INFRASTRUCTURAL v. SUPERSTRUCTURAL EFFECTS OF INSTITUTIONS ON INCOME DETERMINATION ACROSS U.S. NATIVE AMERICAN ECONOMIES

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ABSTRACT

Institutions either promote or constrain economic performance, but which part of institutions does so, and why do economies sharing similar institutions sometimes perform differently? This paper applies a novel model that is capable of separating infrastructural and superstructural effects of institutions on aggregate and average income using a cross-section of 84 U.S. Native American economies (USNAEs). It finds that aggregate and average incomes for these economies depend mainly on the accumulation of physical resources**.** However, resources and resource productivity are necessary but insufficient determinants of income for institutional reasons. Infrastructures that aid human capital formation are inadequate so that even when the local superstructure is generally accepting of external technology, the impact of human capital on income (performance) remains modest. It appears that infrastructural and superstructural aspects of institutions are competitive rather than complementary, thereby weakening the Nelson-Phelps channel for transmitting external technology into USNAEs.

JEL CODE: O15, O57, R30, D24, C31, P47, O51

KEYWORDS: infrastructural and superstructural constraints, institutions, human capital, U.S. Native American economies

MOST CONVENTIONAL economic growth theories argue that differences in economic performance across economies are due to differences in factor endowment, factor productivity, technology, or some combinations of the above, and therefore predict positive externalities from interactions among economies via trade, human capital, and even geographical location (Moreno and Trehan, 1997). The predictions suggest that parts of one economy should perform approximately the same as the whole economy, *ceteris paribus*. Yet during the 1980-1990 decade U.S. Native American economies (USNAEs) differed in economic performance among themselves and from their host(s) - the general U.S. economy and U.S. state economies, with significant implications for Native Americans in terms of high unemployment rate and low median family income (Cornell and Kalt, 1998).[1] Considering the largest 25 American Indian tribes alone, for example, there exists a large gap between the average per capita income of Native Americans and the U.S. national average. Hence, many Native American families live in poverty (Vinje, 1996). It is not surprising that the high school and higher educational attainment of Native Americans averages only 43.3% compared to 53.1% or more for the entire U.S. population.

In a recent analysis of the 2000 U.S. Census data Taylor and Kalt (2005) report that USNAEs did better in the 1990-2000 decade than in previous years, with their per capita incomes growing faster than the rest of the U.S. economy in some cases. Even so, the policy implications of these results remain unclear because wide disparities persist and even at the current rate of economic growth some of the differences would still take decades to eliminate. In one respect popular interpretations attribute 1990-2000 growth to the good performance of the gambling industries in many USNAEs; in another, they give empirical support to Cornell and Kalt's (1998) claim that the growth problem for USNAEs is the lack of effective institutions and sovereign rights to nation-building and self-governance. Cornell and Kalt's claim is not universally accepted as others such as Pickering and Mushinski (2001) and Mushinski and Pickering (2000) emphasize cultural imperatives.

Granted recent growth has been extraordinary. The question still is: What explains the difference in economic performance between USNAEs and the U.S. economy? Why did USNAEs lag behind in the 1980-1990 decade and apparently outperformed the U.S. and state economies in the 1990-2000? Many researchers have been grappling with this question for a long time. While the jury is still out with the verdict, a general consensus has emerged that economic growth across USNAEs, just like across other economies, is not about resources and resource productivity alone (Henson, 2003). This paper applies a novel model for assessing how aggregate and average incomes across 84 USNAEs are determined.[2] The paper has five parts plus an appendix. The next section summarizes the relevant literature. Section 2 outlines the model, which is extended in the third section to allow for separate estimates of infrastructural and superstructural effects of institutions on economic performance (income generation). Section 4 estimates and presents the results. The final section states the implications of the results and their conclusions. The appendix deals with variables, data, and other measurement issues.

I. LITERATURE

Solow's (1956, 1957), Swan's (1956, 2002) and other findings that capital contributes less than expected to observed economic growth split research on economic growth into two groups. In one group some economists disputed the appropriateness of the aggregate production functions employed, while in another others sought to explain how and why the Solow residual deviated markedly from present-day theoretical expectations.[3] In recognizing the cumulative nature of learning-by-doing and its implications for both economic growth and the Solow residual, Arrow (1962) upgraded Solow *originale* to a neo-Solow status.[4] The first generation of neo-Solow models focused on the "elusive quest" (Easterly, 2002) for the causes of economic growth, measures of growth, and especially why growth rates differ across economies (Temple, 1998, 1999, Denison, 1962). The second generation of neo-Solow models sought to understand the interplay between the factors and forces of production on the one side, and policy on the other, leading theory into two interdependent directions, see, e.g., Abramovitz (1979), Kendrick (1961), Jorgenson and Grilliches (1967), Kaldor (1966), and many others. In one direction Lewis (1954) suggested that differences in economic growth (development) are explained by the presence of a surplus supply of labor in the traditional sector and a shortage in the modern sector.[5] Lewis then argued that with good incentives sustained growth of the modern sector should bring upward the backward sector, increasing economic performance overall - Verdoon's law (Kaldor, 1978, 1975, Dixon and Thirlwall, 1975). Some researchers accepted Lewis's implication, but disputed its conclusion because of the possible existence of the Young (1928)-Myrdal (1957) effect, or the so-called circular and cumulative causation in which good performance always begets good performance, and poor performance breeds poor performance. Viewed from this narrow angle dual economy models are powerful, yet hardly useful tools for describing USNAEs and their relationships to their host(s).

In the second direction research stressed the political economy of performance in which comparative growth rate differences are due to the interactions of political and economic factors (Mueller, 1983). The ideas generated by this line work led to the third generation of neo-Solow growth models marked by influential efforts like those by Romer (1986), Mankiw, Romer, and Weil (1992), Barro (1991, 1994), and Barro and Sala-I- Martin (1995). The initial modeling emphasis went into adjusting labor for quality, but theory progressed just enough to create the momentum for endogenous growth models (Romer, 1989, 1990, 1994, Solow, 1994). In these new models economic growth is a function of "objects" and "ideas", to borrow Paul Romer's lingo. Objects are subject to the initial conditions of the economy and subsequent diminishing returns to scale, while ideas are not. Hence, different economies can grow at different rates even if their objects and object productivities are the same. Thus, one of the strongest contributions of the new growth models, after accounting for the shortcomings pointed by Pack (1994), is bringing to renewed attention the old idea that the factors and forces of production can, perhaps must, be treated as endogenous determinants of economic growth (Lucas, 1988, 1993, Grossman and Helpman, 1991, Romer, 1990, 1993, 1994, Islam, 2004).

While clearly assertive that differences in factor productivities explain growth differences across economies, extant models are ambiguous in their explanations of the sources of factor productivity differences. This ambiguity is hard to comprehend beacuse Adam Smith's reincarnations like Sir W. Arthur Lewis (1965), T.W. Schultz (1981), and Gary Becker (1964) have long argued that , although necessary, resources and resource productivity are insufficient drivers of economic growth. For Lewis, basic to resources and resource productivity are the historical, philosophical, and social structures that motivate and sustain "*the will to economize*". *The will to economize* leads to the creation of institutions capable of organizing resources into productive uses, and therefore progress.[6] Thus, in attributing differences in average labor productivity across countries to institutions, broadly speaking, or social infrastructure particularly, Hall and Jones (1998, 1999) have resurrected the Smith-Lewis hypothesis. Their research effort is fresh, but the positive association alleged between strong economic performance and "good" institutions, is not new, see, e.g., Polanyi (1957) and others. Acemoglu, et. al. (2001), and Lee (2002) also found evidence supporting the link between institutions and economic performance, that is consistent with the model in which Smith sought the creation of institutions for progress (Angresano, 1992). Institutions are crucial to economic performance because they define the social relationships surrounding economic activities, and enable economic agents to pursue their self-interests to the ultimate benefit of society (Smith, 1957, 1974).

Although is sufficiently clear that the differences in factor productivity across countries, and hence in economic growth rates, come from differences in institutions, current literature on this topic does not tell us which parts of institutions are responsible for economic progress. It also leaves an information gap about the fact that in the real-world some economies sharing similar institutions perform differently, nonetheless.

II. DETERMINING INCOME ACROSS USNAEs

Aggregate income

Let us measure the economic performance (income) of the ith USNAE by Y_i (Amavilah, 2004a, b). Suppose Y_i is produced using local physical capital (K_i), technology (A_i), and the *economically capable population* (N_i). Also let Y_i be influenced by the general economic condition (Y_j) and the state of technology (A_j) of the host economy. Next assume that A_i augments N_i , Y_j affects Y_i directly, and A_j affects Y_i indirectly through N_i .[7] By supposing further a multiplicative production function and following Jones (1997, 1999) and Hall and Jones (1998, 1999), one can treat N_i as decomposable into raw labor (L_i) and human capital (H_i), so that

$$Y_i \;=\; [(A_iL_i)^{\alpha}K_i^{\beta}(A_je^{\phi S_i}L_i)^{\gamma}Y_j^{\delta}]e^{\mu_i}, \tag{1}$$

where A_iL_i is effective local L_i, neoclassically human capital is the equivalent of the quality-enhanced component of total labor given by $H_i = e^{\varphi S_i} L_i$; S_i is a measure of the processes leading to H_i building, such as schooling; and μ is a normally-distributed random error term.

So far so good. However, (1) underutilizes "good" theory. For one, L_i is too narrow a base for H_i ; it fails to recognize that the rate of diffusion of A_j is a function of the capacity rate of the embedded economy to soak up A_j. In other words, the rate of diffusion depends on the rate of adoption of A_j by N_i (Rogers, 1983, p. 233).[8] Thus, (1) is mistaken in its implication that the value of both human capital and raw labor becomes zero at retirement and/or during periods of unemployment, and that children do not own human capital before the legal working age. It seems reasonable to argue that once accumulated, human capital retains some of its "scrap value" past retirement and during periods of unemployment, and the accumulation process and contribution to the economy start early in life. The point? - Capitalized people continue to add value to economic performance even when those people are not directly employed in production.

Such an argument contrasts to conventional approaches like those by Sianesi and Van Reenan (2003), and Harnom, et. al. (2003), which measure returns to H_i only as returns to education. Hence, it makes better sense to say that $H_i = e^{\varphi S_i} N_i$ such that

$$Y_i = [(A_i L_i)^{\alpha} K_i^{\beta} (A_j e^{\phi S_i} N_i)^{\gamma} Y_j^{\delta}] e^{\mu_i}, \tag{2}$$

i.e., instead of L_i, N_i is the Nelson-Phelps channel that allows the flow and adoption of external technology (A_j) via H_i.

Average income

Dividing by L_i and taking the natural logarithms of both sides of (1) gives the log average labor productivity as

$$lny_i = \alpha_0 + \beta \ln k_i + \phi S_i + \gamma \ln n_i + \delta \ln y_j + \mu_i, \quad [\alpha_0 = \alpha \ln A_i + \gamma \ln A_j], \tag{3}$$

where $y_i = Y_i/L_i$, $k_i = K_i/L_i$, $n_i = N_i/L_i$, and $y_j = Y_j/L_i$ are familiar primitives. Similarly, from (2), but this time using N_i as the numeraire and logging naturally both sides, we get

$$\ln y_i^* = \alpha_0 + \alpha \ln \ell_i + \beta \ln k_i^* + \phi S_i + \delta \ln y_j^* + \mu_i, \quad [\alpha_0 = lnA_i + \ln A_j], \tag{4}$$

where $\ell_i = L_i/N_i$ is the local physical labor intensity of N_i, $k^*_i = K_i/N_i$ is the physical capital intensity of N_i, and $y^*_j = Y_j/N_i$ is the host's output (income) relative to N_i. From (3) and (4), y_j and y^*_j can be read either as spill-over effects of the host economy on the local economy, or as measures of what labor productivity would be if all U.S. output were produced by U.S. Native American labor alone, that is, the relative difference between local and host labor productivity.

At the aggregate level the lefthand sides of (1) and (2) mean the same thing. On the righthand side of (2) H_i is drawn from the economically capable population (N_i) larger than L_i, and it is not surprising that (3) ≠ (4). But the difference between the two is reconcilable since L_i is some proportion of N_i, we can rewrite (2) as

$$Y_i = [(A_i \Psi N_i)^{\alpha} K_i^{\beta} (A_j e^{\phi S_i} N_i)^{\gamma} Y_j^{\delta}] e^{\mu_i}, \quad [\Psi N_i = L_i]. \tag{5}$$

Now for a precisely defined relationship between N_i and L_i, the intensive form of (5) is equivalent to (3). The remaining task, to which I turn next, is to specify and measure N_i.

III. INCOME DETERMINATION AND INSTITUTIONS

Mining population for human capital: the Lasky adaptation

Previous research measures H_i as an institutional variable, and represents it with schooling, literacy, and the like. Then one can estimate (1) and (3), assuming $H_i = e^{\varphi S_i} L_i$. In theory one can also estimate (4) and (5) assuming $H_i = e^{\varphi S_i} N_i$. The question is: how does one measure N_i? To measure N_i I introduce a quantity-quality model familiar to economic geology, mining and geological engineering, and mineral economics. In its original use this model illustrates the responsiveness of a stock of resource, such as a mineral ore (*quantity*), to its average grade (*quality*) in one deposit or across deposits (Lasky, 1950).[9] By analogy I treat N_i as a rich stock that can be "mined" for human capital, and represent the transformation as an inverse relationship between the log of (cumulative) stock (N_i) and its corresponding quality ($\bar{q}_i$), i.e.,

$$lnN_i=\theta_0+\theta_1\bar{q}_i \Rightarrow \bar{q}_i=\lambda_0+\lambda_1 \ln N_i, \quad [\lambda_0=\theta_0/\theta_1 > 0,\ \lambda_1=1/\theta_1 < 0]. \tag{6.1}$$

Then for $N_i = f(\bar{q}_i), H_i = f(\bar{q}^i, S_i)$, or more specifically

$$N_i=e^{\theta_0+\theta_1\bar{q}_i},\ H_i=e^{\phi_i S_i}[N_i]=e^{\theta_0+\theta_1\bar{q}_i+\phi_i S_i}. \tag{6.2}$$

Eq. (6) implies that measured conventionally, S_i is not an adequate measure of H_i, and here is the difference.

According to the standard models, the desirable level of human capital (H_i^*) is

$$H_i^*=(1-\sigma)e^{\phi S_i}L_i=e^{\phi S_i}L_i,\ \sigma=0,\ 0<dlnH_i^*/dS_i=\phi<1, \tag{7.1}$$

implying that there is no human capital drain (or depreciation), either because L_i is fully employed already, or because, being tied to local A_i , it is unemployable outside the embedded economy. However, with nonzero human capital drain,

$$H_i^* = (1-\sigma)e^{\theta_0+\theta_1\bar{q}_i+\phi S_i} \Rightarrow dlnH_i^*/d\bar{q}_i = \theta_1, \quad dlnH_i^*/dS_i = \phi \qquad (7.2)$$

Eq. (7.2) means that A_j transforms N_i into H^*_i that can be employed on and off embedded economies such as USNAEs, and in that case σ would be nonzero. Hence, $H_i^* < H_i$ depreciates slower with old age than it appreciates with youth.

Infrastructural v. superstructural effects of institutions

The extent of the influences of H_i on Y_i reflects the strengths and/or weaknesses of institutions in supporting economic performance. The question is: What parts of institutions are responsible for growth, since it is pretty obvious that economies with similar institutions are not performing similarly? To answer this question one can take advantage of an old Marxian dichotomy that holds that institutional determinants of economic growth can be both infrastructural and superstructural. The dichotomy acknowledges the dynamics underlying production forces and social relations, in the sense that factors of production are responsible for the transformation of the material conditions of the economy - the basic infrastructure. Changing the infrastructure in turn alters the factors of production and social relations of production, but infrastructural changes alone do not automatically lead to progress (development). They do not lead to progress because the infrastructure without the superstructure is like a skeleton without flesh on it - it won't purposely move. Again, changing the infrastructure is changing resources as well as social relations of production, but the effects of the change and their extent are muted or amplified by the superstructure (Marx, 1906, 1973, Cornforth, 1962, cf Rosenberg, 1982, pp. 34-51). Thus, one benefit of applying the Lasky model is that it permits separation of the two aspects of institutions by letting S_i to proxy infrastructural elements of institutions, and $\bar{q}_i$ to represent the superstructural components of institutions. Compactly,

$$H_i^* = (1-\sigma)e^{\omega R}(N_i), \ [N_i = N_i^* - L_i] \qquad (8)$$

where ω is a vector of parameters θ and ϕ, and R is a vector of variables S_i and $\overline{q}_i$. For $0 < \sigma < 1$, $H_i^* < H_i$, so that after accounting for H_i^* drain, (8) combines infrastructural and superstructural factors in its first term; completely infrastructural elements in its second term; and the difference holds the place of purely superstructural factors.

IV. MODEL ESTIMATION AND RESULTS

Given sufficient information on human capital drain and depreciation (σ), the appropriate human capital to use is (7) and (8). Without such information (6.2) is a second-best alternative so that aggregate income (output) is

$$\ln Y_i = \alpha_0 + (\alpha+\gamma)\ln L_i + \beta \ln K_i + \phi S_i + \theta \overline{q}_i + \delta \ln Y_j + \mu_i,\ \ [\alpha_0 = \alpha \ln A_i + \gamma \ln A_j + \theta_0]. \tag{9}$$

The average productivity of (9) is

$$\ln y_i = \alpha_0 + \beta \ln k_i + \phi S_i + \theta \overline{q}_i + \delta \ln y_j + \mu_i,\ \ [\alpha_0 = \alpha \ln A_i + \gamma \ln A_j]. \tag{10}$$

Again variables S_i and $\overline{q}_i$ measure institutional effects of human capital on performance (income). The next part of this paper presents the results from the estimation of equations (9) and (10) for 84 USNAEs. Tables 1.1 and 1.2, respectively, displays the findings for aggregate and average incomes considering the separate impacts of the economic conditions of the U.S. states in which USNAEs are located. The results of Tables 1.2 and 2.2 consider the economic condition of the USA as whole.

U.S. Native American aggregate income and the economic conditions of U.S. states

At the aggregate level the coefficient of capital ranges from 0.258 to 0.555, implying that the marginal effect of a one dollar increase in capital raises aggregate income by twenty-six to fifty-six cents. This range contains the usual “1/3 rule” and is consistent with the results of previous cross-sectional studies (Holtz-Eakin, 1993, Benhabib and Spiegel, 1994, Bloom, et. al., 2004). At between 0.60 and 0.86 the marginal effect of labor on aggregate income is higher than that of capital - meaning an additional worker adds nearly an extra dollar to aggregate income.

The effect of human capital on aggregate income depends on which measure of human capital is considered. If I took human capital to be the percentage of workers with high school or better education (E_{1i}), which is close to the schooling variable often used, human capital contributes positively to aggregate income. For example, a one percentage point increase in the educational attainment of a worker adds a minimum of three cents to aggregate income. When broadened from simple educational attainment to include health/life expectancy and "other" components, human capital (S_{1i}) adds about 50 cents to aggregate income for every 10% rise. Whether in its narrow (E_{1i}) or expanded (S_{1i}) version, the impact of human capital on aggregate income is not statistically significant. But, while econometric tuition recommends dropping E_{1i} and S_{1i} from estimation because they are not statistically different from zero, intuition argues for maintaining these variables, and for considering them in relation to the effects of $\overline{q}_i$ on aggregate income. Doing so shows that superstructural forces measured via $\overline{q}_i$ have a negative effect, so that the net marginal impact of human capital on aggregate income is cut in half to only 26 cents.

Next take human capital as E_{2i} and S_{2i} as outlined in the appendix below. In this case human capital has a negative, and significantly different from zero, impact on aggregate income. Between $8.20 and $12.40 of income is lost if human capital is increased by one percentage point. There is a negative net loss of income even after considering that $\overline{q}_i$ adds three cents to income for every increase in human capital. This suggests that human capital is both *thinly* and *shallowly* spread over the economically capable population (N_i). The consequence is that even when the superstructure is generally accepting of the transmission of external technology, the infrastructure is inadequately prepared for H_i accumulation as evidenced by a low human capital per economically capable person.

Finally, aggregate income responds with a fall of $1.50 to $1.80 for every one percent increase in the gross state product. One reason for this may be that 1990 was not a good year for the states involved. After all the prospects of the Gulf War I was already on the economy's mind. A second reason might be that the interaction between states and USNAEs is either weak, absent, or the economic conditions of states is not a good way of measuring state-USNAE relationships. One can also speculate that states and USNAEs are competitors for federal resources, especially in recessions, as occasional debates over casinos and gaming often seem to indicate.

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TABLE 1.1
AGGEGATE INCOME OF USNAEs GIVEN ECONOMIC CONDITION OF U.S. STATES, 1990[a]
(Dependent variable: $\ln Y_i$; Mean $\ln Y_i$: 18.517; Number of Observations: 84)

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Constant	10.540 (6.342)	10.119(3.700)	14.193(8.542)	10.106(3.678)	10.819(4.074)	17.250(9.940)	17.249(9.873)
$\ln K_i$	0.237(2.417)	0.555 (4.088)	0.258(2.964)	0.555(4.088)	0.475(3.545)	0.258(2.964)	0.258(2.933)
$\ln L_i$	0.858(13.508)	0.602 (5.86)	0.815(14.285)	0.603(5.586)	0.671(6.282)	0.815(14.285)	0.815(14.195)
E_{1i}		0.034 (0.229)					
E_{2i}	-8.537(-10.565)		-8.284(-11.528)				
S_{1i}				0.512(0.229)	0.187(0.849)		
S_{2i}						-12.425(-11.528)	-12.437-10.709)
$\bar{q}_i$					-0.247(-2.722)		0.002(0.03?)
$\ln Y_s$		-0.181(-3.414)	-0.155(-4.765)	-0.181(-3.414)	-0.172(-3.366)	-0.155(-4.765z0	-0.155(-4.734)
R^2	0.7524	0.4844	0.8076	0.4844	0.5292	0.8076	0.8077
SEE	0.92457	1.3425	0.8200	1.3425	1.2911	0.8200	0.8252
LLF[b]	-110.554	-141.353	-99.9434	-141.353	-137.540	-99.9434	-99.9434
DW(ρ)	2.156(-0.080)	2.107(-0.074)	1.901(0.047)	2.107(-0.074)	2.248(-0.126)	1.901(0.046)	1.899(0.048)

[a]Parentheses are t-values evaluated at the 5% level of significance.

[b]Log likelihood function.

TABLE 1.2
AGGREGATE INCOME OF USNAEs GIVEN ECONOMIC CONDITION OF THE USA, 1990[a]
(Dependent variable: lnY_i; Mean lnY_i: 18.517; Number of Observations: 84)

Variable	**1**	**2**	**3**	**4**	**5**	**6**
Constant	No Constant	No Constant	No Constant	No Constant	No Constant	No Constant
lnK_i	0.540(3.737)	0.236(2.417)	0.540(3.737)	045493.192)	0.236(2.417)	0.236(2.383)
lnL_i	0.661(5.29)	0.859(13.508)	0.661(5.29)	0.731(6.536)	0.859(13.508)	0.859(13.422)
E_{1i}	0.072(0.456)					
E_{2i}		-8.537(-10.565)				
S_{1i}			0.108(0.456)	0.252(1.709)		
S_{2i}					-12.805(-10.565)	-12.775(-9.776)
$\bar{q}_i$				-0.266(-2.771)		-0.0049-0.064)
lnY_u	0.188(2.1830	0.359(6.342)	0.188(2.160)	0.222(2.635)	0.466(7.752)	0.466(7.700)
R^2	0.4084	0.7524	0.4084	0.4608	0.7524	0.75624
SEE	1.4291	0.9246	1.4291	1.3729	0.9246	0.93038
LLF[b]	-147.132	-110.554	-147.132	-143.236	-110.554	-110.552
DW(ρ)	2.324(-0.183)	2.156(-0.080)	2.324(-0.183)	2.452(-0.227)	2.156(-0.080)	2.162(-0.083)

[a]Parentheses are t-values at 5% level of significance.

[b]Log likelihood function.

TABLE 2.1
AVERAGE INCOME OF USNAEs GIVEN ECONOMIC CONDITION OF THE U.S. STATES, 1990[a]
(Dependent variable: $\ln y_i$; Mean $\ln y_i$: 12.158; Number of Observations: 84)

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Constant	8.049(11.15)	8.078(10.61)	10.28(10.40)	11.79(20.15)	13.53(20.71)	10.26(10.52)	10.88(11.25)	16.61(20.57)	16.63(20.32)
$\ln k_i$[b]	0.423(8.830)	0.417(4.891)	0.603(6.099)	0.171(3.239)	0.340(5.621)	0.603(6.099)	0.521(5.211)	0.340(5.621)	0.341(5.581)
E_{1i}		0.019(0.125)	0.014(0.291)						
E_{2i}				-8.58 (-10.7)	-8.36(-11.53)				
S_{1i}						0.062(0.291)	0.199(0.944)		
S_{2i}								-12.54(-11.5)	-12.60(-10.8)
$\bar{q}_i$							-0.25(-2.70)		0.009(0.151)
$\ln y_s$			-0.223(-3.25)		-0.189(-4.49)	-0.223(-3.52)	-0.209(-3.16)	-0.189(-4.49)	-0.190(-4.47)
R^2	0.2930	0.2932	0.3757	0.7058	0.7652	0.3757	0.4285	0.7652	0.7653
SEE	1.4214	1.4300	1.3524	0.9225	0.8293	1.3524	1.3020	0.8293	0.83437
LLF[c]	-147.717	-1.47.70	-142.497	-110.888	-101.414	-142.497	-138.783	-101.414	-101.402
DW(ρ)	2.141(-0.14)	2.233(-0.15)	2.162(-0.10)	2.142(-0.07)	1.923(0.035)	2.162(-0.10)	2.303(-0.15)	1.923(0.035)	1.907(0.042)

[a]Parentheses are t-values at 5% level of significance.

[b] lnki = ln (K_i/L_i).

[c]Log likelihood function.

TABLE 2.2
AVERAGE INCOME OF USNAEs GIVEN ECONOMIC CONDITION OF THE USA, 1990[a]
(Dependent variable: $\ln y_i$; Mean $\ln y_i$: 12.158; Number of Observations: 84)

Variable	**1**	**2**	**3**	**4**	**5**	**6**
Constant	11.476(3.486)	13.317(6.707)	11.449(3.500)	11.992(3.808)	16.467(8.067)	16.452(7.951)
$\ln k_i$[b]	0.541(3.746)	0.237(2.423)	0.541(3.746)	0.455(3.199)	0.237(2.391)	0.237(2.391)
E_{1i}	0.073(0.459)					
E_{2i}		-8.536(-10.565)				
S_{1i}			0.109(0.459)	0.253(1.082)		
S_{2i}					-12.84(-10.565)	-12.774(-9.776)
$\bar{q}_i$				-0.266(-2.771)		-0.431(-0.063)
$\ln y_u$	-0.203(-1.061)	-0.095(-0.809)	-0.203(-1.016)	-0.187(-1.061)	-0.095(-0.808)	-0.0949-0.794)
R^2	0.3030	0.7082	0.3030	0.3647	0.7082	0.7082
SEE	1.4289	0.92449	1.4289	1.3728	0.9245	0.9303
LLF[c]	-147.122	-110.546	-147.122	-143.227	-110.546	-110.544
DW(ρ)	2.3146(-0.183)	2.156(-0.080)	2.3146(-0.183)	2.453(-0.228)	2.156(-0.080)	2.162(-0.083)

[a]Parentheses are t-values at 5% level of significance.

[b]$\ln k_i = \ln (K_i/L_i)$.

[c]Log likelihood function.

However, one cannot write these arguments in stone because the presence of large constant terms may mean that some important variables are missing. Even so, the regressions are well estimated, and most of them significant at the five percent level or lower. The included variables explain 49-81% of variations in the regressions. The predictive power of each model is also reasonable, given the narrow range of the standard error of the estimate (0.82 - 1.35).

U.S. Native American aggregate income and the economic condition of the USA

The preceding discussion focused on aggregate income given the economic condition of the U.S. states in which USNAEs are located. Considering the economic condition of the USA as a whole, the results show capital and labor contributing about the same to aggregate income as they did in the previous case (Table 1.1). *Ceteris paribus*, a one unit increase in capital and labor leads aggregate income to rise by 24 - 54 cents, and 67 - 86 cents, respectively. Estimates for both variables are reasonable, and compare well to findings about other developing areas (Benhabib and Spiegel,1994, Cohen , 1996, Holtz-Eakin, 1993, Bloom, et. al., 2004).

With respect to human capital both E_{1i} and S_{1i} have positive, but non-significant, effects on aggregate income. The social return to E_{1i} is about seven per cent, and between 11% and 25% for S_{1i}. But there is a loss in aggregate income of 27% due to an increase in $\overline{q}_i$. Furthermore, the negative effect of $\overline{q}_i$ on aggregate income in the case of S_{2i} is only -0.004, yet both E_{2i} and S_{2i} tend to reduce aggregate income by \$8.50 to \$12.80 for a 10% rise in the infrastructural basis of human capital, leaving an net impact of only two percent. The economic condition of the USA has a strong marginal impact on the aggregate income of USNAEs. A one dollar increase in U.S. GDP leads to an improvement in income of \$19.00 at the minimum and \$47 at the maximum. USNAEs benefit from many U.S. federal government programs.

The predictive power of the estimated models is good judging from the standard error of the estimate of 0.93 - 1.43. An R^2 of 0.41 to 0.75 suggests reasonable goodness-of-fit. Even so, the constant terms and associated standard errors of the estimates are large, leading to low t-statistics, and were therefore suppressed. While suppressing the constant terms improved the technical efficiency of parameters, it also cautions the interpretation of the results for well-known econometric reasons.

U.S. Native American average income and the economic conditions of the U.S. states

Turning to average income, the results show that increasing the capital-labor ratio by one percent increases average income by a minimum of \$17.00 and a maximum of \$60.00. Measured conventionally, human capital (E_{1i}) adds about two percent to average income. Infrastructural dimensions of human capital as represented by S_{1i} increases income by six percent to19.9%. Although these effects are not statistically significant, they are consistent with similar results for developing areas (Bloom, at. al., 2004). Broadening the human capital measure, the results indicate that a one percentage point increase in human capital reduces average income by $8.50, considering E_{2i}, and by $12.60, using S_{2i}. What this means is that infrastructural aspects of Native American institutions tend to increase average income, but their effects are negated strongly by superstructural elements of institutions. The economic condition of states does not aid Native American average income very much. A dollar's worth of an increase in gross state product, means a reduction in Native American average income of up to $2.20. One reasonable explanation is that with free movement of labor some Native American workers find employment and make a living outside tribal economies when the host economies are doing relatively better than native economies. Another explanation, and one I lean towards, is that the negative sign means that Native American average income is low because infrastructural and superstructural elements of institutions are out of sync. The models are reasonably well-explained and predicted as the goodness-of-fit of 29 % to 76% and standard error of the estimate of 1.43 respectively suggest.

U.S. Native American average income and the economic condition of the USA

While the U.S. economic condition in 1990 helps Native American aggregate income to rise, it reduces average income by up to 20%. At between 0.24 and 0.54 the coefficient of the capital-labor ratio is strongly related to average income, and it falls within the range predicted by the studies cited above. As in the case of the economic condition of states, conventional human capital (E_{1i}) contributes to average income in a manner not statistically different from zero, while the returns from extended human capital (S_{1i}) range from 11% to 25%. But those infrastructural effects are almost all offset by superstructural effects for which each percentage point reduces human capital impact on average income by 27%. Similarly the superstructural forces reduce the contribution of human capital to average income by 43% in addition to significant losses due to E_{2i} and S_{2i}.

The tables show that 30-70% of variations in average income are explained by the included variables. However, the large constant terms are a concern as they suggest missing variables. Figures 1 and 2 summarize the goodness-of-fit. Figure 1 compares actual to two predictions. The first (Predicted1) is Column 7 of Table 1.1 and Predicted2 is Column 6 of Table 1.2. Both indicate declining linear profiles of aggregate incomes across USNAEs. Aggregate income falls between log $14 and log $22, with few exceptions below and above this narrow band. By the same token, Figure 2 shows even a more pronounced downward trend in average income. Based on actual data and two predictions (Predicted1 or Column 9 of Table 2.1 and Predicted2 or Column 6 of Table 2.2). About half and half observed USNAEs have average incomes that fall within a band ranging from log $8 to log $16.

V. IMPLICATIONS AND CONCLUSIONS

What are the implications of the results for policy and further research, and what conclusions do they suggest? The results indicate that aggregate income of USNAEs depends mainly on the accumulation of t*hings* (K and L). Marginal products of capital and labor in these economies are comparable to those of developing areas, and in that limited sense USNAEs have more in common with developing countries than with the developed economies of which they are physical parts. Average investment in physical capital play the most important role; the marginal returns of 20% or higher seem to be well above the cost of capital in comparable situations. They clearly imply capital scarcity. If this implication is correct, the calls for more investment made by people like Senator Tim Johnson (South Dakota) on behalf of Native economies are fully justified. Even so, it must be noted that dependence on objects is not such a bad thing in itself. Extensions of Romer shows that economic growth depends on the accumulation of objects in the early stages of economic development, and increasingly on ideas in the late stages of development (Graca, et. al., 1995, Amavilah and Newcomb, 2004).

A further policy implication of low investment in physical capital is the less than expected effect of human capital on both aggregate and average incomes of USNAEs. Measured conventionally as educational attainment of labor and extended as educational attainment of labor plus two other dimensions of the quality of labor, health being one, human capital generally has a positive effect on the economic performance of USNAEs. However, these measures of human capital are too narrow to capture the full effect of a change in economic performance resulting from a change in human capital. For instance, one potential benefit of human capital accumulation is the creation of the Nelson-Phelps conduit (channel) through which external technology and other forms of productive knowledge can flow into USNAEs. This linkage appears weak; analysis suggests that because of low investment in physical capital, human capital per capita is much lower than human capital per worker. The former slows down the rates of adoption and spread of technology across the economically capable population; the latter does little stellar. The model used here shows two forces at work. On one hand are infrastructural

PUT FIGURES ABOUT HERE

Figure 1 - Actual and Predicted Aggregate Income of USNAEs, 1990

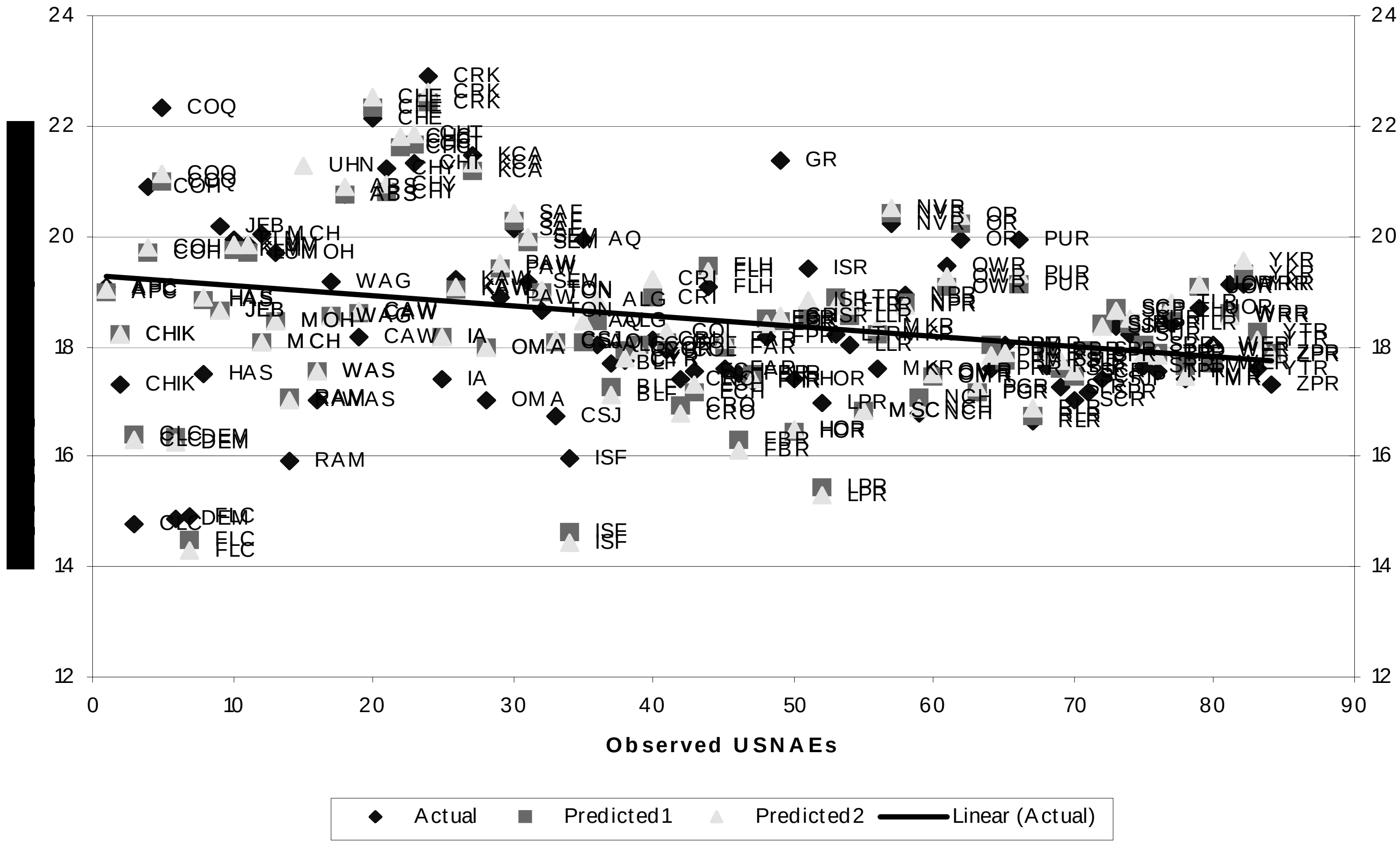
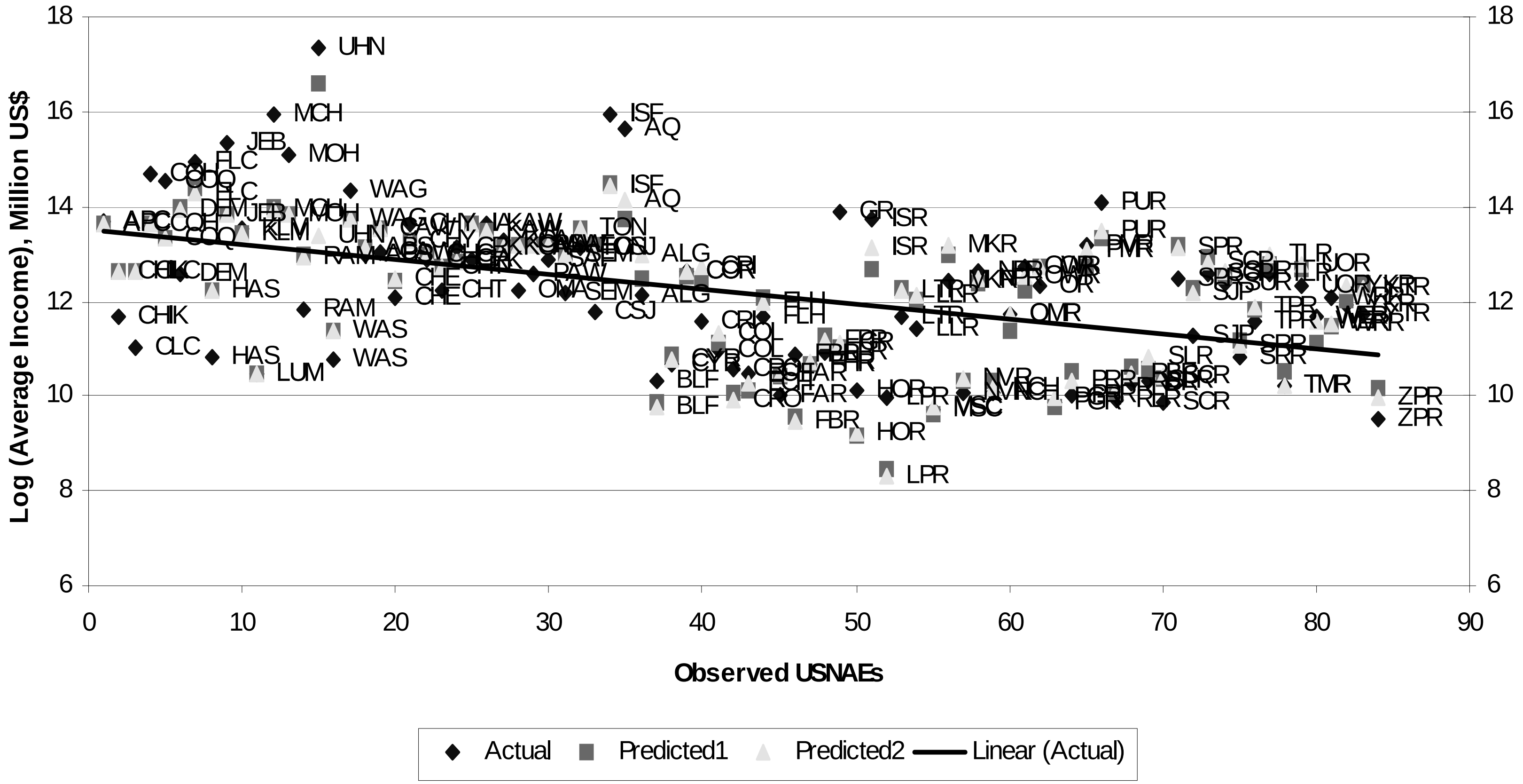


Figure 2 - Actual and Predicted Average Income of USNAEs, 1990



aspects associated with investment in physical stuff (schools, hospitals, and such, collectively S_i). On the other hand are superstructural elements designated by $\overline{q}_i$. Unless the two forces are in sync, or growth-promoting infrastructural forces are stronger than growth-retarding superstructural forces, the positive effect of human capital on performance is similarly constrained. To benefit from human capital accumulation, and through it economic performance, it is imperative that the forces of infrastructure and superstructure are allied, or friction between them minimized. How that can be done is a good research question, but not a new question. In a statement before the U.S. Committee on Indian Affairs, Henson (2003) called for the creation of "capable institutions", establishment of a "cultural match", and enhancement of "sovereignty and self-determination" of USNAEs in order to "create environments that are conducive to economic development" (p. 5). Cornell and Kalt (1998) stress the need for sovereignty and nation-building in order to enable effective institutions, while Mushinski and Pickering (2000) and Pickering and Mushinski (2001) argue that culture is more important to the performance of USNAEs than previously shown.

The results also show that the economic condition of the U.S. economy as a whole is more important to the performance of USNAEs than the state of U.S. states in which USNAEs are located. That seems counterintuitive, but it is not. USNAEs and the U.S. states are competitors for scarce resources and for federal government resources, especially in bad economic times, like 1990. In that sense it is easy to see why states and USNAEs may not count good performance by the other as beneficial to themselves.

I claim neither a unique expertise nor authority on USNAEs - and that may be the major weakness of this study. The motivating objective was to understand how embedded economies come to perform differently from their host(s), with whom they share basic institutions and location. USNAEs provide a useful case. Obviously the cost of aggregation is limited depth and possibly errors of commission and omission. The large constant terms of estimated regressions may be one example of the latter, which brings us back full circle to asking why the Solow residual is so large. As for errors of commission, I have deliberately refused the counsel of the econometric purist by leaving statistically insignificant variables in some regressions. My judgment is that the tradeoff between significance and substance was worth the loss of elegance. Technical efficiency of parameters is obviously important, but for now it belongs to a different project.

APPENDIX - VARIABLES, DATA AND OTHER MEASUREMENT ISSUES

(*How much of this I you think I need? Help!*)

The data for this study comes mostly from *The Statistical Record of Native North Americans (1996).* The *Statistical Record* draws mainly from the 1990 U.S. Bureau of Census and various Bureau of Indian Affairs's documents. Other sources of data used here are indicated as the need arise. Data collection focuses on a sample of 84 of the largest USNAEs listed in Table 0.0, and covers the variables described below.

Local Dependent Variables (Y_i, y_i): - The dependent variables are aggregate (Y_i) and average (y_i) income in thousands of 1990 US dollars. We assume that (Y_i,y_i) is approximately equal to the value of local production, and treat income and output interchangeably.

Local Independent Variables: Investment (I_i) and Capital (K_i , k_i): - In most empirical studies current capital stock (K_i) is calculated by the "perpetual inventory method" as the sum of current year investment (I_i) and depreciated previous year's capital stock (K_{it-1} - ΔK_{it-1}), or $K_i = I_i + (1-\Delta)K_{i-1}$, where Δ is the rate of depreciation (time subscript is ignored for obvious reasons). Unfortunately, there was no data on either K or I readily available. Instead, we found aggregate data on sales and receipts of all Native American-owned firms (ASR) by state and corresponding data on sales and receipts of Native American-owned firms with paid employees (WSR). One can argue that if capital is not paid, then the difference between ASR and WSR is *apparent profit* that was re-invested. This argument is no mere measuring without theory; the relationship between investment and expected profit is a clear one: high profit expectation drive demand for capital. And so profit is a reasonable proxy for capital. Hence it is assumed ASR-WSR is a reasonable proxy for that K_i[10]

Population: - The U.S. Native American population is a significant resource as well as a constraint. As a resource economies with high population have high aggregate income; as a constraint high population means low average income, and even lower per capita income.[11] The bulk of the population is in the 22 -59 and older group. From the *Statistical Record* there is a strong indication that Native Americans accumulate human capital later in life, and the process often continues past 65. This regularity ran against our *a priori* expectation which was that with technological advancement there would be a backward and forward propagation of human capital formation.

Total Labor and Workforce (L_i): - The labor force is workforce (L_i) plus the number of unemployed workers. The conventional and extended measures of human capital (E_{1i}, S_{1i}) are based on L_i as no data is available on the number of aggregate hours worked, which is a more precise measure of labor effort.

Economically Capable Population (N_i)*: -* This variable includes all *economically capable* people aged 14 - 74 years, i.e., all people that are neither underage nor in restrictive institutions. Some people who are 16 - 65 years of age already belong to L_i, so that N_i is the sum of L_i, pre-L_i aged 14-15 years, and post-L_i aged 66-74 years not already part of L_i. A detailed investigation of the data shows that the majority of L_i is in the 22-59 years age group, and it is here where unemployment has its worst effect, because at that age many people are married or are considering marriage and family. But since graduation from both high school and college comes later in life, with 25 years of age not uncommon, it appears that full-time careers start late in life, and often last past the typical retirement age of 65. Also past the retirement age, private sector employment of persons 66-74 years old falls, while employment in traditional occupations and self-employment increase, which tends to reduce the transmission of A_j. Preliminary investigations of the relationship between aggregate income and capital, labor, and the economically capable population show that aggregate income is generally more correlated with capital than with labor and N_i, but the correlation between N_i and aggregate income has the steepest slope.

Human Capital (H_i, h_i)*: -* Note that S_i has three dimensions to it. The first dimension is educational attainment measured here in two ways. In the first E_{1i} is the ratio of workers with high school or better education to the total workforce (L_i). The second measure of educational attainment (E_{2i}.) is the number of people with high school or better education relative to the economically capable population (N_i). From previous literature such as UNDP's calculation of the Human Development Index (HDI) the E_{ki} dimension accounts for two-thirds of the S_i index.

The second dimension of S_i is "Health". The rationale for this dimension is that a healthy population is likely to be physically and mentally more productive than a "sick" population. High productivity enables a population to earn high income. *Ceteris paribus*, with the high incomes a healthy population can stimulate and sustain human capital accumulation, reduce human capital depreciation, and probably (unfortunately) increase the rate of human capital drain. Here we measure "Health" by the average life expectancy (Life) of Native Americans over the 1980-1990 decade, calculated as

$$Life = \frac{LifeAct - LifeMin}{LifeMax - LifeMin} = \frac{71.5-61}{74.9-61} = 0.755, \tag{11}$$

where *LifeAct* is actual life expectancy, *LifeMin* is the minimum life expectancy, which is what life expectancy was in the 1960s-1970s, and *LifeMax* is average life expectancy of all US racial groups.

The third and last dimension of S_i, is "Other", which approximates the percentage sum of Native American representations in radio and television (0.002), law and law enforcement (0.005), electoral process (0.2002), and their impartial attitudes toward governance (0.4763), i.e., Other = 0.002+ 0.005 + 0.2002 + 0.4763 = 0.7215.

The "Health" and "Other" variables account for 1/6th of Si such that

$$\begin{aligned} S_{1i} &= 1.47265 + 0.667 * E_{1i} \\ S_{2i} &= 1.47265 + 0.667 * E_{2i}. \end{aligned} \tag{12}$$

In general $S_{ki} = a_0 + bE_{ki}$, implying that all USNAEs are equally disposed to human capital accumulation, given the initial educational condition, $a_0 = 1.47265$.

The three dimensions of S_i reflect institutional processes and systems that require investment in physical capital (schools, hospitals, public systems, etc.). Hence, they represent infrastructural aspects of institutions. To measure superstructural aspects of institutions we construct $\overline{q}_i$ as an index of local cultures and traditions that assist or resist H_i building, and through it the transmission of E_{2i}. via H_i. We argue that cultures and traditions can be open or closed to external influences, and construct $\overline{q}_i$ in a multidimensional way so that it is capable of capturing superstructural effects of institutions. First, we consider the ratio of people who served or are currently serving in the U.S. military to N_i (r_{m2n}). The military exposes servicemen and women to other cultural and traditional experiences. Hence, a high military-N_i ratio implies greater cultural/traditional openness, which eases the transmission and adoption of E_{2i}.. Second, we look at the ratio of languages spoken at home to the English language (r_{h2e}). In a closed economy people are more likely to speak their home language(s) than foreign languages, including English if that is foreign to them, and the ratio should be high. Third, we take the ratio of Native Americans residing in tribal areas to total enrolled in respective tribes (r_{r2e}). If $r_{r2e} = 1$, the tribal economy is completely closed; if $0 < r_{r2e} < 1$, the economy is *open inwards*, hence more people live on tribal land than are enrolled in that tribe. And if $r_{r2e} > 1$, the economy is *open outward*, i.e., more people are enrolled in the tribe than reside on tribal lands. An inwardly open economy is potentially more accepting of the inward flow of A_j than an outwardly open economy. Fourth, we consider the ratio of people in tribal occupations to N_i (r_{t2n}). The higher this ratio, the more closed the economy. Finally, we take the ratio of people with telephones to those without (r_{t2nt}), the rational being that one would have telephone services only if external communications need to be maintained. For $r_{t2nt} > 1$, the economy is open and accepting of external technologies. Thus,

$$\bar{q}_i = r_{t2nt} + r_{t2n} + r_{r2e} + r_{h2e} + r_{m2n} = \sum_{i=1}^{M=5} r_i,\ 0 < r_i < 100\%. \tag{13}$$

A priori expectations are for the effects of S_i and $\bar{q}_i$ on performance (income) to be positive and negative, respectively.

External Independent Variables: Conditions of State and National Economies (Y_j, y_j) and Technology (A_j): The condition of U.S. states (Y_s, y_s), and those of the entire U.S. economy (Y_u,y_u) affect the performance of Native American economies, where (Y_u,y_u) = real U.S. GDP MINUS (Y_i, y_i), real state products (Y_s, y_s) LESS (Y_i, y_i), and capital letters represent aggregate, and lowercase stands for average, variables. The connection is not hard to make; many Native Americans have full-time equivalent (FTE) employment with the federal, and local and state governments. In addition different federal departments support many programs for Native Americans. Support for these programs ebbs with the condition of the national economy. Data for these variables comes from the *Statistical Abstract of the United States: 2003*, 123rd Edition. A_j is assumed to be exogenous and to flow to Native American economies via H_i.

TABLE 0.0
CODES AND NAMES OF USNAEs[a]

No. Code	Full Name
1. APC	Apache Choctaw
2. CHIK	Chickahominy
3. CLC	Clifton Choctaw
4. COH	Coharie
5. COQ	Coquille
6. DEM	Delaware-Muncie
7. FLC	Florida Tribe, Eastern Creek
8. HAS	Haliwa-Saponi
9. JEB	Jena Band, Choctaw
10. KLM	Klemath
11. LUM	Lumbee
12. MCH	Meherrin
13. MOH	Mohegan
14. RAM	Ramapough
15. UHN	United Houma Nation(s)
16. WAS	Waccamaw Siouan
17. WAG	Wampanong Gay Head
18. ABS	Absentee Shawnee
19. CAW	Caddo-Wihita-Delaware
20. CHE	Cherokee
21. CHY	Cheyenne-Arapaho
22. CHC	Chickasaw
23. CHT	Choctaw
24. CRK	Creek
25. IA	Iowa
26. KAW	Kaw

[a]1-17 are TDSAs; 18-34 are TJSAs; and 35-84 are reservations and trust lands.

No. Code	Full Name
27. KCA	Kiowa-Comanche-Apache
28. OMA	Otoe-Missouria
29. PAW	Pawnee
30. SAF	Sac-Fox
31. SEM	Seminole
32. TON	Tonkawa
33. CSJ	Creek-Seminole, Joint
34. ISF	Iowa-Sac-Fox, Joint
35. AQ	Agua Caliente
36. ALG	Allegany
37. BLF	Blackfeet
38. CYR	Cheyenne River
39. COR	Coeur d’Alene
40. CRI	Colorado River Indian
41. COL	Coville
42. CRO	Crow
43. ECH	Eastern Cherokee
44. FLH	Flathead
45. FAR	Fort Apache
46. FBR	Fort Berthold
47. FHR	Fort Hall
48. FPR	Fort Peck
49. GR	Gila River
50. HOR	Hopi
51. ISR	Isabella
52. LPR	Laguna Pueblo
53. LTR	Lake Traverse
54. LLR	Leech Lake
55. MSC	Mississippi Choctaw

No. Code	Full Name
56. MKR	Muckleshoot
57. NVR	Navajo
58. NPR	Nez Perce
59. NCH	Northern Cheyenne
60. OMR	Omaha
61. OWR	Oneida West
62. OR	Osage
63. PGR	Papago
64. PRR	Pine Ridge
65. PMR	Port Madison
66. PUR	Puyallip
67. RLR	Red Lake
68. RBR	Rosebud
69. SLR	Salt River
70. SCR	San Carlos
71. SPR	Sandia Pueblo
72. SJP	San Juan Pueblo
73. SCP	Santa Clara Pueblo
74. SUR	Southern Ute
75. SRR	Standing Rock
76. TPR	Taos Pueblo
77. TLR	Tulalip
78. TMR	Turtle Mountain
79. UOR	Uintah & Ouray
80. WER	White Earth
81. WRR	Wind River
82. YKR	Yakima
83. YTR	Yankton
84. ZPR	Zuni Pueblo

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NOTES

1.In this paper the USNAEs refer to selected American Indian and Alaska Native Tribal Designated Statistical Areas (TDSAs), Tribal Jurisdiction Statistical Areas (TJSAs), and Reservations and Trust Lands (RATLs). The U.S. Bureau of Census defines TDSAs as "areas, delineated outside of Oklahoma by federally- and state-recognized tribes without land base or associated trust lands, to provide statistical areas for which the Census Bureau tabulates data. TDSAs represent areas generally containing the American Indian population over which federally-recognized tribes have jurisdiction and areas in which state tribes provide benefits and services to their members. The Census Bureau did not recognize TDSAs before the 1990 census", because some delineated TDSAs were only state-recognized tribes.

TJSAs are defined as "areas, delineated by federally recognized tribes in Oklahama without a reservation, for which th Census Bureau tabulates data. TJSAs represent areas generally containing the American Indian population over which one or more tribal governments have jurisdiction. If tribal officials delineated adjacent TJSAs so that they include duplicate territoy, the overlap area is called 'joint use area', which is treated as a separate TJSA for census purposes."

RATLs are defined as “areas with boundaries established by treaty, stature, and/or executive or court order, and recognized by the Federal Government as territory in which American Indian tribes have jurisdiction. State reservations are lands held in trust by State governments for the use and benefit of a given tribe. Trust lands are property associated with a particular American Indian reservation or tribe, held in trust by the federal Government. Trust lands may be held in trust either for a tribe (tribal trust land) or for an individual member of a tribe (individual trust land).” For a brief definition of all three designations, see http://factfinder.census.gov/metadoc/1990stf3td.pdf or the US Bureau of Census and Bureau of Indian Affairs (BIA) for details.

2.For a theoretical motivation and two other applications see Amavilah (2004a, 2004b).

3.The contribution of capial left unexplained a surprisingly large residual which Solow attributed to exogwnous tchnical change. However, som critics pointed to model specification error (wrong functional form), while others saw mis-specification error (wrong variables included or correct variables excluded). The latter set of criticism has not gone away to-date; the former is not peculiar to Solow because it has been raised about the restrictiveness of the original Cobb-Douglas production function (Douglas, 1949). Professor Joan Robinson was among those who detested the aggregate production function approach. In a related area, the interested reader may start with a recent retrospective and a reply by Cohen and Harcourt (2003a, 2003b) and the comments it provoked from Pasinetti (2003), Fisher (2003), Filipe and McCombie (2003), and Greenfield (2003).

4.In my view neo-Solow models start with Solow’s (1960) vintage paper, and matures with Arrow’s (1962) learning-by-doing. Solow’s (1997) reflection on the significance of of Arrow learning is excellent reading for any growth economist.

5.See Choi (1983, pp. 167-180) and Thirlwall (1978, pp. 129-142) for an extensive review of the literature.

6.The will to economize phrase is Lewis’s, but in some sense Paul Romer’s objects-versus-ideas version of the new growth model is a re-interpretation of Lewis (1965), especially Chapter 2, pp.23-56. Lewis’s book, first published in 1953, remains one of the best book on economic growth based on its coverage of theory, methodology, and policy.

7.This analysis does not seek to characterize this channel; information theorists such as Shannon (1948, 1998), Ash (1965), and Khinchin (1957) are good references.

8.This is an old idea on how cultural factors, for example, can aid or inhibit technical change, see, e.g., Bury (1932), Mead (1953), Cipolla (1965), Volti (1992), Rogers (1983), Pytlik, Lauda, and Johnson (1985), and Fryer (2003). Many authors have hinted at that observation such as Adelman and Morris (1967), Temple and Johnson (1998), Coleman (1990), Fryer (2003), Nisbet (1980), and Castle (2003). The term “institutional sclerosis” has also been used to make this very same point, see, e.g., Choi (1983: Chapters 3 and 9).

9.Following Harris (1993), Amavilah (2004a) outlines two other models of this type.

10.The problem here is that when this proxy is applied equally it favors smaller Native American economies located in large states like California. We offer no remedy for this bias at this time.

11.Further examination of the Native American population by age shows a high number of people in the 1-4 year age group, followed by a drop in the 5-6 age group, a rise in the 7-14 age group, and a very steep decline in the 17-21 age group, which seems consistent with the above national average suicide rate in this group.

ACKNOWLEDGEMENTS