THE RELATIONSHIP BETWEEN REGIONAL INCOME INEQUALITY, PERSONAL INCOME INEQUALITY, AND DEVELOPMENT

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In William Alonso's [1] 1980 presidential address to the Regional Science Association he identified five bell-shaped curves that permeate development literature: (1) development stages, (2) social inequality, (3) regional inequality, (4) geographic concentration. and (5) demographic transition. In the address Alonso stressed two points, both of which are important to this study. First, he indicated the need to investigate the relationship between the bell-shaped curves, which he undertook at a general intuitive level. Second, he indicated the need to consider more closely, the *right-hand* side of the curves, associated with later developed stages. The objective of this paper is to empirically investigate the relationship between two of Alonso's five curves: social inequality and regional inequality.

Social and Regional Inequality Interactions

Social inequality, or the distribution of personal income, was first discussed in a development context by Kuznets [10] in 1955, leading to the *inverted-U* curve. Many authors, since 1955, including Kuznets, have explored the personal income inequality — development relationship [7, 9, 11, 12, 20].

Regional income inequality has also permeated the development literature. The "north-south" problem, or regional dualism, has been discussed by several authors [3, 5, 6, 22]. The vast literature on growth poles also deals with regional variation of income [8, 13, 14, 15, 16, 17, 18, 19]. With the exception of Alonso's presidential address, the interaction and relationship between regional and personal income inequality has not been explored.

In a 1965 study by Williamson [21] regional inequality in U.S. states decreased from 1950 to 1960. For the same two decennial years Al-Samarrie and Miller [2] also identified a decrease in social inequality. The question raised in this study is whether a correspondence exists between lower social inequality and lower regional inequality. As Alonso states: "It is possible, and not uncommon, for social inequality within regions to increase while regional inequality diminishes" [1, p. 6].

In exploration of this topic it is clear that both inverted-U curves have similarities. First, increasing inequality is likely the result of unbalanced growth. Either the growth is spatially unbalanced (e.g., the emergence of a city) or socially unbalanced (e.g., the emergence of wealthy individuals). Clearly there are reasons to think both divergent trends could coincide (e.g., in which the wealthy individuals live in the cities). The second point of similarity is that "social, economic, and geographic integration" [1, p. 5] leads to convergent trends in both regional and personal income inequality. As areas within a region become integrated and dependent on one another, the development of all *areas* benefit,

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reducing regional inequality. As social and economic integration increases, all *members* of society are also able to benefit reducing personal income inequality.

Whether convergent trends of regional and social inequality coincide to the same degree that divergent trends coincide is not clear. Using a simple example: If wealthy individuals live in cities in early development stages then regional *and* personal income inequality would coincide. If there were a relocation of some wealthy individuals to suburbs, with no change in social inequality, then regional income inequality would be reduced. On the other hand, if any rural inhabitants, after they became wealthy, immediately moved to the city, then social inequality would be reduced, but not regional income inequality.

This study investigates the convergent right-hand side of the regional and social inequality bell-shaped curves. Clearly, by data on personal income inequality presented by Al-Samarrie and Miller [2]and so inequality presented by Williamson [21], most U.S. states are on the convergent, right-hand side. But does the correspondence go any deeper? Are states with greater social convergence also states with greater regional convergence?

Methodology and Data

To investigate the relationship between spatial and personal income distribution, state data for 1950, 1960, and 1970 are used. All data are either directly or indirectly obtained from the U.S. Census of Population. To measure personal income inequality the standard Gini coefficient is used, in which 0.0 represents a perfectly equal income distribution. For years 1950 and 1960 Gini coefficients estimated by Al-Samarrie and Miller are used [2]. In 1970 the U.S. Census began including the Gini coefficient, of "Index of Income Concentration" for each state using the same methodology employed by Al-Samarrie and Miller.

The measure of regional income inequality used here was developed by Williamson [21]. It is the variance of per capita income between counties within each state, weighted by the proportion of state population in each county. This measure (V_w) is estimated as:

$$V_w = \frac{\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2 \frac{f_i}{N}}}{\bar{Y}} \qquad (1)$$

Where:

Y_i = per capita income in county i,
$\bar{Y}$ = per capita income for the state,
f_i = population in county i,
N = total state population,
V_w = a measure of the spatial distribution of income,
n = the number of counties in the state.

Like the Gini coefficient, if V_w is 0.0, there is perfect spatial equality. For 1950 and 1960 V_w measures calculated by Williamson are used. For 1970 V_w measures were calculated directly from census data, in accordance with equation (1) and Williamson's methodology. To remain consistent with Williamson's data, only 46 states are included in this analysis, excluding Alaska, Delaware, Hawaii, and Virginia, as well as the District of Columbia.

Two types of analyses are performed on the data. First, to enable a general overview, simple contingency tables are used, similar to those used by Borts [4]. Secondly, ordinary Least Square Regressions are run on various groupings of the data. Statistical tests are performed to test significance of the results.

Empirical Results

The equalization, or convergence, of both the regional income inequality and the personal income inequality have generally continued in 1970 the trends discussed by Williamson, and Al-Samarrie and Miller, respectively, for 1950 and 1960. Table 1 presents estimates of V_w and Gini for 1950, 1960, and 1970 for the 46 states used in this study. Casual observation of Table 1 (See also Table 2) indicates most states had a smaller V_w and Gini in 1970 than 1960, and 1960 than 1950. Those states that show an increase in V_w generally have an increase or small decrease in Gini also, and vice versa.

Contingency Table Analysis

A general indication of convergence of regional and personal income distributions is possible using simple contingency tables. The differences between consecutive year V_w and Gini values are present in Table 2. If convergence is occurring either for V_w or Gini, then states with above average values in the first year will have above average decreases to the next year. In addition, states with below average values in the first year will have below average decreases (or possibly increases) to the next year. Therefore, the diagonal of a contingency table should contain a large number, if not all, of the states.

Table 3 identifies the number of states with above and below average 1950 V_w, that have either above or below average decrease in V_w from 1950 to 1960. Table 4 presents the similar analysis but for 1960 V_w and 1960 to 1970 change in V_w. Tables 5 and 6 are similar to Tables 3 and 4 except Gini coefficients are analyzed.

Clearly all four tables present a pattern of convergence. From 32 to 42 of 46 states fall on the diagonal in the tables. In Tables 3 and 5, 34 states are following a pattern of convergence from 1950 to 1960 for regional income inequality and 32 states for personal income inequality, respectively. In Tables 4 and 6, the period from 1960 to 1970, there are 42 states illustrating regional income convergence and 38 states illustrating personal income convergence, respectively. There appears to be a degree of correspondence between Gini and V_w convergence for 1950 to 1960 and 1960 to 1970. There are 34 states in the diagonal for the V_w, and 32 states for the Gini. Of the states in the diagonals in Tables 3 and 5, 19 states are on the diagonals of *both* contingency tables (i.e., states which experienced both regional *and* personal income convergence between 1950 and 1960).

For the period 1960 to 1970, 42 states follow a pattern of regional income convergence, and 38 personal income convergence. There are 28 states on the diagonal of both Tables 4 and 6. This very simple analysis indicates interesting results. Between 1950 and 1960 only 19 of 46 states follow both a pattern of spatial and personal income convergence. However, 28 states follows this pattern between 1960 and 1970. The contingency tables indicate an increasing degree of correlation between V_w and Gini from 1950 to 1970.

Regression Analysis

Simple Ordinary Least Squares regressions equations were run on the data using V_w as the independent variable and Gini as the dependent variable. This

Table 1: Measures of Spatial and Personal Income Inequality for U.S. States, 1950, 1960, 1970

State [a]	1950		1960		1970	
	V_w [b]	Gini [c]	V_w [b]	Gini [c]	V_w [d]	Gini [e]
Alabama	.353	.475	.280	.424	.186	.393
Arizona	.164	.424	.112	.369	.150	.363
Arkansas	.336	.491	.292	.437	.176	.404
California	.105	.366	.099	.345	.129	.357
Colorado	.166	.398	.163	.344	.177	.349
Connecticut	.063	.365	.053	.331	.128	.336
Florida	.217	.453	.147	.399	.176	.398
Georgia	.397	.474	.300	.418	.244	.381
Idaho	.138	.381	.121	.338	.122	.350
Illinois	.169	.375	.167	.348	.138	.342
Indiana	.201	.365	.136	.339	.102	.322
Iowa	.166	.384	.201	.372	.113	.347
Kansas	.239	.412	.211	.362	.119	.362
Kentucky	.391	.454	.352	.425	.256	.392
Louisiana	.292	.464	.267	.420	.202	.403
Maine	.127	.386	.110	.330	.103	.328
Maryland	.248	.384	.223	.349	.226	.349
Massachusetts	.085	.356	.092	.327	.099	.334
Michigan	.179	.351	.124	.334	.156	.329
Minnesota	.198	.378	.236	.362	.206	.346
Mississippi	.386	.526	.366	.466	.211	.427
Missouri	.362	.427	.301	.386	.225	.369
Montana	.169	.390	.146	.344	.105	.349
Nebraska	.162	.404	.238	.371	.164	.355
Nevada	.124	.371	.094	.331	.083	.332
New Hampshire	.107	.362	.056	.319	.047	.317
New Jersey	.144	.360	.110	.334	.126	.341
New Mexico	.329	.446	.227	.379	.204	.389
New York	.174	.389	.152	.352	.222	.369
North Carolina	.270	.445	.274	.415	.197	.372
North Dakota	.146	.414	.204	.373	.133	.369
Ohio	.160	.360	.120	.330	.128	.331
Oklahoma	.313	.443	.252	.403	.201	.387
Oregon	.092	.369	.077	.330	.114	.345
Pennsylvania	.134	.363	.138	.339	.157	.334
Rhode Island	.107	.367	.050	.332	.039	.341
South Carolina	.310	.467	.229	.421	.163	.375
South Dakota	.304	.415	.252	.391	.141	.386
Tennessee	.316	.459	.288	.424	.194	.390
Texas	.176	.445	.242	.403	.214	.380
Utah	.144	.340	.109	.312	.127	.330
Vermont	.114	.384	.112	.329	.141	.335
Washington	.135	.354	.112	.329	.141	.335
West Virginia	.218	395	.230	.397	.181	.371
Wisconsin	.210	.362	.183	336	.144	.326
Wyoming	.138	.369	.115	.334	.098	.340

[a] Alaska, Delaware, Hawaii, and Virginia are excluded.
[b] Source: Williamson [21, pp. 20-21].
[c] Source: Al-Samarrie and Miller [2, p. 63].
[d] Estimated from 1970 U.S. census data using equation (1).
[e] Derived from Table 57, Volume 1, parts 2-52, 1970 *Census of Population.*

Table 2: Change in Spatial and Personal Income Inequality for U.S. States, 1950 to 1960, 1960 to 1970

State [a]	1950 to 1960		1960 to 1970	
	ΔV_w	ΔGini	ΔV_w	ΔGini
Alabama	-.073	-.051	-.094	-.031
Arizona	-.052	-.055	.038	-.006
Arkansas	-.044	-.054	-.116	-.033
California	-.066	-.021	.030	.012
Colorado	-.003	-.054	.014	.005
Connecticut	-.010	-.034	.075	.005
Florida	-.070	-.054	.029	.001
Georgia	-.097	-.056	-.056	-.037
Idaho	-.017	-.043	.001	.012
Illinois	-.002	-.027	-.029	-.006
Indiana	-.065	-.026	-.016	-.017
Iowa	.035	-.012	-.088	-.025
Kansas	-.028	-.050	-.092	.000
Kentucky	-.039	-.029	-.096	-.033
Louisiana	-.025	-.040	-.065	-.017
Maine	-.017	-.056	-.007	-.002
Maryland	-.025	-.035	.003	-.009
Massachusetts	.007	-.029	.007	.007
Michigan	-.055	-.017	.032	.005
Minnesota	.038	-.016	-.030	-.016
Mississippi	-.020	-.060	-.155	-.039
Missouri	-.061	-.041	-.076	-.017
Montana	-.023	-.046	-.041	.005
Nebraska	.076	-.033	-.074	-.016
Nevada	-.030	-.040	-.011	.001
New Hampshire	-.051	-.043	-.009	-.002
New Jersey	-.034	-.026	.016	.007
New Mexico	-.102	-.067	-.016	.010
New York	-.022	-.037	.070	-.046
North Carolina	.006	-.030	-.077	-.043
North Dakota	.058	-.041	-.071	-.004
Ohio	-.040	-.030	.008	.001
Oklahoma	-.061	-.040	-.051	-.016
Oregon	-.015	-.039	.037	.015
Pennsylvania	.004	-.024	.019	-.005
Rhode Island	-.057	-.035	-.011	.009
South Carolina	-.081	-.046	-.066	-.046
South Dakota	-.052	-.024	-.111	-.005
Tennessee	-.028	-.035	-.094	-.034
Texas	.067	-.042	-.028	-.023
Utah	-.035	-.028	.018	.018
Vermont	-.020	-.041	-.011	-.002
Washington	-.023	-.025	.029	.006
West Virginia	.012	.002	-.049	-.026
Wisconsin	-.027	-.026	-.039	-.010
Wyoming	-.023	-.035	-.017	.006

[a] Alaska, Delaware, Hawaii, and Virginia are excluded.

Table 3: Number of States with Above (Below) Average 1950 V_w and 1950 to 1960 ΔV_w

	ΔV_w 1950 to 1960	
1950 V_w	**Above Average**	**Below Average**
Above Average	15	3
Below Average	9	19

Table 4: Number of States with Above (Below) Average 1960 V_w and 1960 to 1970 ΔV_w

	ΔV_w 1960 to 1970	
1960 V_w	**Above Average**	**Below Average**
Above Average	20	2
Below Average	2	22

Table 5: Number of States with Above (Below) Average 1950 Gini and 1950 to 1960 ΔGini

	ΔGini 1950 to 1960	
1950 Gini	**Above Average**	**Below Average**
Above Average	14	5
Below Average	9	18

Table 6: Number of States with Above (Below) Average 1960 Gini and 1960 to 1970 ΔGini

	ΔGini 1960 to 1970	
1960 Gini	**Above Average**	**Below Average**
Above Average	15	5
Below Average	3	23

procedure in no way is meant to imply a casual relationship between V_w and Gini, but is only intended to identify correlation. Table 7 presents regression equations using all three years together (equation (1)) and 1950, 1960, and 1970 data separately (equations (2), (3), and (4), respectively).

The first equation in Table 7, with Gini regressed on V_q for all three years, gives an $R^2 = 0.68$, indicating a significant correlation between regional and personal income inequality. This corresponds with the contingency table analysis in the preceding section. The next three equations in Table 7 regress Gini on V_w separately for 1950, 1960, and 1970, respectively. Between 1960 and 1970 R^2 decreased from 0.79 to 0.46. However, in 1950 $R^2 = 0.69$, less than in 1960. These results indicate a pattern of increasing correlation from 1950 to 1960, and decreasing correlation from 1960 to 1970.

The fact that R^2 increases then decreases from 1950 to 1970 is interesting. The contingency tables indicated greater correlation, in terms of the number of converging states on both diagonals, for the 1960 to 1970 period than the 1950 to 1960 period. Thus, the trend of increasing correlation from 1950 to 1960 is evident from both analyses.

If a perfect correlation exists between regional and personal income inequality at all levels of development, then both curves being analyzed here would essentially coincide. However, it is possible that as the inverted-U for regional income inequality approaches the horizontal axis (i.e., convergence) the inverted-U curve for personal income inequality becomes less distinct. That is, factors other than development, such as governmental income redistribution programs, become more important in affecting personal income inequality. This would explain $R^2 = 0.79$ in 1960 and $R^2 = 0.46$ in 1970.

If the inverted-U curves for V_q and Gini were offset (i.e., peak at different levels of development) in which regional income inequality either lags or leads personal income inequality, then a lower R^2 in 1950 than 1960 is possible. Near the peaks of the curves, V_w might be increasing, and Gini decreasing, and vice versa. Thus two states with the same V_w, if on different sides of the peak, might have Gini coefficients of considerably different values. A plot of Gini, V_w combinations might look very much like a scatter diagram. This, of course, depends on how much the inverted-U curves are offset, and the range of development covered by the states for a given year.

If 1950 data contain several states near the peak in regional and/or personal income inequality, it could significantly reduce the R^2. If 1960 data contain fewer or no states near the peak, then this effect would be less important. As indicated by the contingency tables, and data in Table 1, states with very high Gini's or V_w's

Table 7: Regression Analysis for Gini, V_w, 1950, 1960, 1970

Equation	Number of Observations	Slope (t-value)	Intercept	R^2 ($F_{1,46}$)
(1) All 3 years Gini on V_w	138	.432* (16.887)	.298	.68* (285.173)
(2) 1950 Gini on V_w	46	.404* (9.996)	.320	.69* (99.925)
(3) 1960 Gini on V_w	46	.413* (12.859)	.292	.79* (165.365)
(4) 1970 Gini on V_w	46	.351* (6.153)	.305	.46* (37.858)
(5) 1950 to 1960 ΔGini on ΔV_w	46	.173* (2.867)	-.032	.16* (8.218)
(6) 1960 to 1970 ΔGini on ΔV_w	46	.243* (7.461)	-.002	.55* (54.664)

* Statistically significant at $\alpha = 0.01$.

in 1950, across the board decreased in 1960. Therefore, any states near peaks in 1950 would have moved down the respective curves in 1960. Together, the "peak" effect and the "development" effect could explain the pattern of R^2 from 1950 to 1970 depicted in Table 7.

The key to offset inverted-U curves might be in the relative location and movement of human versus physical capital. Regional income inequality is directly affected by both physical and human capital. Growth of per capita income in urban and peripheral areas depend on the location of human and physical capital. Thus the movement of human capital (i.e., skilled, professional labor) from urban to rural areas might reduce regional income inequality. This movement would not reduce personal income inequality. Therefore, if regional income inequality is reduced after a period of divergence, due to both physical *and human* capital migration away from urban areas, personal income inequality would not peak at the corresponding level of development. Divergence of regional and personal income would be highly correlated (i.e., coincident curves) in early states of development, but the regional income inequality curve would peak while the personal income inequality curve is continuing to diverge. The personal income inequality curve would peak at a later state of development, while regional income is already converging. Therefore, the two curves might not be completely offset, but coincident up to the peak of regional income inequality, then offset after that point. This would be consistent with results in Table 7, and the contingency table analysis.

Equations (5) and (6) in Table 7 further support this argument. The change in Gini coefficients from 1950 to 1960, and 1960 and 1970 were regressed on the change in V_w for the respective years. The smaller R^2 for 1950 to 1960 (R^2 = 0.18) than 1960 to 1970 (R^2 = 0.55) indicate a lower correspondence between the regional and personal income inequality curves in the first period, than the second. If some states were near the peak of inequality in 1950, this result would be expected.

Further support of results identified above are possible by regrouping data in Table 1 and performing additional regression analysis. It is expected that states in later stages of development have less correlation between V_w and Gini, than states in earlier stages. For 1950, 1960, and 1970 data, states were divided in two groups: one with above average V_w, and the other with below average. For each year states above average should be more correlated than states below average. In addition, above average states across all three years should follow a pattern of increasing, then decreasing R^2, to correspond with the "peak" effect. However, below average groups across all three years should follow a pattern of continual decreasing correlation, since it is unlikely that any of the most developed states in 1950 were near the peak area.

Table 8 presents the six regression equations used to test this pattern. The above/below average pattern for a given year exists for 1950 and 1960 equations. For 1950, R^2 = 0.50 for the above average group and R_2 = 0.14 for the below average group. For 1960, R^2 = 0.66 for the above average group and R^2 = 0.20 for the below average group. This is consistent with earlier results. However, for 1970, R^2 = 0.10 for the above average group but R^2 = 0.18 fo the below average group, contrary to expectations. However, since both R^2's are less than 0.2, the level of correlation is so small the fact that the below average group is greater than the above average does not appear to significantly contradict expectations.

Comparison of above and below average groups separately, across the three years gives similar results. The above average groups follow a pattern of greater, then less correlation between 1950 and 1970, as expected. However, for the below average groups, the pattern is also greater, then less correlation, instead of continuously less correlation. But again, the R^2 for the below average equations in all three years are .2 or less.

Tables 7 and 8 indicate a final point of consideration in support of the reduced correlation hypothesis. Intercept terms in equations (1) through (4) in Table 7 and in Table 8 are very consistent, all near 0.3, ranging from 0.255 to 0.334. If regional income inequality is highly correlated with personal income inequality in early stages of development, but less so in latter stages, this result is expected. By regressing Gini on V_w, the R^2 indicates the amount of variation "explained" by V_w. The hypothesis put forth in this paper states that less variation in the Gini coefficient can be explained by V_q in latter stages of developmet. Consequently relatively more variation in Gini is attributable to "other" factors. The intercept term in the equations presented in Tables 7 and 8 indicate the level of the Gini if V_w were zero. In other words, the level of personal income inequality that would remain if regional income inequality is eliminated. The remaining personal income inequality is attributed to differential human capital. One way to interpret the intercept is as a "natural" rate of personal income inequality, akin to the natural rate of unemployment in macroeconomic literature. As regional development is equalized for all areas, personal income inequality persists. Elimination of this inequality would be possible only by means other than simulating regional growth. For example, education or other government programs could be used to increase the equality of human capital distribution, thus reducing personal income inequality.

Table 8: Regression Analysis for Selected Subdivision of Inequality Data

Equation	Number of Observations	Slope (t-value)	Intercept	R^2 (F)
1950 Gini on V_w				
(1) V_w Above Average	18	.463*** (3.985)	.303	.50*** (15.884)
(2) V_w Below Average	28	.233* (1.851)	.334	.14** (3.427)
1960 Gini on V_w				
(1) V_w Above Average	22	.553*** (6.018)	.255	.66*** (38.462)
(2) V_w Below Average	24	.252*** (2.547)	.311	.20** (6.485)
1970 Gini on V_w				
(1) V_w Above Average	22	.284 (1.501)	.320	.10 (2.253)
(2) V_w Below Average	24	.236** (2.163)	.316	.18** (4.678)

* Statistically significant at $\alpha = 0.10$.
** Statistically significant at $\sigma = 0.05$.
*** Statistically significant at $\alpha = 0.01$.

Conclusion and Implications

This paper has sought to identify the relationship between regional and personal income inequality. It is clearly evident that regional and personal income inequality are significantly correlated. Using cross-sectional state data within limited time series, R^2's were about 0.68. That correlation lessens as development increases, is also indicated by the data. Whether this pattern continues in 1980, and after, is an interesting question that deserves attention when 1970 census data are available.

Based on the reduced correlation of V_q and Gini and the consistency of intercept terms in the regression analysis, one policy implication seems evident. Increasing development in a region is an important, but not the only factor affecting personal income inequality. If the intercept term can be appropriately identified as a "natural" level of personal income inequality, then policies other than those aimed at growth and development are necessary to reduce this level. Clearly, development can significantly reduce personal income inequality. From 1950 to 1970 Gini coefficients for U.S. states range from 0.526 to 0.312, and by all indications, lower Gini coefficients are associated with more developed stages. This is a fundamental principle outlined by Kuznets [10] when the inverted-U hypothesis was initially discussed. However, development will only reduce personal income inequality to a point, where other policies must then be employed.

It is interesting that correlation increased from 1950 to 1960 then decreased to 1970. These results indicate some states might be near the peak of income inequality in 1950. This means further tests in the divergence portion of the inverted-U curves might be possible if corresponding measures of V_w and Gini can be obtained for 1940 and earlier census data. However, initial examination of the 1940 census indicates estimation of the consistent V_w statistic is not possible.

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