Human Capital: Infrastructural and Superstructural Constraints to Economic Performance across U.S. Native American Reservations and Trust Lands

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***Abstract**: The current research emphasis on institutions as key determinants of economic performance, rather than on resources and resource productivity, has uncovered important questions for further research. For example, if institutions are central to economic performance, then what explains observed differences in performance across parts of one economy sharing similar institutions? What specific aspects of institutions are responsible for economic performance? This paper suggests that two broad aspects of institutions are involved - infrastructure and superstructure. The paper then applies a simple model to 50 U.S. reservation economies to assess how the two aspects affect income. The results show that resources and resource productivity are necessary but insufficient determinants of income in reservation economies. A key constraint is human capital; human capital is a serious limitation for two institutional reasons. First, infrastructures for fostering human capital (schools, hospitals, etc.) are either inadequate or inappropriate. Second, the local superstructure seems resistant to existing infrastructures that were supposed to enhance human capital formation. Since infrastructural and superstructural aspects of institutions are competitive rather than complementary, the Nelson-Phelps channel for transmitting external technology into USRATLs appears clogged up.*

***Keywords:** performance constraints, infrastructure, superstructure, institutions, human capital, Native American economies, reservation economies*

***JEL Code:** J15, J24, R30, R23, R38, F43, D24, C31, C51, C21, C53, P47, P47, P17, O15, O57, O51*

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0. Introduction

Economic growth theories have long argued that differences in economic performance across economies are due to a combination of differences in factor endowment, factor productivity, and technology. An obvious reading of these arguments suggests that parts of one economy should perform the same, *ceteris paribus,* because there are significant benefits deriving from interactions among the parts via trade, human capital, and even geographical location (Moreno and Trehan, 1997). Yet **U**.**S**. **N**ative **A**merican **R**eservations and **T**rust **L**ands (***USRATLs***) differ in economic performance among themselves as well as from their host(s) - the general U.S. economy and U.S. state economies - of which they are parts, often with enormous implications for the welfare of Native Americans (USDOC/EDA, 1996, Cornell and Kalt, 1998).[2] For example, during the 1990s the average unemployment rate among Native Americans was above 20%, in some cases topping 35%, compared to six percent for the USA as a whole. The unemployment rate among persons younger than 24 years of age is in double digits (Cornell and Kalt, 1998). Moreover, while the U.S. national median family income is $35,000, for Native Americans it is about $21,000. A large gap exists between the Native American per capita income per of only $8,284 and the U.S. national average of $14,420. Up to 10% of Native American *families* and 13.1% of the *entire* Native American population live in poverty (Vinje, 1996, Mushinski and Pickering, 2000, Pickering and Mushinski, 2001). National poverty statistics are tricky, but it seems about eight percent U.S. families and 11% of U.S. residents live in poverty. Furthermore, and perhaps more so because of low incomes, the high school and higher educational attainment of Native Americans 18 years and older is only 43.3% compared to 53.1% or more for all Americans.

What is the plausible explanation of the difference in economic performance between USRATLs, the U.S. economy, and among USRATLs themselves? Researchers have studied this question for a while. For example, Cornell and Kalt (1998) stress the importance of sovereignty and nation-building as determinants of long-run economic prosperity, which implies that institutions are fundamental to economic performance. Chase-Dunn and Hall (1998) on the other hand use a periphery-center model to demonstrate how in the past economic activities such as trade have depended on tribal networks. The conclusion of their study is that the recent decline in the economic performance of USRATLs is a consequence of weakened networks. While the full verdict on these research efforts is not yet in, there is a discernible consensus that economic growth across USRATLs is not only about lack of resources and simple expertise alone (Henson, 2003, Cornell and Kalt, 1998).

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[2]USRATLs are defined as "areas with boundaries established by treaty, stature, and/or executive or court order, and recognized by the Federal Government as [a] 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 brief definitions of all three designation see http://factfinder.census.gov/metadoc/1990stf3td.pdf or the US Bureau of Census and Bureau of Indian Affairs (BIA) for details.

The objective of this paper is to assess aggregate and average economic performance of USRATLs, using a novel model that is capable of distinguishing infrastructural from superstructural effects of institutions on performance (Amavilah, 2004a). The next section below provides a brief summary of the relevant literature. Section 2 specifies the equations to be estimated. The model specifications are then extended in the third section to allow for separate estimates of infrastructural and superstructural effects of institutions on economic performance. Section 4 describes the key variables, data, and other measurement issues, while Section 5 presents the estimation results. Concluding implications for policy and further research fall under the last section.

1. Brief Summary of Literature

Many generations of economic growth theorists have sought to explain how (and why) economic performance differs across economies, e.g., Denison (1967), Solow (1956, 1957), Arrow (1962), Easterly (2002), Temple (1999), and Lewis (1954). While the efforts spurred by Denison focus on change in the quantity and quality of resources, Lewis influenced other efforts that see the problem of differential performance in terms of the dualistic structure of some economies in which a "modern" (urban) sector and "backward" (rural) sector coexist. According to Lewis the solution to differential performance comes from the employment of surplus labor by the modern sector in the backward sector. However, the solution is too dependent upon continuous and fast expansion of the modern sector. The flow of labor may rise wages in rural areas, but potentially lower urban wages. Thus, dual economy models are hardly useful tools for describing USRATLs and their relationships to the host economy, mainly because USRATLs are dual themselves.

Other researchers and practitioners stress the political economy of economic performance in which comparative growth rate differences are due to the interactions of political and economic factors (Mueller, 1983). The ideas generated by this emphasis marked the beginning of influential works like those by Romer (1986,1989), Mankiw, Romer, and Weil (1992), Barro (1991, 1994), and Barro and Sala-I- Martin (1995) which concentrated on adjusting labor for quality (see Romer, 1990, 1994, Solow, 1994, Pack, 1994), and finally led to the emergence of the new growth models, according to which economic growth is a function of "objects" and "ideas", to borrow Paul Romer's lingo. A key distinction between ideas and objects is that while objects are subject to the initial conditions of the economy and subsequent diminishing returns to scale, ideas are not. In idea-driven economies scarcity is a blessing for it gives incentives that motivate innovations, such that different economies should still grow at different rates even if their objects and object productivities are the same. Thus, despite their shortcomings Pack (1994) points out, the new growth models renew an old idea that resources can, perhaps must, be treated as endogenous determinants of economic growth (Lucas, 1988, 1993, Grossman and Helpman, 1991, Romer, 1990, 1993, 1994).

The common problem with all these models is that the sources of factor productivity differences remained unexplained until the recent revival of Adam Smith's thesis that institutions are central to economic performance. While agreeing with the proposition that economic growth depends on resources, Smith's reincarnations such as Sir W. Arthur Lewis (1965) argue that overlying resources are historical, philosophical, and social structures that motivate and sustain "the will to economize",

i.e., scarcity leads to institutions that are capable of organizing resources into productive uses, and therefore progress. It is little wander that Hall and Jones (1998, 1999) attribute differences in average labor productivity across countries to institutions, broadly speaking, or social infrastructure particularly. Their research effort is not alone in asserting a positive association between strong economic performance and "good" institutions, see, e.g., Polanyi (1957), Hodgson (1988), North (1990), and others. Acemoglu, Johnson, and Robinson (2001) and Lee (2002) also found evidence supporting the link between institutions and economic performance, evidence that is consistent with the model in which Smith sought the creation of institutions (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 (Smith, 1957, 1974). Although it is sufficiently clear that the differences in factor productivity across countries come from differences in institutions, extant literature on this topic does not make it clear whether it is infrastructure or superstructure that is crucial to economic progress. Do, and should, economies with similar institutions perform the same? If yes, is such an answer sustainable with respect to USRATLs? - That is the problem.

2. Economic Performance across USRATLs

2.1 Aggregate Economic Performance

Following Amavilah (2004a) let Y_i be a measure of the economic performance of the ith USRATL. Next, let Y_i be produced from local physical capital (K_i), technology (A_i), and the *economically capable population* (N_i). Because USRATLs are embedded economies, the economic condition (Y_j) and the state of technology (A_j) of the host economy affect the production of Yi as well, i.e., $Y_i = f(K_i, A_i, N_i, Y_j, A_j)$. Assume that A_i augments L_i , Y_j affects Y_i directly, and A_j affects Y_i indirectly through N_i. By treating N_i as decomposable into raw labor (L_i) and human capital (H_i), and supposing a multiplicative production function,

$$\ln Y_i = A_0 + \alpha \ln L_i + \beta \ln K_i + \gamma \ln H_i + \delta \ln Y_j + \mu_i. \quad [A_0 = \ln A_i + \ln A_j]. \tag{1}$$

Human capital (H_i) in (1) is the equivalent of the quality-enhanced component of either total labor (L_i) or the economically capable population (N_i), and is given by

$$\begin{aligned} H_i &= e^{\phi_i S_i} L_i \qquad (a) \\ H_i &= e^{\phi_i S_i} N_i \qquad (b) \end{aligned} \tag{2}$$

where S_i is a measure of H_i such as schooling and the like.

Eq.2(a) is deficient in that it is based on L_i, making H_i too narrow by failing to recognize that the rate of diffusion of technology is a function of the capacity rate of the embedded economy , see, e.g., Rogers (1983:233). Thus, (1) is mistaken in arguing that the values of both human capital and raw labor become zero come retirement date, and that children do not own human capital before the legal working age. In practice human-capitalized people continue to add value to economic performance even when they are not directly employed in production, which contrasts to conventional approaches such as those by Sianesi and Van Reenan (2003), and Harnom, Oosterbeek, and Waltker (2003), which measure returns to H_i only as returns to education.[3] Hence, (2b) is preferable to (2a), and it is easy to interpret A_jN_i as the Nelson-Phelps (1966) channel that allows the flow of A_j via H_i from the host to embedded economies.

2.2. Average Economic Performance

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

$$lny_i = \alpha_0+\beta\ln k_i+\gamma\ln H_i+\delta\ln y_j+\mu_i, \quad (\alpha_0=\alpha\ln A_i+\gamma\ln A_j), \tag{3}$$

where $k_i = K_i/L_i$, and $y_j = Y_j/L_i$ can be read either as a spill-over effect of the host economy on the local economy, or as a relative measure of what U.S. labor productivity would be if U.S. output were produced by local labor alone.

3. Economic Performance and Institutions

3.1 Mining Population for Human Capital

It is common practice to estimate (1) and (3) as stated above, assuming $H_i = e^{\varphi S_i} L_i$. However, H_i is an institutional variable. Even its biological basis has institutional setting. Decisions about procreation, raising children, health, education, etc. are all informed by institutional constraints. Hence, $H_i = e^{\varphi S_i} N_i$ is the appropriate measure of human capital. The question is: How does one measure N_i? To answer that question we introduce the Lasky 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 (quantity) of resource, such as a mineral ore, to its average grade (quality) in one deposit or across deposits (Lasky, 1950).[4] By analogy N_i is a rich stock that can

[3] This is an old idea on how cultural factors can aid or inhibit technical change, available, in one form or another in Bury (1932), Mead (1953), Cipolla (1965), Volti (1992), Rogers (1983), Pytlik, Lauda, and Johnson (1985), Adelman and Morris (1967), Temple and Johnson (1998), Coleman (1990), Fryer (2003), and Nisbet (1980). The term "institutional sclerosis" has also been used to make this very same point, see, e.g., Choi (1983: Chapters 3 and 9).

[4] Following Harris (1993), Amavilah (2004a) outlined two other models of this type.

be "mined" for human capital. The Lasky adaptation represents an inverse relationship between the log of (cumulative) stock - the economically capable population (N_i) - and its corresponding average quality ($\bar{q}_i$), i.e.,

$$lnN_i=\theta_0+\theta_1\bar{q}_i \Rightarrow \bar{q}_i=\lambda_0+\lambda_1 \ln N_i, \quad [\lambda_0=\theta_0/\theta_1 > 0,\ \lambda_1=1/\theta_1 < 0], \tag{4.1}$$

for which

$$N_i=e^{\theta_0+\theta_1\bar{q}_i},\ H_i=e^{\phi_i S_i}[N_i]=e^{\theta_0+\theta_1\bar{q}_i+\phi_i S_i}. \tag{4.2}$$

Eq. (4) implies that measured conventionally, S_i is neither an accurate nor an adequate measure of H_i (Amavilah, 2004a). Here is further evidence. According to the standard models, the desirable level of human capital (H_i^*)

$$H_i^*=(1-\sigma)e^{\phi S_i}L_i=e^{\phi S_i}L_i,\ \sigma=0,\ 0<dlnH_i^*/dS_i=\phi<1, \tag{5.1}$$

suggesting that there is no human capital drain, 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,

$$H_i^*=(1-\sigma)e^{\phi S_i}N_i=(1-\sigma)e^{\theta_0+\theta_1\bar{q}_i+\phi S_i},\ 0<\sigma<1, \Rightarrow dlnH_i^*/d\bar{q}_i=\theta_1, \quad dlnH_i^*/dS_i=\phi \tag{5.2}$$

Eq. (5.2) means that A_j transforms N_i into H^*_i that can be employed inside and outside of USRATLs, and both σ and γ would be nonzero as well. Hence, $H_i^* < H_i$, but H_i depreciates slower with old age than it appreciates with youth.

3.2 Infrastructural Versus Superstructural Aspects of Institutions

The influences of H_i on Y_i imply the strength or weakness of institutions as determinants of economic performance. The question is: What part(s) of institutions, since it is pretty obvious that economies with similar institutions are not performing similarly? To answer this question one can take advantage of a Marxian dichotomy which states that institutional determinants of economic growth can be either infrastructural or superstructural. The dichotomy refers to the dynamics underlying production forces and social relations in transforming the material conditions of the economy - the basic structure or infrastructure. However, infrastructural changes alone progress they do not make, because the

infrastructure without the superstructure is like a skeleton without flesh. The effects and extent of infrastructural changes are muted or amplified by the superstructure (Marx, 1906, 1973, Cornforth, 1962, cf Rosenberg, 1982:34-51). The Lasky model permits one to separate the two dimensions of institutions by letting S_i proxy infrastructural elements of institutions, while $\bar{q}_i$ represents the superstructural components of institutions. Then the appropriate human capital, with the possibility of H_i^* drain, is

$$H_i^* = (1-\sigma)e^{\omega X}(N_i \equiv N_i^* - L_i), \quad [N_i^* = N_i + L_i], \tag{6}$$

where ω is a vector of parameters θ and ϕ, X is a vector of variables S_i and $\bar{q}_i$, and N^*i is the desired level of N_i. For $0 < \sigma < 1$, $H_i^* < H_i$, which means that (6) combines infrastructural and superstructural factors in its first term, infrastructural elements in its second term, and the difference stands for purely superstructural factors.

4. Measurement Issues: **Variables and Data**

The data for this study comes mostly from *The Statistical Record of Native North Americans (1996).* The *Statistical Record* draws its data mainly from the U.S. Bureau of Census and the Bureau of Indian Affairs. Other sources of data used here are indicated as the need arise.

Data collection focuses on a sample of 50 of the largest Reservations and Trust Lands (USRATLs) 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 is no data on either K or I. 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. Exploratory attempts to use the ratio of apparent profit to income ((ASR-WSR)/$Y_i \approx I/Y_i \approx K_i$), produced unacceptable results and was abandoned. Hence it is assumed that $K_i \approx$ ASR-WSR. 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.

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. 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. The bulk of the population is in the 22 -59 and older group. There is a strong indication that Native Americans accumulate human capital later in life, and out, of necessity the process often continues past 65. This regularity ran against our *a priori* expectation that with technological advancement there would be a backward and forward propagation of human capital formation.

Total Labor (L^*) 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 . No data is available on the number of aggregate hours worked.

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. A detailed investigation of the data shows that the majority of Li is in the 22-59 years age group, and it is here where unemployment has the 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 increases, which tends to reduce the transmission of A_j. Figure1 displays the relationship between aggregate income and capital, labor, and
the economically capable population. Generally aggregate income is more correlated with capital than with labor and N_i, but the slope of N_i is steepest.

Figure 1 - Aggregate Income, Capital, Labor, and Capable Population Resources in USRATLs, 1990

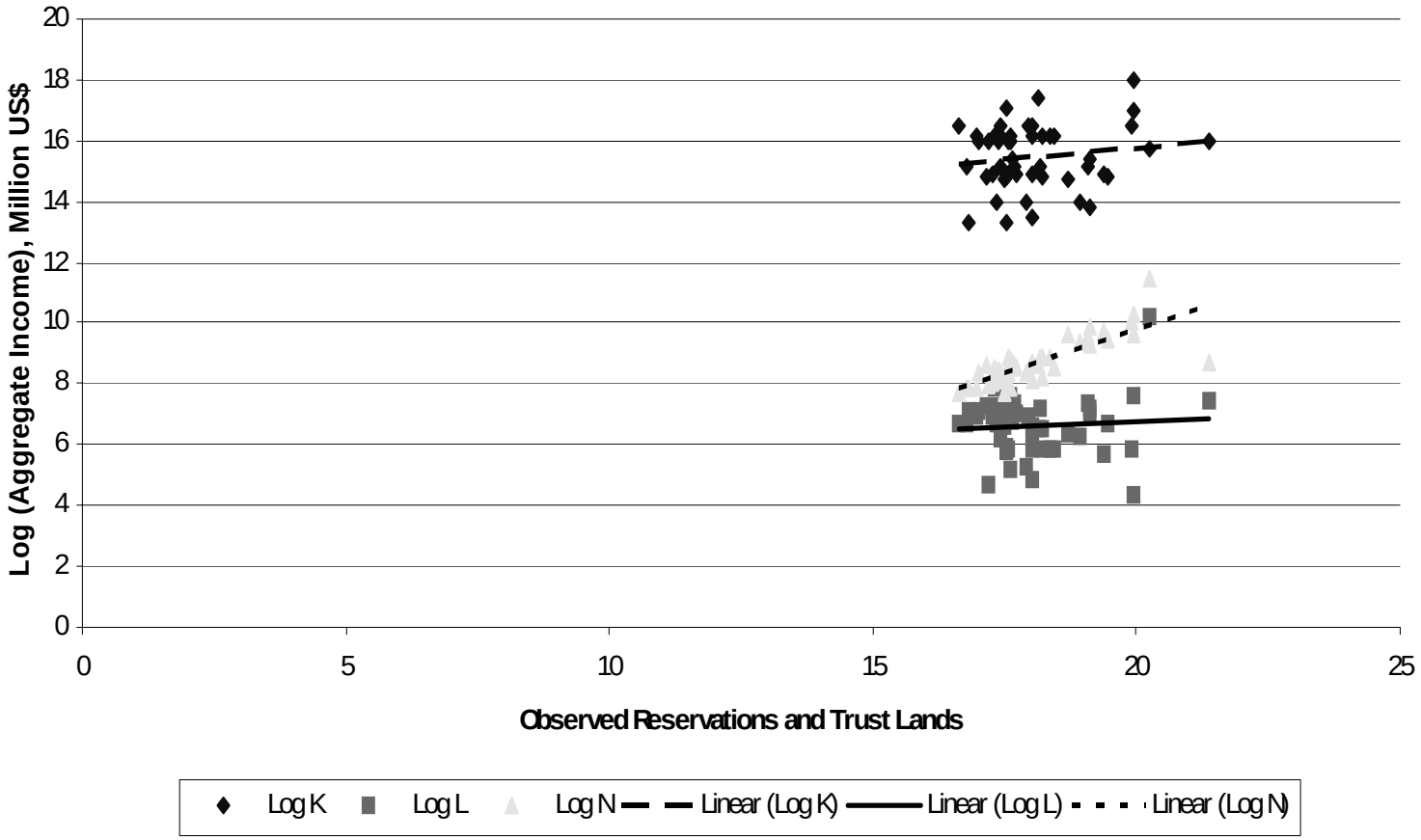


Figure 2 - Aggregate Income and Human Capital of USRATLs, 1990

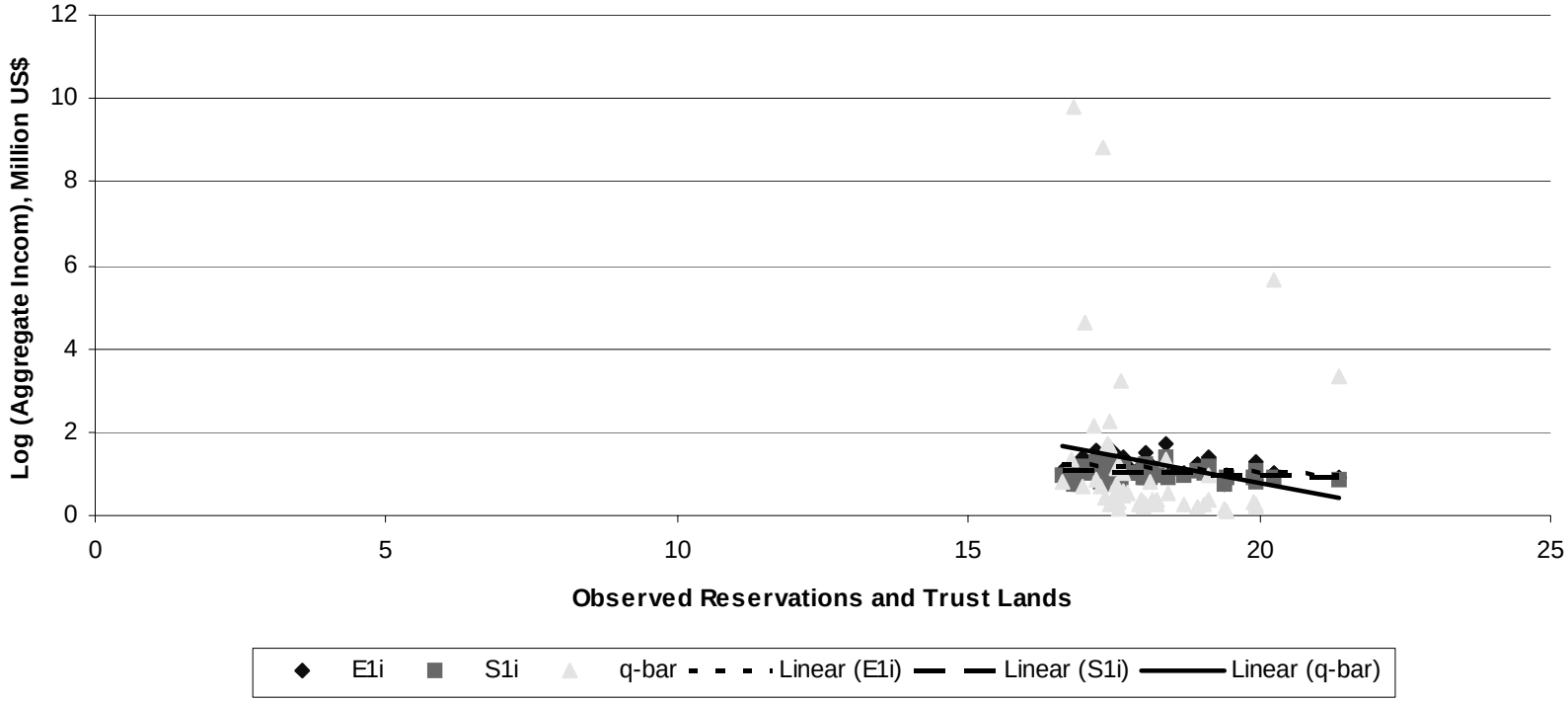


Figure 3 - Aggregate Income and Human Capital of USRATLs, 1990

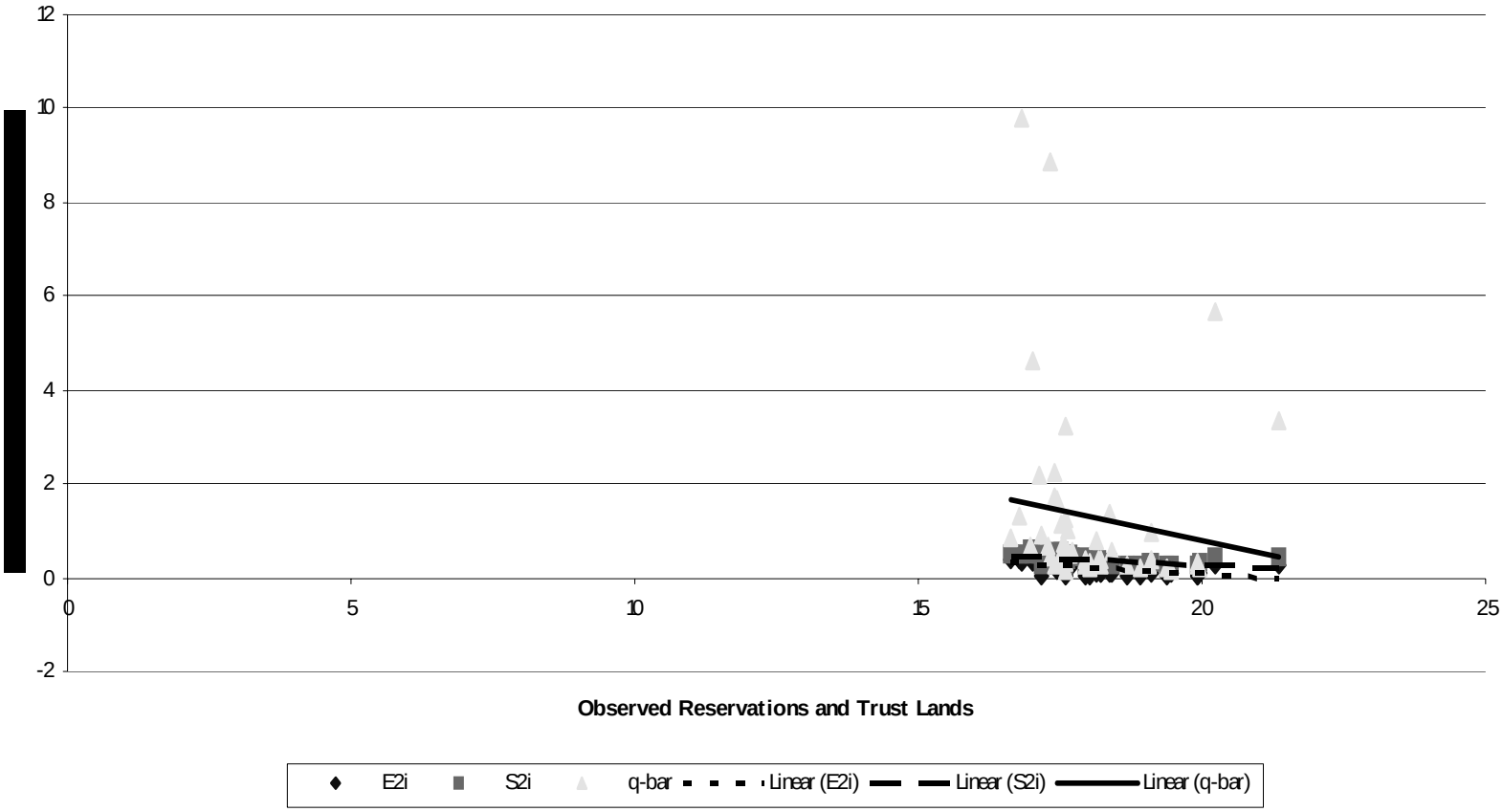


Figure 4 - Capable Population and Human Capital of USRATLs, 1990

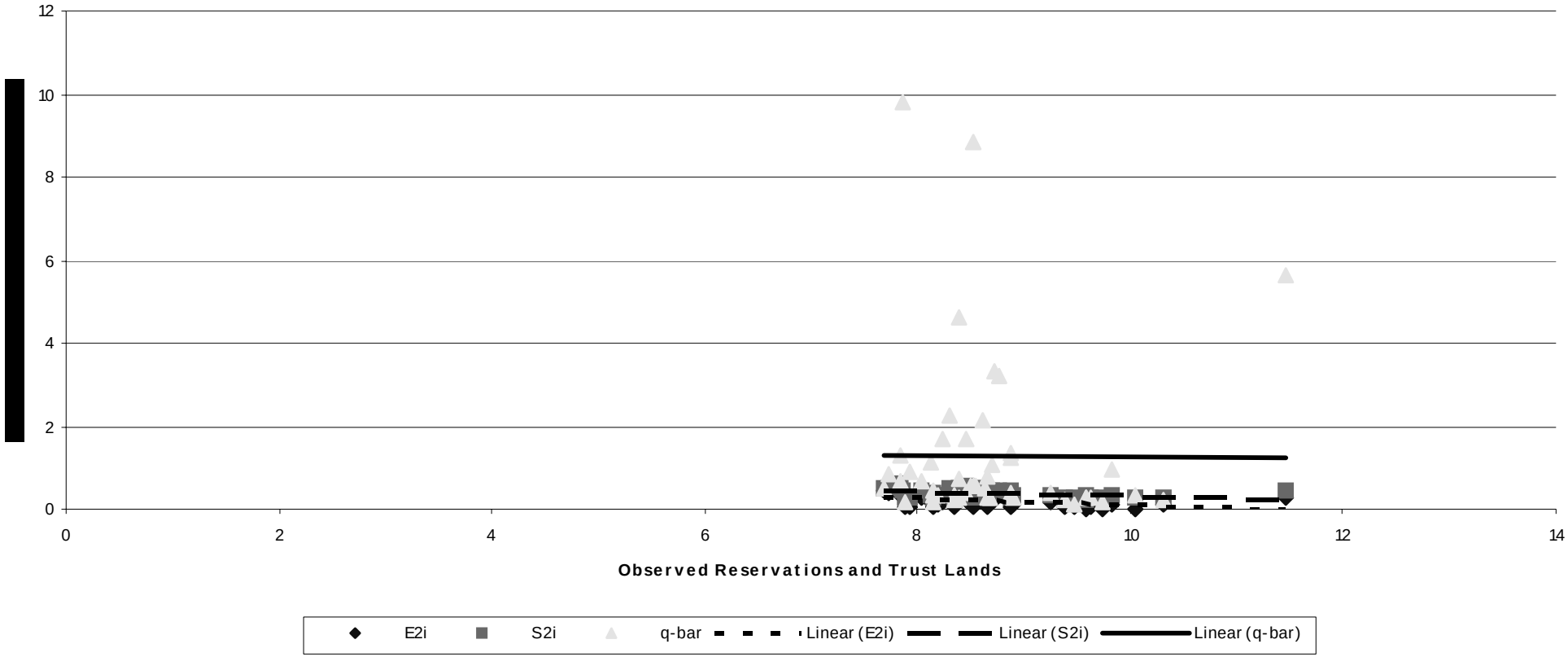


Figure 5 - Capable Population and Human Capital of USRATLs, 1990

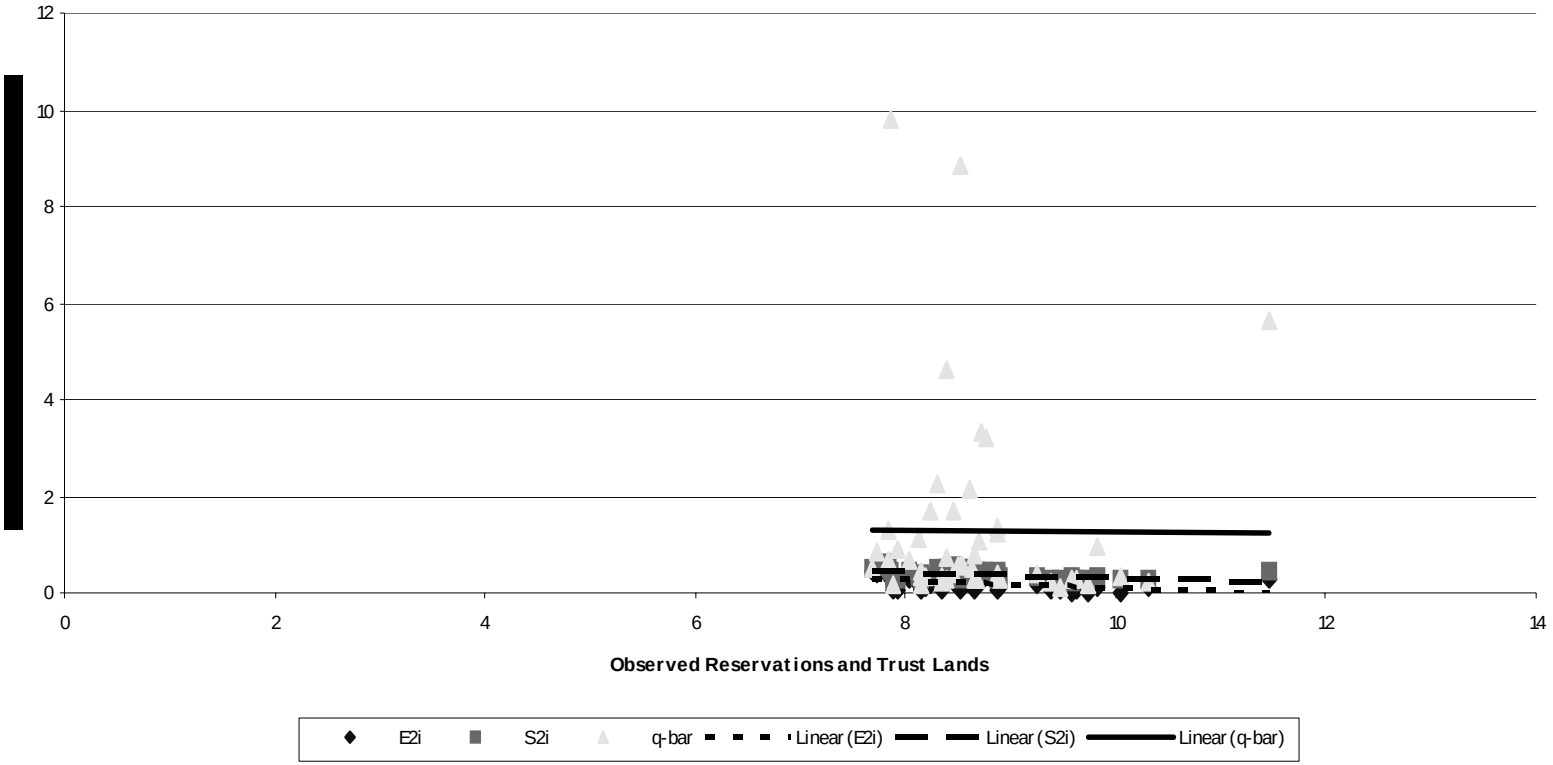


Figure 6 - Labor and Human Capital of USRATLs, 1990

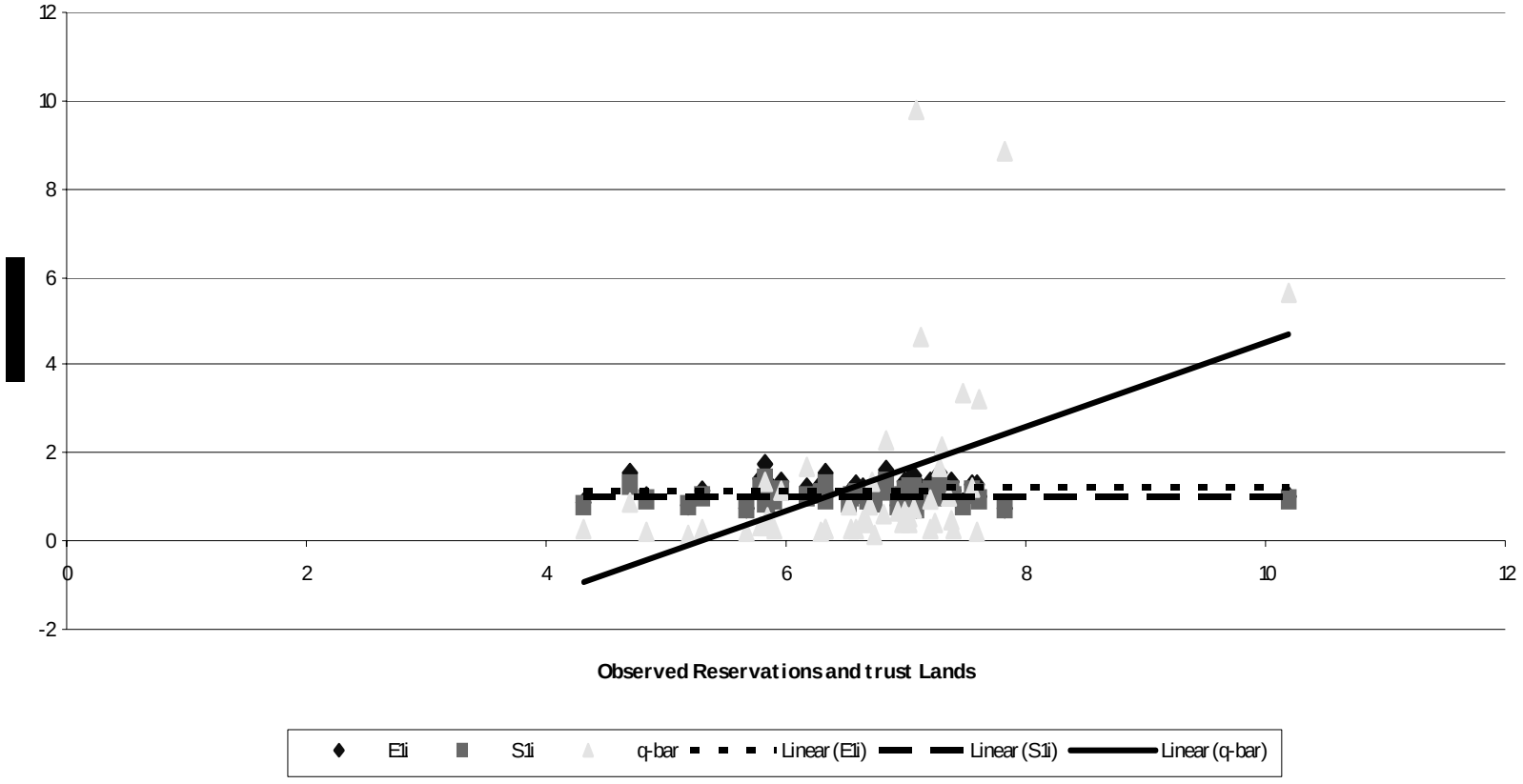


Figure 7a - Average Income and Human Capital of USRATLs, 1990

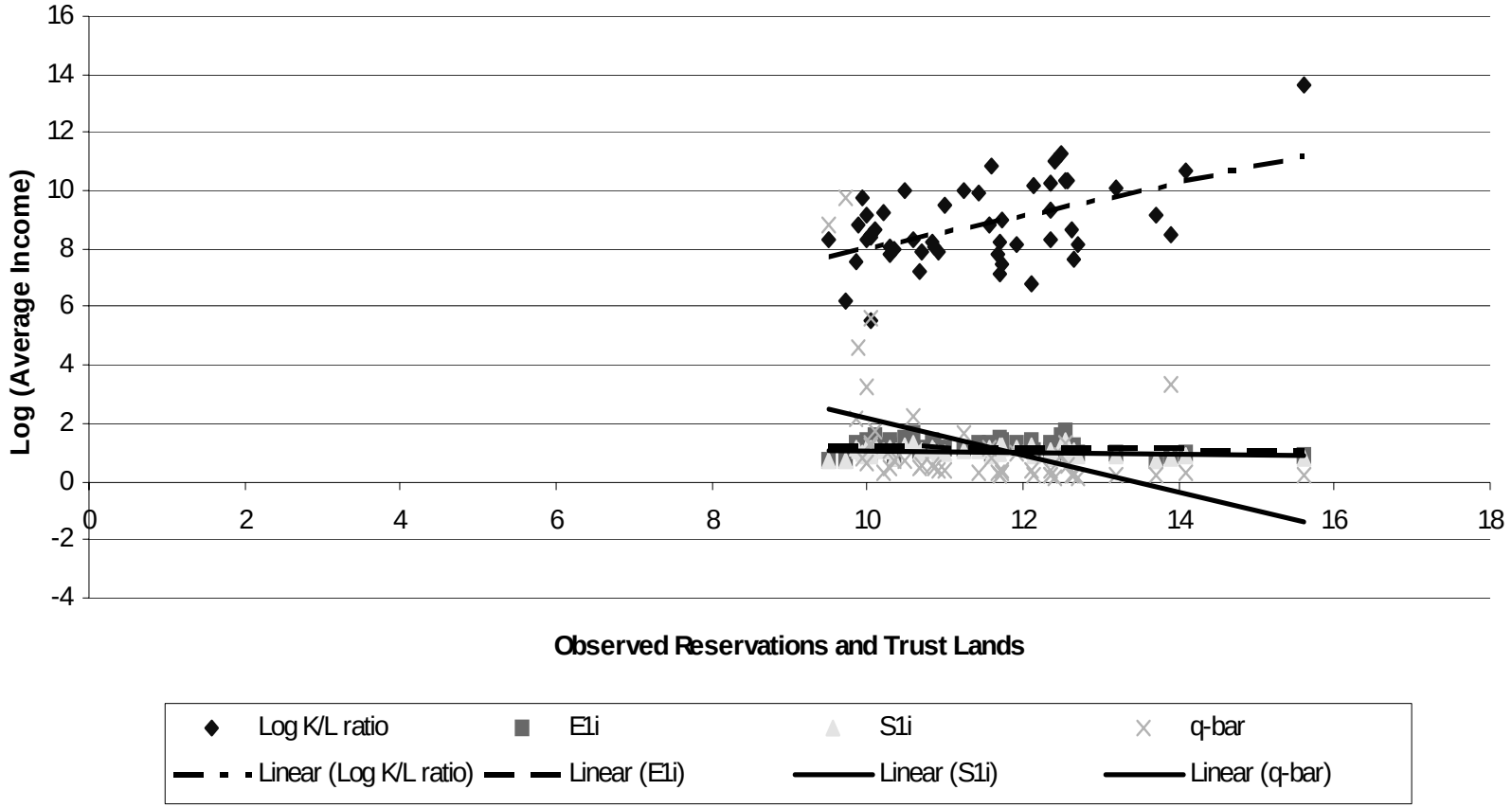
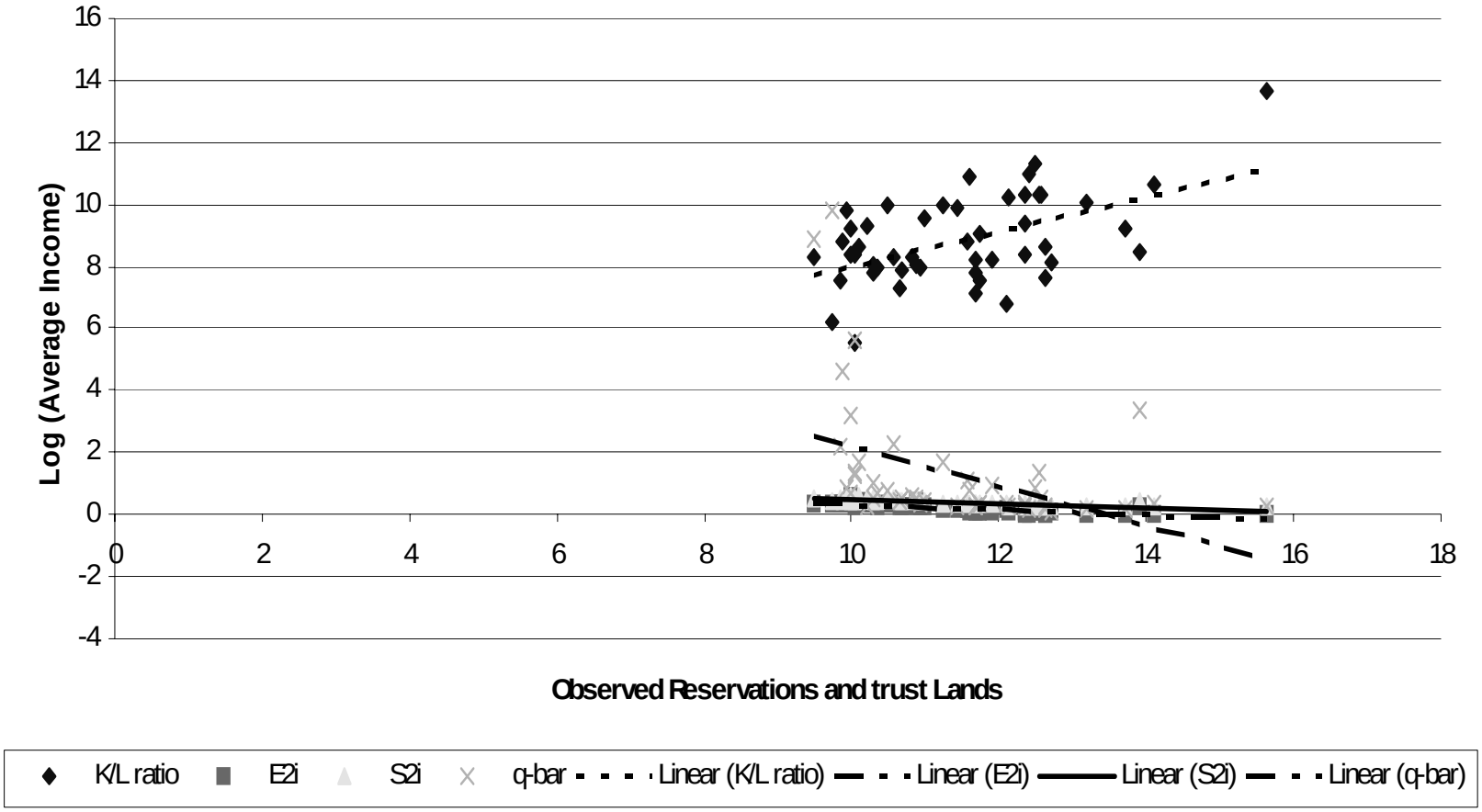


Figure 7b - Average Income and Human Capital of USRATLs, 1990



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 is the number of people with high school or better education relative to the economically capable population (N_i), which we designate by E_{2i}. From previous literature 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 increase the rate of human capital drain (cf. Bloom, Canning, and Sevilla, 2004). Here we measure "Health" by the average life expectancy (Life) of Native Americans over the 1980-1990 decade, calculated as

$$Life = \frac{LifeAct \; - \; LifeMin}{LifeMax \; - \; LifeMin} = \frac{71.5 - 61}{74.9 - 61} = 0.755, \tag{7.1}$$

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 Si, "Other", approximates as 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 and objective 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

$$\begin{aligned} S_{1i} &= 1.47265 \; + \; 0.667 * E_{1i} \\ S_{2i} &= 1.47265 \; + \; 0.667 * E_{2i}. \end{aligned} \tag{7.2}$$

In general $S_{ki} = a_0 + bE_{ki}$, which implies that all USRATLs are equally disposed to human capital accumulation, given the initial 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 A_j 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 currently serving in the 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. 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 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 those 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 in 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,

$$\bar{q}_i = r_{t2nt} + r_{t2n} + r_{r2e} + r_{h2e} + r_{m2n} = \sum_{i=1}^{M=5} r_i,\ 0<r_i<100\%. \qquad (8)$$

A priori expectations are for the effects of Si and $\bar{q}_i$ on performance to be positive and negative, respectively. Figures 2-4 associate aggregate income with various measures of human capital. Figures 5-6 focus on human capital versus human capital measures, as well as N_i versus the measures of human capital, while Figure 7 displays average income.

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. 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 came 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.

5. Estimation Results

Given full information on human capital drain and depreciation, the appropriate human capital to use is (5) and (6). Without such information we utilize (4) to replace N_i so that the equation for estimating aggregate income (output) is

$$\ln Y_i=\alpha_0+(\alpha+\gamma)\ln L_i+\beta\ln K_i+\phi S_i+\theta\bar{q}_i+\delta\ln Y_j+\mu_i,\ [\alpha_0=\alpha\ln A_i+\gamma\ln A_i+\theta_0]. \quad (9.1)$$

The average of (9.1) is

$$\ln y_i=\alpha_0+\beta\ln k_i+\phi S_i+\theta\bar{q}_i+\delta\ln y_j+\mu_i,\ [\alpha_0=\alpha\ln A_i+\gamma\ln A_j+\theta_0], \quad (9.2)$$

where again variables S_i and $\bar{q}_i$ measure institutional effects of human capital on performance.

U.S. Native American Aggregate Income

Table 1.1 reports estimation results given the economic conditions of the U.S. states in which USRATLs are located. From these results the impact of capital on aggregate income ranges from -0.02 to 0.19. The negative effect of capital on aggregate income is not statistically different from zero, and so it seems that a one-unit rise in capital leads aggregate income to increase strongly by 19%. This finding is similar to what Amavilah (2004b) finds with respect to 84 U.S. Native American economies, and it is also comparable to the steady state impact of 15.5% reported by Holtz-Eakin (1993) for U.S. states.

From the same table the effect of an additional worker on aggregate income is an extra $68.00 per year. However the potential gain in aggregate income due to one more raw labor is all but wiped out by the decline in aggregate income resulting from an increase in human capital. For instance, by increasing conventional human capital (E_{1i}) by one percentage point, aggregate income falls by $96 per annum when ys is excluded, and by $58 when y_s is included. The marginal impact of S_{1i} is to increase aggregate income by 0.873 and due to $\bar{q}_i$ reduce it by -1.53. The situation is no better with respect to E_{2i} and S_{2i} whose partial coefficients are as low as -9.30. These results are consistent with Vinje's (1996) -7.8 partial coefficient of educational attainment with respect to income of 23 Western reservations. The implication of the negative effect of education on income suggests that human capital accumulation weakens, or is perceived to weaken, tribal commitment and is thus not well-received. On the other hand, high educational attainment increases human capital drain. Both rationalizations are consistent with the negative impact of $\bar{q}_i$ on aggregate income. Fortunately, the increase in the economic condition of host states tends to increase aggregate income by $26 per year. Up to 58% of variations in aggregate income are explained by the included variables, but the R-square statistic may be misleading given large constant terms.

Table 1.1 - Aggregate Income of USRATLs Given Economic Condition of U.S. States, 1990[e]
(Dependent variable: $\ln Y_i$; Mean $\ln Y_i$: ?; Number of Observations: 50)

Variable	1	2	3	4	5	6	7
Constant	15.195(6.429)	11.996(7.219)	10.365(3.925)	11.368(2.541)	11.444(2.541)	12.643(4.713)	12.112(4.375)
$\ln K_i$	0.150(1.086)	0.194(2.056)	0.147(1.326)	0.010(0.066)	-0.022(-0.143)	0.1479(1.326)	0.131(1.156)
L $\ln L_i$	0.084(0.559)	0.667(5.176)	0.79(5.213)	0.174(1.111)	0.341(1.983)	0.679(5.213)	0.717(5.169)
E_{1i}		-6.375(-7.473)					
E_{2i}			-6.172(-6.909)				
S_{1i}				-0.87(-0.893)	-1.529(-1.533)		
S_{2i}						-9.258(-6.909)	-9.019(-6.554)
q_i					-0.168(-2.054)		-0.047(-0.821)
$\ln Y_s$			0.091(0.797)	0.257(2.541)	0.265(1.629)	0.091(0.797)	0.111(0.950)
R^2	0.0309	0.5623	0.5684	0.1259	0.2024	0.5684	0.5749
SEE	1.0131	0.68826	0.69100	098330	0.94990	0.69100	0.69352
LLF[f]	-70.0526	-50.1827	-49.8324	-67.4711	-65.1814	-49.8324	-49.4522
DW(ρ)	2.025(-0.105)	1.6368(0.115)	1.7540(0.061)	2.129(-0.101)	2.218(-0.136)	1.754(0.061)	1.8732(0.002)

[e]Parantheses are t-values, significance at 5% or lower level.

[f]Log likelihood function.

Table 1.2 - Aggregate Income of USRATLs Given Economic Condition of USA, 1990[a]
(Dependent variable: $\ln Y_i$; Mean $\ln Y_i$: ?; Number of Observations: 50)

Variable	**1**	**2**	**3**	**4**	**5**	**6**
Constant	No Constant	No Constant	No Constant	No Constant	No Constant	No Constant
$\ln K_i$	0.129(0.946)	0.194(2.0560	0.129(0.964)	0.102(0.764)	0.194(2.056)	0.189(1.989)
$\ln L_i$	0.088(0.595)	0.667(5.176)	0.088(0.595)	0.249(1.505)	0.667(5.176)	0.693(5.087)
E_{1i}	-0.964(-1.579)					
E_{2i}		-6.375(-7.473)				
S_{1i}			-1.447(-1.579)	-2.108(-2.221)		
S_{2i}					-9.562(-7.473)	-9.433(-7.234)
$\bar{q}_i$				-0.164(-1.979)		-0.036(-0.635)
$\ln Y_u$	0.566(6.659)	0.408(7.219)	0.578(6.565)	0.587(6.861)	0.489(8.915)	0.485(8.737)
R^2	0.0807	0.5623	0.0807	0.1543	0.5623	0.5661
SEE	0.99741	0.68826	0.99741	0.96723	0.68826	0.69277
LLF[b]	-68.7325	-50.1827	-68.7325	-66.6471	-50.1827	-49.9600
DW(ρ)	1.8974(0.009)	1.368(0.115)	1.8974(0.009)	1.9984(-0.032)	1.6368(0.115)	1.7112(0.077)

[a]Parentheses are t-values, significance at 5% or lower level.

[b]Log likelihood function.

Table 2.1 - **Average Income of RATLs Given Economic Condition of U.S. States, 1990**[a]
(Dependent variable: $\ln Y_i$; Mean $\ln Y_i$: 11.447; Number of Observations: 50)

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Constant	7.04(6.83)	8.12(5.95)	2.41(1.16)	10.7(14.6)	9.34(6.39)	2.48(1.11)	5.37(2.2)	11.67(6.9)	11.63(6.91)
$\ln k_i$[b]	0.49(4.34)	0.48(4.24)	0.072(0.44)	0.243(3.25)	0.161(1.515)	0.071(0.44)	0.013(0.08)	0.161(1.52)	0.136(1.248)
E_{1i}		-0.84(-1.21)	-0.19(0.29)						
E_{2i}				-6.75(-9.27)	-6.31(-7.58)				
S_{1i}						-0.28(-0.29)	-1.27(-1.27)		
S_{2i}								-9.42(-7.58)	-9.09(-6.92)
$\bar{q}_i$							-0.21(-2.58)		-0.05(-0.93)
$\ln y_s$			0.48(3.42)		0.112(1.084)	0.483(3.42)	0.422(3.11)	0.112(1.08)	0.122(1.17)
R^2	0.2814	0.3030	0.4440	0.7459	0.7523	0.4440	0.5155	0.7523	0.7569
SEE	1.1422	1.1368	1.0263	0.68637	0.68510	1.0263	0.96866	068510	0.68614
LLF	-76.575	-75.8107	-70.1613	-50.5828	-49.9527	-70.1613	-66.7207	-49.9527	-49.4795
DW(ρ)	2.186(-0.15)	2.0877(-0.1)	2.389(-0.22)	1.655(0.10)	1.7894(0.04)	2.389(-0.23)	2.384(-0.22)	1.789(0.04)	1.897(-0.009)

[a]Parentheses are t-values, significance at 5% or lower level.

[b]Equal to ln(K/L).

Table 2.2 - Average Income of RATLs Given Economic Condition of U.S. States, 1990[a]
(Dependent variable: $\ln Y_i$; Mean $\ln Y_i$:11.447; Number of Observations: 50)_

Variable	1	2	3	4	5	6
Constant	-6.347(-1.620)	7.894(2.352)	-5.991(-1.514)	-1.829(-0.418)	10.247(2.882)	10.788(2.932)
$\ln k_i$[b]	0.129(0.946)	0.194(2.057)	0.129(0.946)	0.102(0.765)	0.194(2.057)	0.189(1.990)
E_{1i}	-0.965(-1.579)					
E_{2i}		-6.375(-7.473)				
S_{1i}			-1.447(-1.579)	-2.108(-2.221)		
S_{2i}					-9.562(-7.473)	-9.433(-7.235)
$\bar{q}_i$				-0.164(-1.919)		-0.035(-0.635)
$\ln y_u$	0.782(3.879)	0.139(0.861)	0.782(3.879)	0.649(3.139)	0.139(0.861)	0.117(0.703)
R^2	0.4749	0.7500	0.4749	0.5169	0.7500	0.7522
SEE	0.99743	0.68826	0.9743	0.96726	0.68826	06.9277
LLF	-68.7339	-50.1831	-68.7339	-66.6484	-50.1831	-49.9604
DW(ρ)	1.8974(0.009)	1.6368(0.115)	1.8974(0.009)	1.9984(-0.032)	1.6368(0.115)	1.712(0.077)

[a]Parentheses are t-values, significance at 5% or lower level.

[b]Equals to ln(K/L)

From Table 1.2 the impact of the USA economy as a whole on aggregate income of USRATLs is more than double that of the host states; the partial coefficient of regression ranges from 0.41 to 0.59 with up to 56% of variations in aggregate income explained by the included variables. Deviations about the mean fall below one standard error of the estimate, which suggests good predictive power. Even so, large constant terms were suppressed, and that should caution interpretation of the results. However, parameter estimates are consistent; changing labor by one unit, holding other factors constant, increases aggregate income by $69 per year. Holding labor unchanged and raising capital investment by one dollar, results in a 19% rise in aggregate income per year. Similar results are generally found for developing countries.

By all measures used in this analysis, human capital tends to reduce aggregate income; the coefficients range from a low of -9.6 toa high of -0.96. This means that infrastructural components of institutions responsible for human capital formation in USRATLs are weak, while at the same USRATLs appear to resist human capital most likely because of its association with external technology. The latter suggests the importance of culture in economic performance as described by Mushinski and Pickering (2000), and Pickering and Mushinski (2001). One way of reversing the negative effects of human capital accumulation on the aggregate income of USRATLs is to either strengthen infrastructural elements, or neutralize superstructural resistence to institutions expected to foster human capital formation.

U.S. Native American Average Income

Tables 2.1 and 2.2 show that average income of USRATLs depends on physical capital accumulation: holding labor constant, one dollar's worth of investment in physical capital, adds an extra $0.50 to average income, which is in the same ballpark as the 0.61 coefficient of K/L ratio often found for developing economies. The fact that it is above the 1/3 rule, suggests capital scarcity. As in the case with aggregate income, infrastructural aspects of institutions measured as E_{ki} or S_{ki}, are weak, and in the presence of superstructural pressures represented by $\overline{q}_i$. Human capital tends to reduce the average income of USRATLs. The economic conditions of host states contribute significantly to the average income of USRATLs. If the gross state product rises by one dollar, the average income of a representative USRATL increases by anywhere from eleven to forty-eight cents.

Given the included variables, 28% of variations are well-explained. In fact, if we consider the impact of the entire U.S. economy on the average income of USRATLs, the coefficient of y_u rises to 0.78 from 0.48 with respect to the host states. In this case, the K/L ratio contributes 19.4% toward the average income of USRATLs. But here too the results show that infrastructural limitations combine with superstructural resistence of institutions to affect average income negatively, with up to 75% of variations explained by the included variables.

7. Concluding Remarks

Figures 8 and 9 summarize the results with a selection of estimations from Tables 1 and 2. Figure 8 compares actual to estimated aggregate income. Aggregate income for USRATLs falls between log $15 and log $20 million, with the majority of USRATLs falling in a narrow income band rainging from log $16 to log $19 million. In terms of average income the corresponding band is only log $10 to log $12.5

Figure 8 - Actual and Estimated Aggegate Income of Selected US RATLs, 1990

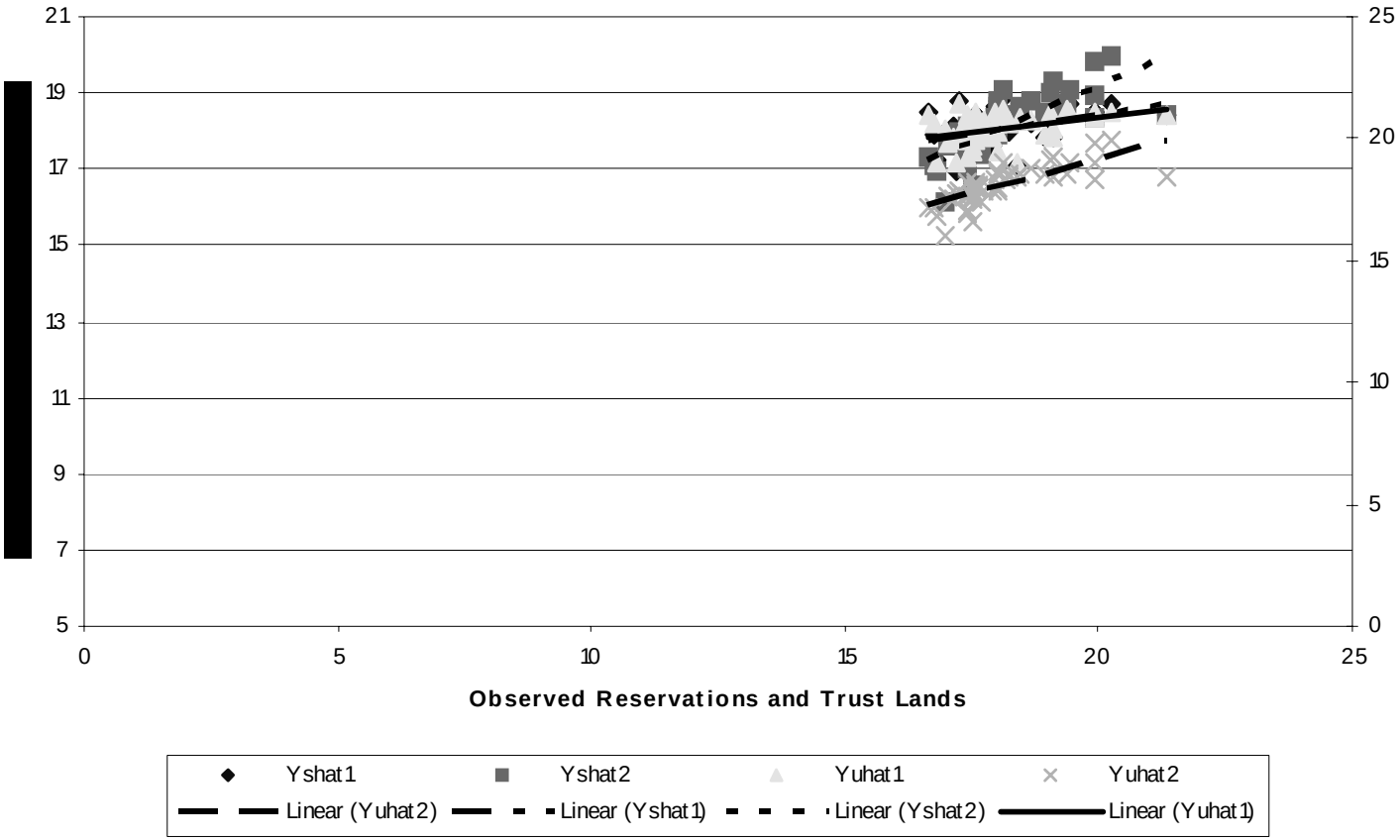
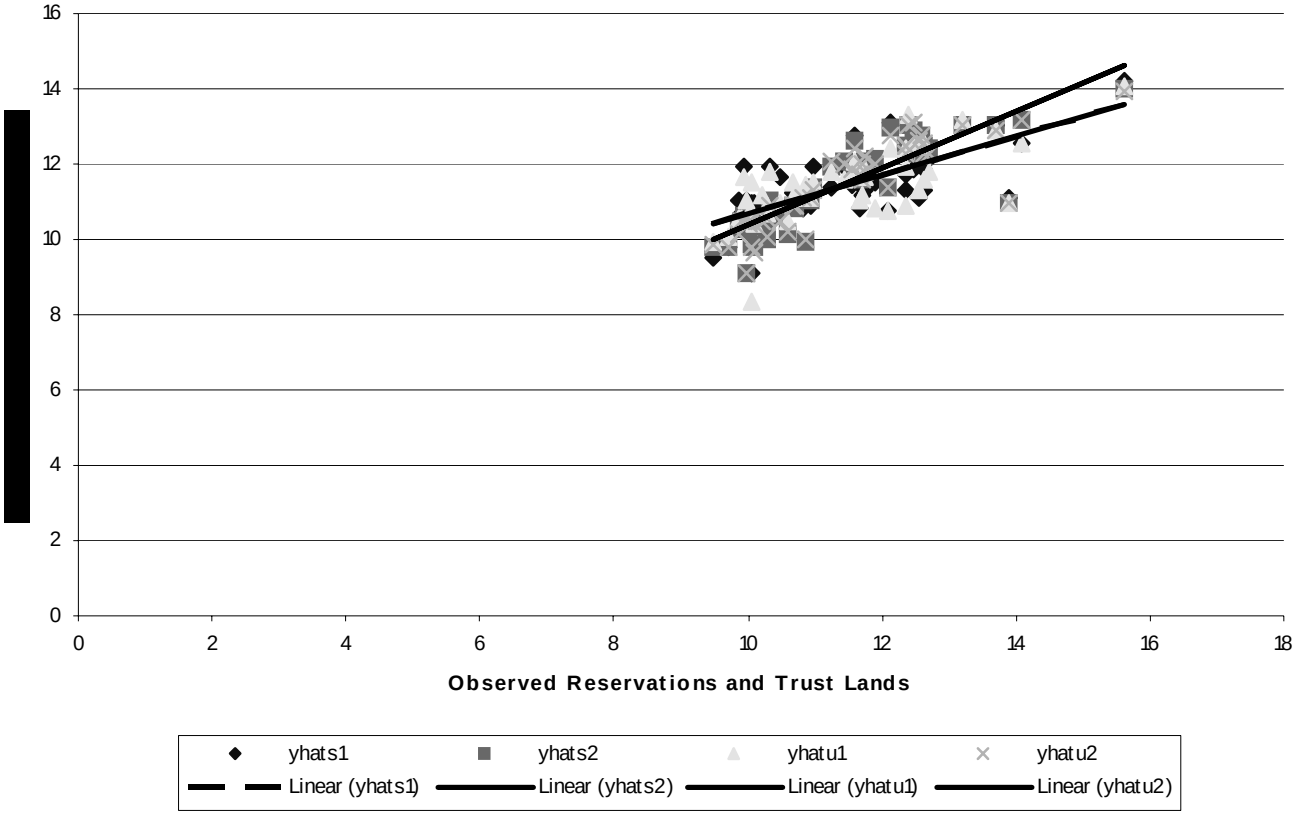


Figure 9 - Actual and Estimated Average Income of USRATLs, 1990



million, but across the board average income falls between log $8.25 and log $14.10 million. Both aggregate income and average income are rising, but at decreasing rates.

The results show that the aggregate and average income of USRATLs depends on resources and resource productivity. On balance the coefficient of K and K/L ratio is a robust 19%. The partial impact of physical labor on income is generally higher than that of physical labor. USRATLs perform like developing countries, and like other developing economies the effects of resources and resource productivity on income are not strong enough to foster meaningful H_i accumulation. Hence, the main constraint on economic performance in USRATLs is human capital, whose effect on income is generally negative.

Previous research explains the negative coefficient of human capital in three ways. Some argue that developing economies have a low initial stock of human capital to begin with. Others suspect some kind of identification problem inasmuch as level and growth effect of human capital on growth are hard to separate. Still others like Romer (op. cit.) insist that the relationship between performance and human capital is an indirect one; performance is a function of technology, and it is technology that is a function of human capital. One or all three of these explanations may be appropriate to USRATLs. However, the model used here takes the argument one step further by showing that Native American infrastructures are weak and that their superstructures are resistant to human capital formation, i.e.,

$$\left|\frac{\partial(Y_i,y_i)}{\partial S_i}<\frac{\partial(Y_i,y_i)}{\partial \bar{q}_i}\right| \qquad (10)$$

Eq.(10) can be interpreted as meaning that H_i and L_i are close substitutes, which in turn suggests that Hi is either not differentiated from L_i or it is under-employed. Either way there is an institutional disconnect that calls for either the strengthening of infrastructures or weakening the resistance of superstructures. Right now it appears that USRATLs do not believe that human capital is in their economic interest. Such a belief clogs up the Nelson-Phelps channel through which A_j was supposed flow. That is one implication for policy. The research implication is to identify clearly what superstructural constraints are.

The results also show that the economic conditions of the U.S. and state economies are important to the performance of USRATLs. Even so, there is no getting away from the fact that unless infrastructural forces and superstructural forces are realigned, the positive effect of human capital on performance will remain 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 then minimized. How that can be done is a good research question.

The results indicate three other areas of further research. First, there is a need for better time-series and/or pooled data in general, and K data in particular. Second, it would be useful to consider why the constant terms are large. One way of doing that may be to account for reservation scale (size) effects, or to separate A_i from A_j. Third, I have deliberately ignored following 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. The technical efficiency of parameters is obviously important, but for now it belong to a different project.

Table 0.0 - U.S. Reservation Economies

Observation	Name
1	Agua Caliente
2	Allegany
3	Blackfeet
4	Cheyenne River
5	Coeur d'Alene
6	Colorado River
7	Colville
8	Crow
9	Eastern Cherokee
10	Flathead
11	Fort Apache
12	Fort Berthold
13	Fort Hall
14	Fort Peck
15	Gila River
16	Hopi
17	Isabella
18	Laguna Pueblo
19	Lake Traverse
20	Leech Lake
21	Mississippi Choctaw
22	Muckleshoot
23	Navajo
24	Nez Perce
25	Northern Cheyenne

Observation	Name
26	Omaha
27	Oneida (West)
28	Osage
29	Papago
30	Pine Ridge
31	Port Madison
32	Puyallip
33	Red Lake
34	Rosebud
35	Salt River
36	San Carlos
37	Sandia Pueblo
38	San Juan Pueblo
39	Santa Clara Pueblo
40	Southern Ute
41	Standing Rock
42	Taos Pueblo
43	Tulalip
44	Turtle Mountain
45	Uintah & Ouray
46	White Earth
47	Wind River
48	Yakima
49	Yankton
50	Zuni Pueblo

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