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Econ 490

Testing for Convergence Among the Potatoes

INTRODUCTION

‘May you live in interesting times’ is an apocryphal chinese curse that embodies the agony and the ecstasy of the modern post industrial economic wave of growth the western world has ridden since the 18th century. This wave has been the main force behind stratospheric levels of income per capita, providing increasing returns to scale on all levels of productivity which has lead to higher levels of learning and human capital accumulation, pushing incomes higher and compounding upon itself. The good is more toys, more free time, more leisure; the better is that millions of human beings who for centuries would have toiled daily for a subsistence existence do not have to worry about dying on a daily basis. Relationships, loved ones, kin, family, friends, these things have a stronger sense of permanence. If growth did nothing else besides the diminution of subsistence poverty then it would be worth investigating ten times over. This growth is and has always been the main focus of the field of economics going so far back as to an observation by Adam Smith who noted in his book *An Inquiry Into the Nature and Causes of the Wealth of Nations*:

"But the rate of profit does not, like rent and wages, rise with the prosperity, and fall with the declension of the society. On the contrary, it is naturally low in rich, and high in poor countries, and it is always highest in the countries which are going fastest to ruin." [SMITH, Book 1 Chapter 11]

Modern neoclassical growth theory is the latest attempt in a storied intellectual lineage dating back to Smith to provide a framework for examining the truly modern (relative) phenomenon that is persistent long run growth. Convergence within the context of this framework can be a powerful metric in answering why nations, post industrial revolution, are growing at ahistorical rates. Further it helps illuminate the nature of accumulated growth and its compounding effect on future growth rates. Simply put, convergence theorem states that the further a region is from a given steady state, the greater the rate of growth. This implies that accumulation of capital per capita cannot ascend forever into the future and shows that capital per capita accumulation will eventually have decreasing returns to scale, holding total factor productivity constant. Convergence can be broken down further; absolute convergence, which assumes that all counties are growing towards a singular steady state, and conditional convergence, controlling for other factors each county moves towards their own steady state.

The goal of this paper was to test the theory of convergence on the state of Idaho and its counties and see if a given initial income of a county has had any effect on growth rates over a ten year period. If there is absolute convergence then those counties who were poorer will have higher levels of growth than wealthier counties

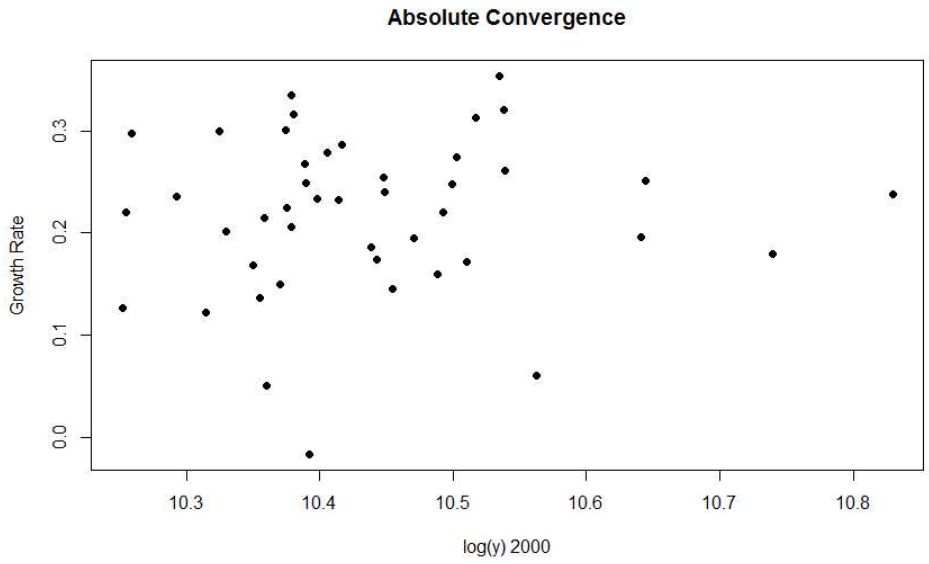
regardless of other factors as they all share a common steady state. In conditional convergence we use explanatory variables to assist in controlling for the different steady states within Idaho and then see if those poorer countries then converge to their own steady state.

Idaho is a region of the western United States, sparsely populated with few urban centers and large swathes of rural areas. It is primarily known nationwide for its potato crop but it contains a variety of biomes and numerous protected national parks. Terrain in idaho ranges from the mountainous to the arid to the aforementioned fertile potato lands. Given the state's relative homogeneity excluding the terrain I expected to see convergence in some form since they probably share similar steady states given their shared key growth-inducing characteristics across counties. Same culture, same institutions and same luck [Acemoglu]. My results were inconclusive from the outset and using the few econometric tricks I know I was only able to encourage that inconclusiveness.

Over the next few paragraphs I will provide some descriptive data on the counties of Idaho. I will provide a methodology for the context in which I am applying economic theory and give a justification for regressions run. Following this I will provide results from the created models and a conclusion.

DESCRIPTIVE ANALYSIS

The first graph presented is a graphical test for absolute convergence. We see here that some of counties that started with highest gdp per capita had growth rates on par with their mid-level counterparts. In fact all counties save for Madison are all experiencing positive growth. The slope of a fitted line through these points would be positive. If the state of Idaho had absolute convergence then the slope of this line should be negative, implying some type of catch up is occurring where the poorest counties in 2000 would be closing in on income per capita levels of their richer neighbors.. This graph implies that there is no absolute convergence for the state of Idaho..



My initial regression for conditional convergence:

$$\overline{g_{2013,200}} = -0.28245 + 0.04792 log(y)_{00}$$

Std. Error ($\bar{g}$) = 0.07834

This equation gives no real evidence for conditional convergence. Not only were my variables insignificant, they were also positive. So even if my beta's were significant there would likely be no evidence for the theory of convergence at work among the counties of Idaho. Controlling for the outliers does little to increase the significance of my variables. Some interesting descriptive facts about the state of Idaho are it enjoyed a paltry .20 percent mean income growth and a .04 percent growth in population over the 13 year period covered in this data set.

The three obvious outlier counties: Clark, Boise, and Madison are probably causing the heaviest interference with the regression. Clark and Boise both individually had positive average growth over the period of 2000-2013 but they both also had negative population growth which would account for the small increase in income per capita, shrink the capita and you will have larger income per, ceteris paribus. Madison had a small degree of positive population growth but also had a negative mean growth rate, this implies that production in this county had not grown and could have possibly shrank despite influx of new people. All other counties at least had positive growth even with no seeming dependence on initial income.

METHODOLOGY

Neoclassical growth from the Solow-Swan model provides a given production function for a region as:

$$y = Bk^{\alpha} \text{ such that } \frac{\dot{y}}{y} \equiv \widehat{y}$$

and

$$\widehat{y} = \alpha\widehat{k}$$

And given a formula for the accumulation of capital per capita:

$$\dot{k} = sy - (n + \delta)k$$

Growth of income is tied to the growth rate of capital. Convergence theorem gives the theoretical steady state which is achieved when capital per capita accumulation is 0 or capital accumulation is equivalent to rate of per capita investment income growth will stabilize to 0%. Incomes will be fixed for as long as that equilibrium holds and only as much capital needed to replace the lost capital of the period will be accumulated.

Because capital growth is predicted to have diminishing marginal returns and will eventually reach a steady state it is possible to calculate how fast a given region is moving towards its steady state. The speed of convergence is given as

$$\beta \equiv \frac{\partial(\frac{\dot{k}}{k})}{\partial k} \Rightarrow \widehat{y} = -\beta \frac{log(y)}{log(y^{ss})}$$

with a given solution of

$$ln(y)_{2000} - ln(y^{ss}) = be^{-\beta t}$$

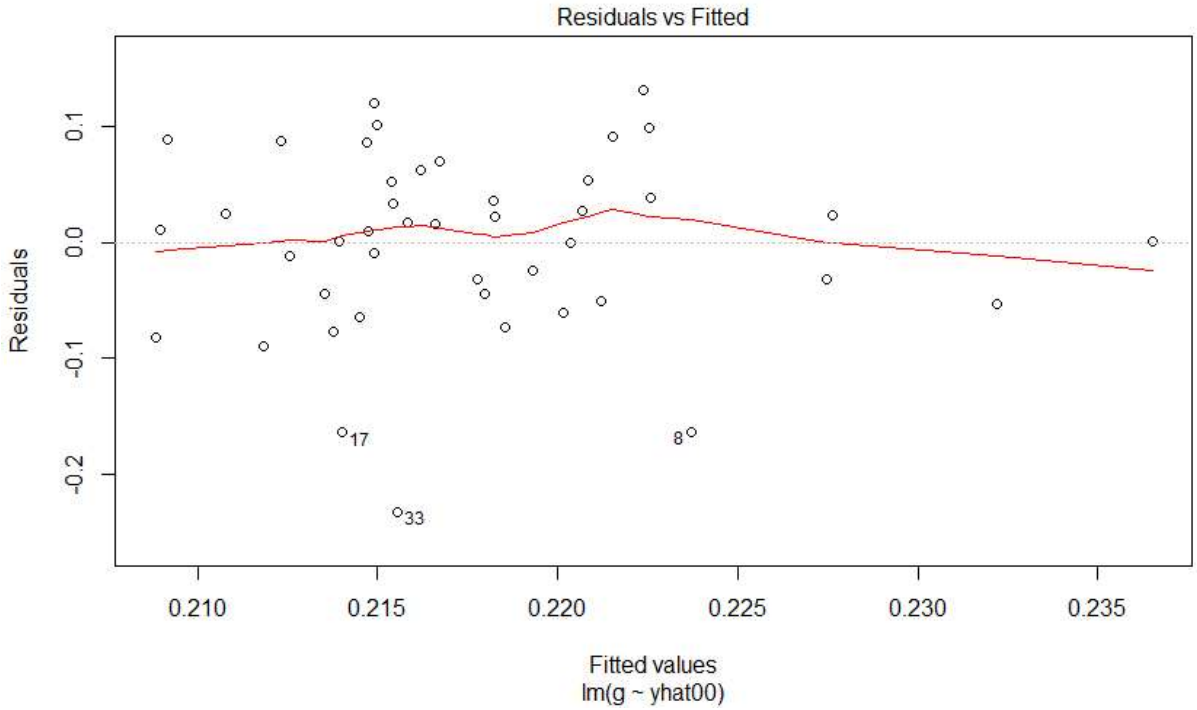
which implies

$$ln(y)_{2013} - ln(y)_{2000} = (1 - e^{-\beta t})ln(y^{ss}) - (1 - e^{\beta t})ln(y)_{2000} + \varepsilon$$

Thus the rate of economic growth depends on its income per capita steady state. Assuming the regions of Idaho are more or less homogenous we can infer that they would share steady state level of income and y^{ss} is treated as a constant giving:

$$\Delta ln(y)_{2013,2000} = \alpha + \eta ln(y)_{2000} + \omega_{2000,2013}$$

As the regressions' R^2 and β_i were essentially 0, I was unable to find any conclusive evidence of conditional convergence for the counties of Idaho on the initial regression with the only control variable of gdp per capita in time period 0. I suspect outlier problems as well as issues with heteroskedasticity.



In an attempt to control for outliers I also ran my regressions omitting first the most outside county, Madison followed by Clark and Boise. The data presented up to this point has all been the given regression of growth of y on initial gdp per capita without any counties omitted due to the inability of the removal of these outliers to provide any more real explanatory power.

To further test for conditional convergence I attempt to hold multiple factors constant to try to control for differing steady states between counties using the regression equation:

$$g_{2013,2000} = \beta_0 + \eta log(y)_{2000} + \eta_n \chi_n + \omega$$

[Acemoglu]

Where χ_n refers to a system of multiple control vectors. Lucas modifies the Solow-Swann model to include human capital development. In order to control for this I include a variable for percentage of population over 25 with a bachelor's degree or higher to see if I could control for differing levels of human capital available in a given counties steady state. Being over 25 would imply a higher degree of experience and advanced college degrees would imply larger technical skill sets. Due to the limited data sets I had available from US Census Office I used percentages from 2013 but as a control this shouldn't affect the regression negatively unless a few counties managed to spike in education levels.

Another control variable was population growth itself. Romer gives an endogenous method for calculating growth rate of technology which relies partially on given population and the division between research & development workers and output workers. Assuming a constant percentage of R&D workers, population growth could push income growth by affecting its steady state through manipulation of total factor productivity. Controlling for population parameters population growth may increase growth of income per capita regardless of initial given steady state by pushing that steady state further out.

RESULTS

Regression for Conditional Convergence:

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.28245	1.03754	-0.272	0.787
yhat00	0.04792	0.09940	0.482	0.632

Residual standard error: 0.07834 on 42 degrees of freedom

Multiple R-squared: 0.005504, Adjusted R-squared: -0.01817

F-statistic: 0.2324 on 1 and 42 DF, p-value: 0.6322

<u>Regression for Conditional Convergence Omitted Outliers Clark, Madison, Boise:</u>

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.09505	0.93189	-0.102	0.919
yhat00	0.03049	0.08927	0.342	0.734

Residual standard error: 0.07023 on 41 degrees of freedom

Multiple R-squared: 0.002837, Adjusted R-squared: -0.02148

F-statistic: 0.1166 on 1 and 41 DF, p-value: 0.7345

We can directly compute the rate of convergence as:

$$\eta = (1 - e^{-\beta t}) \Rightarrow e^{-\beta t} = 1 + \eta$$

$$\beta = -\frac{log(1+\eta)}{t}$$

Which in my model would be $\approx -.003$. This doesn't really make any sense within the context of the regressed model, having a positive slope for η and negative speed implies that the counties are moving further away from a steady state, but I also don't have convergence to begin with so this is more than likely a moot point. To derive the $T_{\frac{1}{2}}$ time to half way from the steady state we use the formula

$$\frac{ln(y_{T\frac{1}{2}}) - ln(y^{ss})}{ln(y)_{2000} - ln(y^{ss})} = \frac{1}{2} = e^{-\beta T_{\frac{1}{2}}}$$

$$\Rightarrow T_{\frac{1}{2}} = \frac{ln(2)}{\beta}$$

I won't bother calculating this because it would be a negative number consistent with the fact that there is either positive or zero slope from the regression. Through regression analysis or graphical observation there is no evidence of absolute convergence.

Regression for Conditional Convergence w/ Explanatory Variables:

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.832646	1.371721	-0.607	0.547
yhat00	0.103117	0.133455	0.773	0.444
PopGrowth	-0.002835	0.221326	-0.013	0.990
Over25	-0.001275	0.001848	-0.690	0.494

Residual standard error: 0.07978 on 40 degrees of freedom

Multiple R-squared: 0.01778, Adjusted R-squared: -0.05589

F-statistic: 0.2414 on 3 and 40 DF, p-value: 0.867

where yhat00 is log(y) in time period 0, PopGrowth is growth rate of population and Over25 is the percentage of population over 25 with college degrees. Ignoring that none of these control variables seems to have much effect on the explanatory power of the model rate of convergence follow from above as well. A negative rate of convergence and a $T_{\frac{1}{2}}$ of never.

Regression of Population Growth on initial log Population (for fun):

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.111044	0.067542	-1.644	0.1076

logPop 0.017146 0.007621 2.250 0.0297 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06091 on 42 degrees of freedom

Multiple R-squared: 0.1076, Adjusted R-squared: 0.08632

F-statistic: 5.062 on 1 and 42 DF, p-value: 0.02975

logPop being logarithm of population in initial year 2000.

CONCLUSIONS

Idaho is a state created via federal mandate rather than geographic boundaries. It is also a state seemingly without convergence, conditional or otherwise. The regressions had strong levels of insignificance and graphs produced did not indicate that counties were moving towards a steady state. Initial income was insufficient in explaining county growth rates. The added explanatory variables attempting to control for population growth and proxy for human capital effects on technological growth were ineffective at providing any further insight beyond the base regression. The lack of absolute convergence could be due to the stark differences in base income among Idaho counties to begin with. Some of the counties are deeply ingrained in poverty. Idaho contains 4 different indigenous peoples reservations. These reservations are notorious sinks for poverty accumulation, violent crime, lack of development and lack of

equal police protections (see: Wounded Knee Incident). So while the poorest counties in Idaho remain poor, the richest counties continue to grow. Small, poor counties Madison, Clark, and Boise experienced low levels of income growth and maintain their poverty. Moderate to rich counties enjoyed much higher rates of growth than their poorer peers.

The lack of conditional convergence probably has more to do with the explanatory variables used. Being a unified state within the Union it is likely that the counties all share similar institutions which are key for economic growth [Acemoglu] however the lack of urbanization could also factor into weak statewide institutional control over the counties which would mean county infrastructure and institution would play larger roles on the development of their seated counties. There are over 40 different counties within Idaho and each could behave independently enough to create deep rooted difference in infrastructure.

The other major factor that could get in the way of correctly measuring convergence would be geography. Idaho has large areas of underpopulated, protected national parks. This is land allowed to effectively lay fallow from an agricultural or economic development standpoint. Also the different regions of Idaho are starkly different from each other. Where a prairie state, such as Illinois, is one large metropolitan area surrounded by farmland, Idaho has mountainous ranges, fertile farmlands and arid steppes. These geographic features could play an influence in institutions inspiring different types of constituents with different institutional needs. Culturally the effects could be as simple as farmfolk culture versus mountain folk culture. These cultural, institutional, and geographic differences would mean that

individual counties within the state of Idaho could have wildly different steady states making regressions for convergence specific to this region difficult to tease out.

Works Cited

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