)-pppi(t-1)	No	Yes	Yes

Table 3: Relationship between changes in inequality and inequality

	Change in inequality g(t)-g(t-1) (1)	inequality reductions g(t)-g(t-1) *1(g(t)-g(t-1)>0) (2)	inequality increases g(t)-g(t-1) *1(g(t)-g(t-1)<0) (3)
g(t-1)	-0.095	-0.083	-0.011
	(0.037)	(0.022)	(0.022)
Countries	45	45	45
Observations	132	132	132
Controls: y(t-1)	Yes	Yes	Yes
Med(t-1) fed(t-1), pppi(t-1)	Yes	Yes	Yes

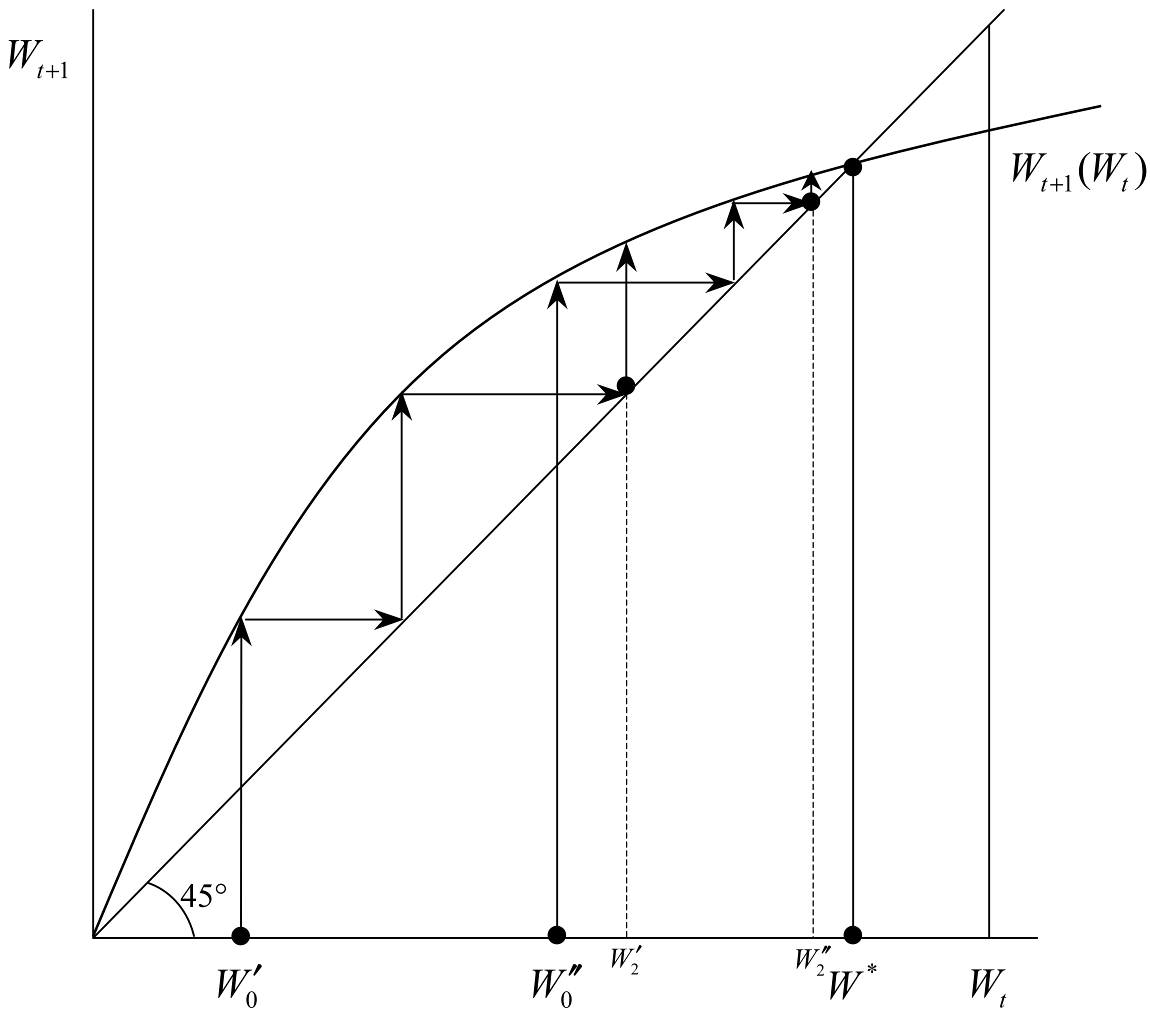

Figure 1

In this figure, two dynasties that started at W_0' are coming closer over time $(W_2'' - W_2' < W_0'' - W_0')$ and the steps up are getting smaller as well.

Figure 2: Relationship between income growth and lagged Gini growth: partially linear model

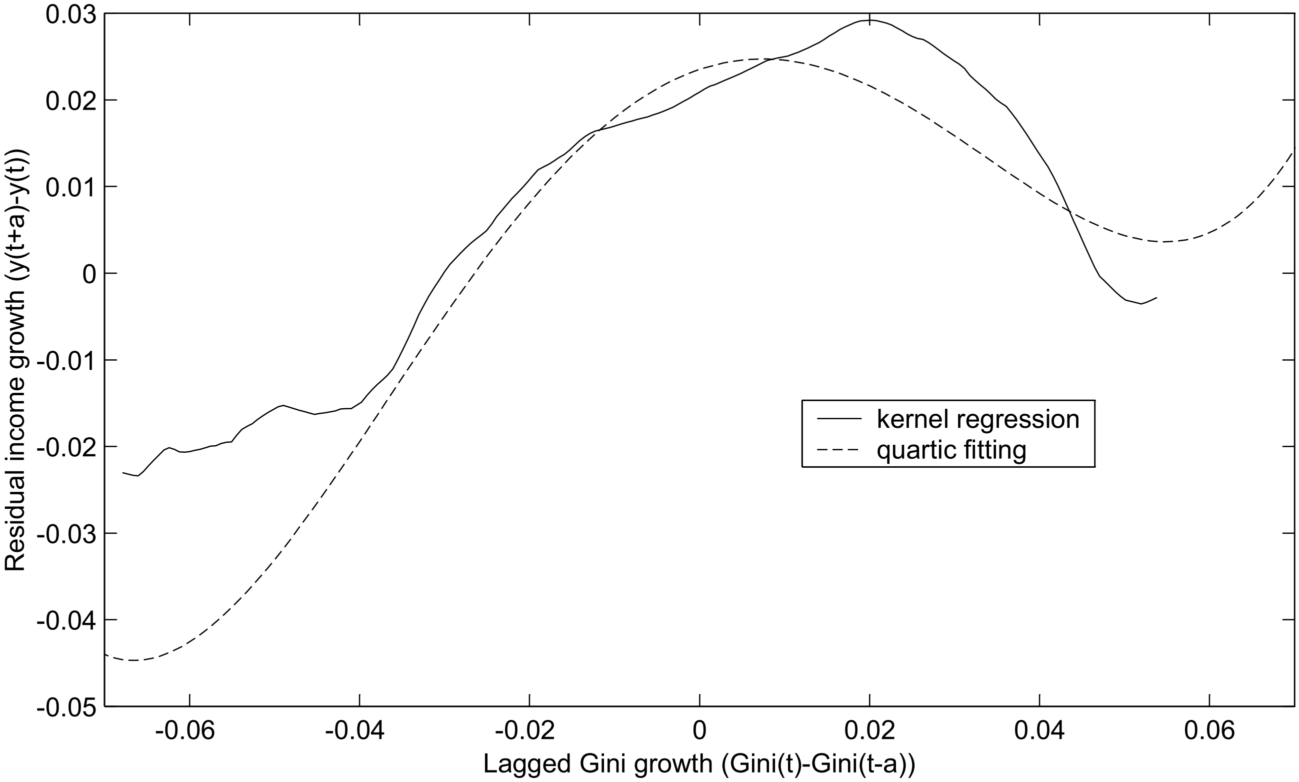

Figure 3: Relationship between income growth and lagged Gini growth: using Arellano and Bond coefficients