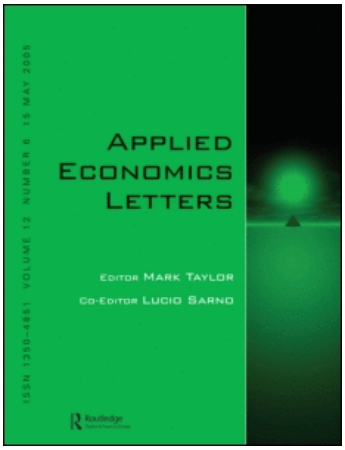

Applied Economics Letters
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713684190

Robust correlates of county-level growth in the United States

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First published on: 09 May 2008

To cite this Article Higgins, Matthew J. , Young, Andrew T. and Levy, Daniel(2010) 'Robust correlates of county-level growth in the United States', Applied Economics Letters, 17: 3, 293 — 296, First published on: 09 May 2008 (iFirst)
To link to this Article: DOI: 10.1080/13504850701720254
URL: http://dx.doi.org/10.1080/13504850701720254

Applied Economics Letters, 2010, **17**, 293–296

Routledge
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Robust correlates of county-level growth in the United States

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Higgins *et al*. (2006), report several statistically significant partial correlates with US per capita income growth. However, Levine and Renelt (1992) demonstrate that such correlations are hardly ever robust to changing the combination of conditioning variables included. We ask, whether the same is true for the variables identified as important by Higgins *et al*. Using the extreme bounds analysis of Levine and Renelt, we find that the majority of the partial correlations can be accepted as robust. The variables associated with those partial correlations stand solidly as variables of interest for future studies of US growth.

I. Introduction

Higgins *et al*. (2006) study US county-level income growth from 1970 to 1998 controlling for 41 demographic conditioning variables. Their findings include: (1) conditional β-convergence; (2) federal, state and local government employment negatively correlate with growth; (3) the relationship between educational attainment and growth is nonlinear; and (4) finance, insurance and real estate industry employment and entertainment industry employment correlate positively with growth, whereas education employment correlates negatively with growth. Higgins *et al*. use a consistent 3SLS estimation method of Evans (1997a, b) and include all 41 conditioning variables in the cross-sectional regressions.

However, Levine and Renelt (1992), employing a version of Leamer's (1983, 1985) extreme bound analysis (EBA), show that growth regression estimates can be very sensitive to small changes in the set of conditioning variables.[1] In order to determine whether findings (1)–(4) from Higgins *et al*. (2006) are model dependent, we replicate Levine and Renelt's EBA using the same data set as Higgins *et al*. We find that 7 out of 11 variables of interest are robust partial correlates with US county-level growth.

Section II outlines the EBA methodology and describes the data. Section III reports our results. We conclude in Section IV.

II. Extreme Bounds Analysis

In response to sensitivity issues, Leamer (1983, 1985) proposes an EBA to identify 'robust' empirical relations. For a specific variable of interest, the extreme bounds of the distribution of the associated coefficient

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[1] Levine and Renelt (1992) find that, using an international sample, very few variables are robust correlates with growth. Sala-i-Martin *et al*. (2004) introduce an alternative Bayesian sensitivity analysis. Their analysis is motivated by the belief that Levine and Renelt's 'test is too strong for any variable to pass: any one regression model (no matter how well or poorly fitting) carries a veto' (p 814). In contrast, we conclude that the majority of variables identified as important by Higgins *et al*. (2006) are not 'vetoed' by the Levine and Renelt test.

http://www.informaworld.com
DOI: 10.1080/13504850701720254

Table 1. EBA on variables of interest

Variable	Upper bound	Source
Income	Real per capita personal income (excluding transfer payments)	US BEA
Education: 9–11 years	Percentage of the population with 11 years of education or less	Census
Education: H.S. diploma	Percentage of the population with a high school diploma but no more education	Census
Education: some college	Percentage of the population with college education but not having obtained a bachelor degree	Census
Education: bachelor +	Percentage of the population holding a bachelor or higher level degree	Census
Federal government employment	Percentage of the population employed by the federal government	BEA
State government employment	Percentage of the population employed by the state government	BEA
Local government employment	Percentage of the population employed by the local government	BEA
Entertainment and recreational services	Percentage of the population employed in entertainment or recreational services	Census
Finance, insurance and real estate	Percentage of the population employed in finance, insurance or real estate	Census
Educational services	Percentage of the population employed in educational services	Census

Notes: BEA denotes the US Bureau of Economic Analysis; Census denotes the US Census Bureau. All variables are 1970 values for 3058 US counties.

estimates are calculated as the smallest and largest values that are not rejected at the 0.05 significance level given all possible combinations of the remaining conditioning variables taken three at a time. If the two bounds have differing signs, then the variable is labelled as fragile; otherwise it is labelled robust.[2]

The 11 conditioning variables of interest are listed in Table 1. These variables are 1970 values for 3058 US counties. The dependent variable is per capita real income growth from 1970 to 1998. See Higgins *et al.* (2006, Table 1 and Section III) for a description of the data set, including the list of the remaining 30 conditioning variables.

Since it is well-established that initial income be included in growth regressions, the EBA for 'income' is constituted by the results of C(40,3) = 9880 OLS regressions. The EBAs for the remaining 10 conditioning variables of interest are constituted by the results of C(39,3) = 9139 OLS regressions.

III. Results of EBA

The extreme bounds for coefficients are reported in Table 2 along with their 95% confidence intervals. A full of 7 out of 11 variables, found to be significant correlates with economic growth by Higgins *et al.* (2006), are robust as defined by the EBA. Furthermore, the robust correlates according to the EBA carry the same signs as reported in Higgins *et al.* (2006).

First, the initial level of income is a robust, negative correlate with per capita income growth. This confirms that a conditional convergence effect exists across the US at the county-level. This can also be viewed as consistent with studies by Barro and Sala-i-Martin (1992), Evans and Karras (1996a, b), Sala-i-Martin (1996) and Evans (1997a, b) who document conditional convergence using state-level data; and with Young *et al.* (2006) who find conditional convergence within many individual US states using county-level data.[3] The existence of conditional convergence is always encouraging in the limited sense that it implies that *if* a relatively poor economy can emulate the policies and institutions of its wealthier counterparts, *then* it can expect to grow faster and catch-up in terms of its per capita income.

The robust estimated effects of educational attainment variables appear reasonable. The larger a percent of a county's population not obtaining the remedial communication and analytical skills associated with completing high school, the lower is the

[2] Statistically insignificant coefficient estimates are discarded from the analysis; including them would make for an unreasonably demanding test. An insignificant coefficient estimate of a different sign than extreme bounds of like signs is, rather than a contradiction of those bounds, merely a tentative acceptance of the null of zero partial correlation.

[3] This type of convergence is known as β-convergence and is necessary but not sufficient for σ-convergence, i.e. for a narrowing of the income distribution over time. Young *et al.* (2008) find that, over the same 1970 to 1998 time period, statistically significant *σ-divergence* actually occurred.

Table 2. Results of EBA

Variable	Lower bound	Upper bound	Verdict
Income	−0.0175	−0.0044	Robust (−)
	(−0.0188, −0.0162)	(−0.0053, −0.0035)	
Education: 9–11 years	−0.0293	−0.0048	Robust (−)
	(−0.0343, −0.0244)	(−0.0095, −0.0002)	
Education: H.S. diploma	−0.0206	0.0071	Fragile
	(−0.0249, −0.0163)	(0.0030, 0.0112)	
Education: some college	−0.0497	0.0376	Fragile
	(−0.0583, −0.0411)	(0.0288, 0.0464)	
Education: bachelor +	0.0225	0.1111	Robust (+)
	(0.0150, 0.0299)	(0.1019, 0.1204)	
Federal government	−0.0212	−0.0054	Robust (−)
Employment	(−0.0268, −0.0156)	(−0.0108, −0.0001)	
State government	−0.0233	0.0212	Fragile
Employment	(−0.0293, −0.0172)	(0.0150, 0.0273)	
Local government	−0.0682	−0.0236	Robust (−)
Employment	(−0.0763, −0.0600)	(−0.0315, −0.0156)	
Entertainment and	0.0376	0.1373	Robust (+)
recreational services	(0.0093, 0.0659)	(0.1082, 0.1664)	
Finance, insurance and real	0.0886	0.1811	Robust (+)
Estate	(0.0696, 0.1075)	(0.1636, 0.1986)	
Educational services	−0.0673	0.0147	Fragile
	(−0.0775, −0.0571)	(0.0089, 0.0206)	

Notes: About 95% confidence intervals are contained under point estimates in parentheses.

county's growth rate. Likewise, a larger percent of a population achieving at least four college-years-worth of human capital correlates with a higher rate of growth.[4] Of note, the effect associated with some college attainment, but less than a bachelor degree, is fragile. This can be viewed as consistent with Higgins *et al*.' s (2006) finding that no statistically significant effect is associated with that variable. One interpretation is that the opportunity costs of education at those levels of attainment are comparable to the social returns.

Turning to the government employment variables, the robust negative correlations associated with federal and local government are consistent with Higgins *et al*. (2006). However, Higgins *et al*. also found state government employment to be negatively correlated (significantly at the 1% level) with growth using 3SLS estimation. Here we find that, using an EBA, that negative correlation is fragile. Of note, Higgins *et al*. (2006) also report, as a baseline, OLS coefficient estimates. For the state employment variable the Higgins *et al*. OLS estimate is negative but insignificant; the EBA here produces a stronger finding that, changing the set of conditioning variables, can produce both negative and positive statistically significant coefficient estimates.

Two of the industry employment variables are robust, positive correlates with county-level growth. In both cases the positive sign is consistent with the findings of Higgins *et al*. (2006). While growth effects associated with entertainment and recreational services are not widely documented in the literature, the robust positive correlation of growth with the prevalence of finance, insurance, and real estate industry is in agreement with existing cross-country evidence.[5]

IV. Conclusions

Higgins *et al*. (2006) report several statistically significant partial correlates with US per capita income growth at the county-level. However, Levine and Renelt (1992) demonstrate that, for cross-

[4] Our conditioning variables include a dummy variable that takes the value of 1 if the county includes a college or university with enrollment of 10 000 or more and accounts for at least 5% of the total population. In Higgins *et al*. (2006) the inclusion did not render the bachelor+ coefficient estimate insignificant.

[5] Levine (2005) provides an overview of the empirical findings, as well as the theoretical literature motivating the studies.

country data sets, such correlations are hardly ever robust to changing the combination of conditioning variables included. It is natural, then, to ask whether the same is true for the variables identified as important by Higgins *et al*.

We carry out an EBA of the Levine and Renelt (1992) type using the US county-level data of Higgins *et al*. (2006). We find that the majority of the partial correlations put to test (7 out of 11) can be accepted as robust correlates with US county-level growth. The variables associated with those partial correlations stand solidly as variables of interest for other studies of US growth.

Acknowledgement

We thank Jordan Rappaport for kindly sharing with us some of his data and computer codes and for providing helpful suggestions throughout the study. All errors are ours.

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