The Debate Over State-Level Inequality: Transparent Method, Rules of Evidence, and Empirical Power

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Abstract: This article challenges the reliance on summary measures to inform trends in state level inequality. Since only a partial ordinal ranking of inequality is available to the researcher, one can never be certain if the results from a cardinal measure of inequality are unambiguous with respect to an implicit value orientation. In addition, we examine the robustness of results examining regional cost-of-living adjusted per capita income data. If cost-of-living differentials across states are substantial, then it is reasonable to expect that individuals with substantial components of unearned income most sensitive to these differentials will tend to reside in low-cost states—states which also tend to have lower incomes. Trends in the price adjusted earnings per worker series is examined to assess the power of analyses using per capita income to inform the process of regional income convergence.

INTRODUCTION

In a recent article Deller, Shields and Tomberlin (1996) examine trends in state income inequality after controlling for state specific cost-of-living differentials. The motivation for the article comes from various studies which have identified divergence in state per capita incomes in the 1980s after a long period of income convergence dating back as far as the 1880s¹. The convergence of incomes derives strong theoretical support from the neoclassical constructs of factor mobility, capital deepening and the resulting relative wage increases in poorer regions of the country. However, the purported period of income divergence suggests an empirical challenge to the long accepted process of income convergence. After analyzing cost-of-living adjusted state income data, the authors conclude that “the pattern of regional income convergence through the 1970s followed by divergence in the 1980s are lost if spatial and temporal differences in regional prices are considered (p. 99).” The Deller et al. piece cautions that more valid data series should be used to examine the phenomenon before hastily concluding that the process of income convergence no longer characterizes the spatial economy.

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¹See Barro and Sala-i-Martin (1992) and Garnick and Friedenberg (1982) regarding the long-term process of income convergence. The studies of Amos (1988, 1989), Coughlin and Mandelbaum (1988, 1989), Garnick (1990), Redman, Rowley and Angle (1992) and Renkow (1996) identify divergence (or non-convergence) of incomes in the 1980s.

By challenging the nearly universal convention that price differentials can be ignored in the examination of state-level inequality, the Deller et al. article opens up other widely accepted conventions in the literature to critique. Thus, the Deller et al. serves as a useful point of departure for the present discussion. While we recognize that conventions can serve as a more efficient shorthand for a literature, the danger is that these conventions may never be examined critically. For this article we restrict our attention to the dangers inherent in sole reliance on summary inequality measures to inform the inequality debate, especially when such analysis is extended to pronouncements regarding income convergence. We have tried to frame the argument to enliven an ongoing debate regarding the most appropriate methods to examine trends in regional inequality. Clearly, bringing more evidence to bear on the problem will not be productive until there is some agreement over what constitutes valid evidence.

Our critique is composed of two parts. First, the commonly accepted practice of relying on a particular summary measure of income inequality to inform trends toward convergence or divergence is challenged. Reliance on several inequality measures "to minimize the potential that...results are due to measurement construction" (Deller et al. p. 102) is also inadequate. We argue that more transparent results are available through the construction of Lorenz curves. If in comparing two distributions the Lorenz curves cross, then one can always find a valid summary measure that will rank the inequality of the two distributions differently (Dalton 1920, Atkinson 1970). Results by construction are in fact results of the implicit value orientation in various measures of inequality. Sole reliance on summary measures cannot easily provide 'clear and convincing' evidence (Gastwirth 1988, pp. 700-704) of either increasing or decreasing inequality. Since the array of valid inequality measures is large it will always be more parsimonious to construct Lorenz curves first rather than exhaust all possible sources of evidence through the computation of summary measures.

The second issue addresses the selection of appropriate data series to inform trends in increasing or decreasing inequality and its extension to the process of convergence. More specifically, we are concerned with increasing the power of statistical tests; i.e., that alternative hypotheses of close empirical association do not validate substantially different economic interpretations (McCloskey and Ziliak 1996). This is exactly the intent of the Deller et al. article in examining the importance of regional price differentials. The observed nominal pattern of increasing inequality could either represent a real increase in inequality or an increase in regional cost-of-living differentials. But while the article is successful as a research note demonstrating the importance of regional cost-of-living differentials changing through time, its policy conclusions are merely suggestive. More pointedly, the success of the technical exercise questions the appropriateness of the income per capita variable to inform the validity of the convergence hypothesis. If cost-of-living differentials across states are substantial, then it is reasonable to expect that individuals most sensitive (e.g., those on fixed incomes, or those most able to migrate due to a large component of unearned income) to these differentials

will tend to reside in low-cost states—states which also tend to have lower incomes. While total income is arguably the best indicator of welfare, it may confuse tests of the convergence hypothesis. Earnings per worker introduces far fewer alternative explanations to the capital deepening and factor mobility foundations of the maintained hypothesis. A comparison of these two data series suggests that results of previous studies relying on income per capita to examine trends in state-level equality may not be robust.

THE IMPLICIT VALUE ORIENTATION IN INEQUALITY MEASUREMENT

All single valued inequality measures provide only a partial ordering of income distributions. This is to be expected whenever a cardinal index is used to summarize an implicit welfare ordering. The result makes explicit the different value orientations embodied in summary inequality measures (see Blackwood and Lynch 1994 for a survey; also Allison 1978; Atkinson 1970 and 1983; and Champenowne 1974). Atkinson paraphrases Dalton (1920): “[U]nderlying any such measure is some concept of social welfare and it is with this concept that we should be concerned” (1970, p. 244). Given the subjective nature of selecting a particular social welfare function, it is surprising that economists have not made more use of the ordinal ranking of income distributions. Atkinson (1970) demonstrates that two income distributions can be unambiguously ranked with respect to (in)equality if the Lorenz curve of one lies everywhere above (below) that of the other. Although this condition is often violated—denying the possibility of an unambiguous ranking—its rejection would sensitize researchers to the fact that one can always find a summary inequality measure that will rank two distributions differently. Thus, our first exercise will be to determine if the ordinal ranking condition is violated for periods of interest using the cost-of-living adjusted income data from Deller et al. which forms the basis of our analysis.

The selection of inequality measures used in the Deller et al. article is justified largely on the basis of past use in the literature they are addressing. This effectively demonstrates that cost-of-living differences matter in the calculation of commonly used inequality measures. However, it is less convincing from the social welfare perspective especially since three of the measures are derived from the coefficient of variation—a measure which embodies a relatively conservative value orientation by placing equal weight on transfers over the entire distribution (Atkinson 1970). Alternatively, the Atkinson Index allows one to explicitly define the social welfare orientation by adjusting an “inequality aversion parameter.” The second part of the exercise compares a specification of the Atkinson Index with the coefficient of variation using the cost-of-living adjusted data providing a concrete demonstration of how different value orientations lead to different conclusions regarding trends in regional inequality.

COST-OF-LIVING ADJUSTMENTS

It should be noted that the state cost-of-living adjustment used by Deller et al. is a rather crude price index. Given the substantial effort directed to the con-

struction of valid purchasing power parity measures in international income convergence studies, it is surprising that the topic has received little attention in domestic studies (but see Eberts and Schweitzer 1994). It is the expenditure on immobile, nontradable services which introduces both the possibility of substantial regional cost-of-living differences as well as the difficulty of correcting for it. In fact, if using the non-adjusted income data abstracts from true regional cost-of-living differentials undervaluing nominal income in poorer regions, then an argument can be made that the McMahon and Melton (1978) adjustment used in the Deller et al. article is prone to undue bias undervaluing income in wealthier regions in the 1980s. In deriving a regional adjustment, the median value of standard housing "emerges as by far the most significant predictor of geographical differences in the cost-of-living" (McMahon and Melton 1978, p. 324). However, this is erroneously used as a proxy for housing cost. Since 1983 the Bureau of Labor Statistics (BLS) has recognized the conceptual problem of the hybrid investment/consumption character of housing expense by owner-occupants in constructing the national Consumer Price Index. Current 'best practice'

uses a "rental equivalence" approach to homeownership (the title of the CPI homeownership component is "owners' equivalent rent"). This is the same basic approach used in the inflation indexes of all advanced countries. Rental equivalence measures the change over time in the value of shelter services provided by homeownership. It is important to note that this approach measures the value to the homeowner of the daily *consumption* of a home's flow-of-services (a place to fix meals, relax, entertain, garden, etc.) and not the value to the homeowner of an *investment* in a long-lived asset (home) that can fluctuate widely. (Emphasis in original, BLS 1995, p. 1).

Abraham and Hendershott (1992) examine the wide fluctuations in housing prices in some regions of the country during the 1980s. The inability of market fundamentals to explain a major share of variation in housing prices, combined with the substantial explanatory power of a lagged appreciation rate variable is consistent with the existence of speculative bubbles in Western and Northeastern housing markets.

Any cost-of-living deflator derived partly from housing values will be biased, effectively undervaluing income in those regions experiencing housing asset price appreciation as opposed to housing service price inflation. Rather than dismiss the McMahon and Melton index on this basis, we interpret it as a lower bound in the observed range of per capita income across states. The unadjusted series can be thought to comprise the upper bound of this observed range. As a lower bound it is least likely to identify an increase in inequality. It thus provides the hardest test of our argument that summary measures are unable to adequately identify patterns of increasing inequality for important subsets of states. For this reason the price adjusted per capita income series from the Deller et al. article based on the McMahon and Melton index is used throughout our analysis. However, it is important to reiterate that the regional price index used is imperfect, suggesting a highly productive area for future research (see Blanciforti 1996).

METHODS

We begin the analysis by constructing Lorenz curves of the price adjusted data.² To operationalize the fundamental question of whether a process of convergence in the 1970s was replaced by a process of divergence in the 1980s we calculate 1970, 1980 and 1990 curves. To avoid the possibility that our results are influenced by spurious shocks in the data, a three-year moving average is calculated made up of the preceding, subsequent and target year of interest. The analysis gives equal weight to all of the states.³ The cumulative distribution of the income share which makes up the Lorenz curve is provided in Table 1. Our analysis also makes use of three summary measures of inequality. Their derivation is described below.

COEFFICIENT OF VARIATION

The coefficient of variation provides a link to the Deller et al. analysis. The same measure is applied to the unadjusted per capita income series used by Coughlin and Mandelbaum (1988, 1989) and Redman, Rowley and Angle (1992). The unweighted income variation, used in the studies cited above, is characterized by the following expression:

$$V_{uw} = \frac{\sqrt{\frac{\sum_{i=1}^N (y_i - y)^2}{N}}}{y}$$

where y_i and y refers to the state and mean income respectively and N denotes the number of states. We rely on the unweighted measure since an equal weighting is assigned to states in constructing the Lorenz curve.

²As the name suggests, a Lorenz curve is a graphical representation of an income distribution. More precisely, a Lorenz curve defines the ranked cumulative share of income with the share of income represented on the y-axis and the share of population represented on the x-axis. Thus, a Lorenz curve representing perfect equality would be a 45-degree line from the origin. In comparing two Lorenz curves across periods, we are most interested in whether or not these curves cross. Unfortunately, a graphical comparison of data used in this study is unsatisfactory due to the compression of the state per capita income distribution relative to, say, a personal income distribution. For this reason we present our Lorenz curve results in table format. The maintained assumption is one of convergence. Thus, the expectation is that latter period values will be greater (i.e., closer to the 45 degree perfect equality line) than earlier periods along corresponding rows. Where this expectation is contradicted, the value of the earlier period is in bold type.

³There are strong conceptual reasons to use unweighted measures in the analysis of regional inequality. First, weighting by population suggests that inequality with respect to the national population is the motivating interest. If so, then it is much more informative to examine the personal distribution of income for the nation as a whole. Analyzing mean levels for each state introduces an unnecessary intermediate step serving only to reduce the amount of relevant information in the analysis. Second, weighting by population may lead to erroneous conclusions regarding the pattern of inequality and how it informs the convergence process. There are two general ways that worker productivity can be increased leading to rising incomes in poorer regions. Capital can move into a region or labor can move out effectively increasing the capital-to-labor ratio. Assume that convergence is not the true process characterizing the economy, i.e., there is outmigration from poorer to richer regions but per capita incomes remain unchanged across regions. A weighted analysis will identify a reduction in regional inequality, and from the national perspective there is less regional inequality. But weighting leads to an incorrect inference on the convergence process.

ATKINSON INDEX

Unlike many conventional inequality measures, the Atkinson index allows the researcher to define an explicit value orientation. The Atkinson index is given by:

$$I = 1 - [\sum (y_i/y)^{(1-e)} f_i]^{1/(1-e)}$$

where f_i denotes the proportion of the population in state i (here assumed to be $1/48$ given the equal weights maintained throughout the analysis), and e symbolizes the inequality aversion parameter. In the index, the value of the parameter e reflects an explicit welfare value orientation. As e rises, more weight is attached to transfers at the lower end of the distribution. The value e takes on 0 and ∞ in the extreme cases; $e = 0$ does not assign any value to how income is distributed, ranking distributions only according to total income while $e = \infty$ considers only transfers from the lowest income group in calculating I . The I index, more usefully termed the 'equally distributed equivalent measure,' is interpreted as the share of income that could be forsaken to maintain the current level of welfare if incomes were redistributed equally (Atkinson 1970).

THEIL INDEX

In the analysis we also find it informative to compute the Theil entropy index. The Deller et al. article identified the Theil-derived Nissan-Carter index as the one aberrant measure. We revert to measures in logs, consistent with the original Theil entropy measure, which allows additive decomposition of national inequality. The index is computed as

$$J = \sum_{i=1}^{48} p_i \log \left(\frac{p_i}{y_i} \right)$$

where y_i and p_i denote the income share of state i and its population share which is assigned an equal share of $1/48$ in our computations. The index can be additively decomposed into inequality between regions and between states within regions (Theil 1989). Regional inequality is characterized as

$$J_R = \sum_{g=1}^4 P_g \log \left(\frac{P_g}{Y_g} \right)$$

where Y_g and P_g are the income and population share of region g . Using the same notation, the inequality among states in region g can be expressed as

$$J_g = \sum_{i=1}^{48} \left(\frac{p_i}{P_g} \right) \log \left(\frac{p_i/P_g}{y_i/Y_g} \right)$$

Finally, the Theil index J can be expressed in terms of the two components as

$$J = J_R + \sum_{g=1}^4 P_g J_g$$

Thus the index is comprised of regional inequality and the population weighted average of inequality among states within regions.

INCOME DATA RESULTS

Our results from the Lorenz curve exercise provide a hint as to why researchers generally have avoided this step: the Lorenz curves for the 1970 and 1980 distributions as well as the 1980 and 1990 distributions cross (Table 1). No ordinal ranking exists for each of the ten-year intervals. However, our results also suggest that avoiding this step may be a false economy. An unambiguous result for the 1970 and 1990 interval is available and allows one to state unequivocally that price adjusted 1990 state per capita incomes are more equally distributed than 1970 state per capita incomes (Table 1).

More importantly, the Lorenz curves provide visual hints as to the trend over the entire distribution across the two decades. In the first decade, the 1980 curve is everywhere above the 1970 curve except for the two wealthiest states. That is, if we are not as concerned with inequality among wealthier states, then the 1980 distribution would likely be ranked higher than the 1970 distribution. Similarly, for the great majority of states the 1990 curve is above the 1980 curve. The critical difference is where these curves cross—the 1990 distribution lies below the 1980 distribution for the two poorest states. This example provides illustrative proof to the conjecture in Deller et al. “that there did indeed occur some level of divergence after 1978 (p. 109).” It also demonstrates that whether one characterizes the 1980s as a process of divergence or convergence depends fundamentally on one’s weighting of inequality across the distribution.

Our attempt to demonstrate this more concretely reinforces the shortcomings of sole reliance on summary inequality measures. Since the cumulative share of income table (Table 1) suggests that increasing inequality was limited to the very poorest states, we use Atkinson $e = 100$ to try to capture this phenomenon.⁴ The unweighted coefficient of variation is also computed. Despite the strong weight put on increasing inequality at the lower end of the distribution embodied in Atkinson $e = 100$, the trend lines of the two measures through the 1970s and 1980s are fairly similar (Figure 1).⁵ And yet, both the Lorenz curve analysis and the aberrant Nissan-Carter entropy derived measure from the Deller et al. article suggest that *some* degree of divergence characterizes the 1980s.

The value of the Lorenz curve exercise (Table 1) becomes evident at this juncture. The two states commanding a lower share of per capita income in 1990

⁴This value is quite large relative to that used in the literature. However, in contrast to this other literature the current analysis examines mean per capita incomes which have a much tighter distribution than the personal income distributions commonly using the Atkinson Index.

⁵To derive a more objective comparison of the trends we estimated regression equations. The magnitude of the slope coefficients was very similar (-0.0005 for the Coefficient of Variation measure compared to -0.0004 for the Atkinson measure). However, the Atkinson estimate was not significantly different from zero and the estimated equation provided a poor fit to the data. The estimates are provided below (t-statistics in parentheses):

Coefficient of Variation	= 1.216 - 0.0005*Year (3.735) (-3.44)	R2 = 0.3604	F = 11.833
Atkinson (e = 100)	= 0.952 - 0.0004*Year (0.913) (-0.738)	R2 = 0.253	F = 0.544

TABLE 1
Cumulative Income Share by Inverse Ranking of State Per Capita Income

Inverse Rank	Equal Share	1970 Cumulative Share	1970 State	1980 Cumulative Share	1980 State	1990 Cumulative Share	1990 State
1	0.02083	0.01583	MS	0.01663	MS	0.01645	MS
2	0.04167	0.03305	AR	0.03454	ME	0.03443	AR
3	0.0625	0.05083	AL	0.05245	AR	0.05246	LA
4	0.08333	0.06880	ME	0.07040	NC	0.07079	NM
5	0.10417	0.08704	LA	0.08849	SC	0.08922	WV
6	0.125	0.10534	SC	0.10665	AL	0.10793	KY
7	0.14583	0.12378	NC	0.12530	TN	0.12671	UT
8	0.16667	0.14230	NM	0.14412	VT	0.14560	ND
9	0.1875	0.16093	ND	0.16305	KY	0.16461	OK
10	0.20833	0.17963	TN	0.18211	SD	0.18377	ME
11	0.22917	0.19834	KY	0.20140	GA	0.20294	AL
12	0.25	0.21711	SD	0.22071	WV	0.22212	MT
13	0.27083	0.23611	WV	0.24003	NM	0.24151	SC
14	0.29167	0.25536	VT	0.25955	UT	0.26120	NC
15	0.3125	0.27518	VA	0.27918	ND	0.28091	VT
16	0.33333	0.29505	GA	0.29896	RI	0.30070	SD
17	0.35417	0.31514	UT	0.31914	LA	0.32077	TN
18	0.375	0.33535	NH	0.33932	VA	0.34088	ID
19	0.39583	0.35557	OK	0.35952	MA	0.36105	IA
20	0.41667	0.37594	MT	0.37978	ID	0.38142	RI
21	0.4375	0.39639	RI	0.40042	MT	0.40199	IN
22	0.45833	0.41723	ID	0.42108	MO	0.42274	PA
23	0.47917	0.43817	MA	0.44181	NH	0.44365	WI
24	0.5	0.45918	MO	0.46259	NE	0.46465	TX
25	0.52083	0.48019	PA	0.48346	IN	0.48565	OH
26	0.54167	0.50123	KS	0.50444	DE	0.50666	MO
27	0.5625	0.52232	IA	0.52569	PA	0.52770	AZ
28	0.58333	0.54353	NE	0.54699	MN	0.54878	NE
29	0.60417	0.56476	MN	0.56836	IA	0.57001	KS
30	0.625	0.58599	TX	0.58975	OH	0.59125	OR
31	0.64583	0.60752	WI	0.61128	WI	0.61265	GA
32	0.66667	0.62907	IN	0.63299	OK	0.63424	WY
33	0.6875	0.65082	CO	0.65475	NY	0.65590	CA
34	0.70833	0.67289	NJ	0.67661	AZ	0.67771	MN
35	0.72917	0.69498	OR	0.69848	NJ	0.69955	MI
36	0.75	0.71720	AZ	0.72052	CT	0.72142	MA
37	0.77083	0.73952	OH	0.74260	KS	0.74337	VA
38	0.79167	0.76188	WY	0.76484	OR	0.76539	DE
39	0.8125	0.78425	CT	0.78713	MD	0.78768	CO
40	0.83333	0.80717	CA	0.80943	MI	0.81004	NH
41	0.85417	0.83027	MI	0.83194	FL	0.83280	NY
42	0.875	0.85339	FL	0.85448	CA	0.85591	IL
43	0.89583	0.87668	WA	0.87738	TX	0.87925	WA
44	0.91667	0.90032	MD	0.90033	CO	0.90263	NJ
45	0.9375	0.92404	NY	0.92348	IL	0.92617	FL
46	0.95833	0.94824	DE	0.94725	WA	0.94998	CT
47	0.97917	0.97246	IL	0.97355	NV	0.97474	MD
48	1	1	NV	1	WY	1	NV5

Figure 1
Coefficient of Variation and Atkinson e=100
Price Adjusted Income Series

relative to 1980 (MS and AR) are in the South. In addition, some of the states demonstrating the most robust growth in income are also located in the South (e.g., VA, GA and FL). Since the Nissan-Carter measure in the Deller et al. article gives weight to increasing inequality within a region as well as between regions, increasing inequality due to the declining share of two southern states and the robust income growth of others may have overwhelmed the composite national measure. Figure 2 provides a decomposition of national inequality into between region and within region inequality. The decomposition demonstrates a persistent increase in inequality in the Southern states consistent with the Lorenz curve conjecture. While the spike in inequality in the West is the most dramatic feature of the graph it is the persistent increase in the Southeast component which is conceptually most troubling. From a national perspective the Nissan-Carter measure may be seen as aberrant. However, economists interested in Southern economic development could dismiss the measure only at their peril.

THE COST-OF-LIVING ADJUSTMENT BASIS FOR EXAMINING EARNINGS TRENDS

The results from the Deller et al. analysis themselves cast doubt on the usefulness of total income to examine trends toward regional convergence. If one is interested in identifying empirical regularities which are consistent with the capital deepening rationale of the theory, then the data series used should introduce as few potential alternative hypotheses as possible (McCloskey and Ziliak 1996). A data series which may introduce close alternatives with substantially different economic explanations will reduce the power of the test. That is, convergence may be confirmed but the test may not allow differentiating between a number of possible interpretations. In demonstrating that cost-of-living differentials do matter, the analysis gives greater credence to a number of alternative explanations.

From a regional science perspective it is important to recognize that some sources of income are better able to locate in low cost areas. Most importantly, this relocation of income is wholly independent of the process of capital deepening. For example, workers in high wage, high income states may choose to retire in lower income states where the cost-of-living is also substantially less. However, the strongest argument for using the earnings-per-worker series is that the earnings data do not exclude sources of income thought to be crucial to confirming the convergence hypothesis.⁶ The model is quite explicit in identifying increased wages through increased productivity due to higher rates of capital investment as

⁶Our initial analysis used earnings per capita which has been utilized in Renkow (1996) and Carlino and Mills (1996). However, comparison of the earnings per capita distribution with the income per capita distribution suggested an inherent weakness in the measure. The most dramatic example was the shift for Florida which was the fourth wealthiest state in 1990 using the income per capita series. However, using earnings per capita Florida fell below the median (19th in inverse rank). In both cases a variable unrelated to the 'income convergence through capital deepening hypothesis' was driving the ranking—unearned sources of income in the former and labor force participation rates in the latter. This points to the added value of routinely constructing Lorenz curves.

Figure 2
Within Region and Between Region Per Capita
Income Inequality: Theil Decomposition

TABLE 2
Cumulative Earnings Share by Inverse Ranking of State Earnings Per Worker

Inverse Rank	Equal Share	1970 Cumulative Share	1970 State	1980 Cumulative Share	1980 State	1990 Cumulative Share	1990 State
1	0.02083	0.01744	MS	0.01756	VT	0.01746	ND
2	0.04167	0.03509	ME	0.03519	ME	0.03543	MT
3	0.0625	0.05296	NH	0.05290	SD	0.05350	VT
4	0.08333	0.07099	AR	0.07081	ND	0.07193	ME
5	0.10417	0.08913	NC	0.08883	NH	0.09055	SD
6	0.125	0.10735	SD	0.10709	NC	0.10919	IA
7	0.14583	0.12595	VT	0.12542	RI	0.12790	MS
8	0.16667	0.14469	SC	0.14392	MA	0.14696	AR
9	0.1875	0.16345	VA	0.16246	MS	0.16610	KS
10	0.20833	0.18235	RI	0.18116	VA	0.18551	RI
11	0.22917	0.20139	ND	0.20003	NE	0.20493	OK
12	0.25	0.22063	MA	0.21923	AR	0.22456	NE
13	0.27083	0.24000	KS	0.23844	KS	0.24442	WY
14	0.29167	0.25944	TN	0.25778	SC	0.26431	NH
15	0.3125	0.27914	AL	0.27718	CT	0.28422	KY
16	0.33333	0.29908	CT	0.29692	IA	0.30416	NM
17	0.35417	0.31912	NE	0.31682	MT	0.32428	NC
18	0.375	0.33934	IA	0.33676	TN	0.34445	WI
19	0.39583	0.35956	GA	0.35694	MN	0.36495	VA
20	0.41667	0.37981	KY	0.37719	MD	0.38552	MO
21	0.4375	0.40007	OK	0.39755	GA	0.40626	SC
22	0.45833	0.42064	NJ	0.41794	FL	0.42705	UT
23	0.47917	0.44142	CO	0.43841	MO	0.44787	CO
24	0.5	0.46226	WY	0.45891	NJ	0.46869	TN
25	0.52083	0.48315	MT	0.47958	AL	0.48964	MA
26	0.54167	0.50411	MO	0.50024	WI	0.51065	MN
27	0.5625	0.52519	ID	0.52110	ID	0.53172	OR
28	0.58333	0.54632	LA	0.54233	CA	0.55284	ID
29	0.60417	0.56768	NM	0.56362	KY	0.57403	LA
30	0.625	0.58911	WI	0.58492	CO	0.59525	PA
31	0.64583	0.61060	PA	0.60649	NM	0.61648	IN
32	0.66667	0.63214	MN	0.62815	OK	0.63783	AL
33	0.6875	0.65369	FL	0.65003	OR	0.65931	FL
34	0.70833	0.67533	MD	0.67224	IN	0.68100	WV
35	0.72917	0.69708	TX	0.69449	DE	0.70295	OH
36	0.75	0.71901	UT	0.71678	PA	0.72495	AZ
37	0.77083	0.74117	OR	0.73921	NY	0.74698	CT
38	0.79167	0.76340	CA	0.76166	UT	0.76921	DE
39	0.8125	0.78589	DE	0.78460	OH	0.79148	MD
40	0.83333	0.80863	IN	0.80758	AZ	0.81375	NJ
41	0.85417	0.83149	WV	0.83082	LA	0.83624	CA
42	0.875	0.85443	NY	0.85410	NV	0.85888	WA
43	0.89583	0.87758	WA	0.87765	TX	0.88159	TX
44	0.91667	0.90105	AZ	0.90124	WA	0.90432	GA
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This result has important implications for the practice of using summary inequality measures to inform processes of income convergence. While the trend in the Atkinson index appears volatile, its linear trend is relatively flat, suggesting neither an increase or decrease in inequality. That is, poorer states are not catching up with richer states in terms of earnings per worker given that the Atkinson index with an inequality aversion parameter of 100 puts greater weight on the lower part of the distribution. However, the fact that the linear trend of the unweighted coefficient of variation displays a statistically significant negative slope does suggest a decline in inequality. In other words, when equal weight is attached to transfers across the entire distribution, the summary measure indicates a decline in inequality. Consequently, the convergence implication suggested by the coefficient of variation measure is nullified by the fact that poorer states are not catching up with richer states as suggested by the Atkinson index.

CONCLUSION

The Deller et al. article provides suggestive evidence that regional and temporal price adjustments substantially alter trends in state per capita income identified by commonly used summary measures. It thus provides a counter to previous analyses identifying a process of regional income divergence. In this paper we have attempted to demonstrate that the convention in the literature of relying on summary inequality measures is supported by very weak rules of evidence. More transparent results are available to the researcher using a simple tool of inequality analysis such as the Lorenz curve. The Deller et al. article goes on to suggest the policy implications of examining the price adjusted data regarding income inequality generally and the process of income convergence more specifically. This paper takes issue with the policy implications derived from the analysis. Specifically, the price adjusted analysis provides insights toward selecting more appropriate data to examine the income convergence hypothesis. In fairness to the Deller et al. article it should be noted that the literature they rebut has also accepted the per capita income measure as appropriate to address issues of regional convergence.

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Our results suggest there is much to be gained by routinely examining Lorenz curves to determine if an unambiguous statement can be made and, if not, identifying those parts of the distribution commanding a lesser share of total

income. Most importantly, the examination of Lorenz curves allows examining information from the entire distribution in a meaningful way—a rare opportunity in most empirical work. This is an important addendum to a debate meant to inform best practice in the analysis of regional inequality.

We have demonstrated that the policy implications from articles which either identify a process of divergence or convergence through the use of summary measures should be used cautiously for a number of reasons. There is no theoretical or empirical support for equating decreases in regional income inequality using summary measures with regional income convergence. The process of regional convergence requires that poorer states catch up with richer states. This may or may not be indicated by an overall decrease in income inequality. Yet, even if one does identify a genuine empirical process of income convergence, the question remains whether the data series used is appropriate to inform the capital deepening hypothesis of the theory. In the Deller et al. article, the argument that price differentials do matter raises questions as to the appropriateness of the total income measure for testing the theoretical basis of convergence through capital deepening. Our analysis of earnings per worker data suggests that the widely accepted process of income convergence over the 1970s may be a spurious result driven by unearned sources of income.

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the principal mechanism of convergence.⁷ We are not suggesting that the policy focus should necessarily shift to convergence in earnings-per-worker. Rather, we suggest that the earnings data introduce the fewest number of close alternatives to the capital deepening rationale developed in the theory.

EARNINGS DATA RESULTS

The strongest result from the adjusted per capita income analysis is that 1990 incomes are more equally distributed than 1970 incomes. Is this result robust against using a more narrowly defined data series such as earnings-per-worker? The simple answer is 'Yes.' The Lorenz curve constructed for the three-year average of income around 1970 is everywhere below the 1990 Lorenz curve (Table 2).

This would appear to corroborate the per capita income analysis and the predictions of regional convergence. However, examining the 1970 and 1980 data suggests not only that the close alternative hypotheses introduced by the unearned sources of income are significant, but that they may be determinative of the observed trends in income inequality.

The well documented convergence in state incomes over the 1970s is strongly challenged by the Lorenz curve analysis when examining earnings per worker. It is only for a handful of the wealthiest states that 1970 income appeared more equally distributed. However, this result changes dramatically in examining the earnings data. While earnings-per-worker among the two poorest states (and that claimed by the six richest states) suggest a more equal distribution in 1980 compared to 1970; everywhere else the 1970 distribution dominates 1980. Again, it must be reiterated that there is wide agreement in the literature that per capita state incomes converged over the 1970s. These results were corroborated in the price adjusted analysis of Deller et al. (1996). But the earnings data provide disconfirming evidence of the convergence through capital deepening hypothesis for the 1970s. As a measure introducing far fewer alternative explanations of the presumed convergence result, the earnings data suggest that the test of capital deepening using the per capita income measure may be spurious.

Quantifying yearly changes in earnings inequality using summary measures is very informative. In examining per capita income inequality, the coefficient of variation and the Atkinson $e = 100$ index demonstrated very similar trends. This is not the case in examining per worker earnings. The coefficient of variation measure (Figure 3) is downward sloping over the period despite an increase in volatility relative to the income series. However, the Atkinson measure, characterized by large year-to-year volatility, indicates a very flat trend over this period.⁸

⁷Conceptually, dividend incomes capture a part of the capital deepening story as returns on capital investment. However, exclusion of dividend data is justified on the grounds that it is impossible to match the receipt of dividend payments in a state to the actual capital investment in a state.

⁸Comparing regression equations corresponding to the trend lines is again very informative. This time the magnitude of the estimates differs substantially. Although both estimates are negative the Atkinson estimate is very close to zero relative to the Coefficient of Variation estimate. But the very poor fit of the Atkinson equation cautions against making any substantive inferences. The statistics are provided below (t-statistics in parentheses):

Coefficient of Variation	= 2.014 - 0.00097*Year	R ² = 0.5159	F = 22.380(0.406) (-4.73)
Atkinson ($e = 100$)	= 0.201 - 0.000026*Year	R ² = 0.00001	F = 0.001
	(0.12) (-0.031)		

TABLE 2
Cumulative Earnings Share by Inverse Ranking of State Earnings Per Worker

Inverse Rank	Equal Share	1970 Cumulative Share	1970 State	1980 Cumulative Share	1980 State	1990 Cumulative Share	1990 State
1	0.02083	0.01744	MS	0.01756	VT	0.01746	ND
2	0.04167	0.03509	ME	0.03519	ME	0.03543	MT
3	0.0625	0.05296	NH	0.05290	SD	0.05350	VT
4	0.08333	0.07099	AR	0.07081	ND	0.07193	ME
5	0.10417	0.08913	NC	0.08883	NH	0.09055	SD
6	0.125	0.10735	SD	0.10709	NC	0.10919	IA
7	0.14583	0.12595	VT	0.12542	RI	0.12790	MS
8	0.16667	0.14469	SC	0.14392	MA	0.14696	AR
9	0.1875	0.16345	VA	0.16246	MS	0.16610	KS
10	0.20833	0.18235	RI	0.18116	VA	0.18551	RI
11	0.22917	0.20139	ND	0.20003	NE	0.20493	OK
12	0.25	0.22063	MA	0.21923	AR	0.22456	NE
13	0.27083	0.24000	KS	0.23844	KS	0.24442	WY
14	0.29167	0.25944	TN	0.25778	SC	0.26431	NH
15	0.3125	0.27914	AL	0.27718	CT	0.28422	KY
16	0.33333	0.29908	CT	0.29692	IA	0.30416	NM
17	0.35417	0.31912	NE	0.31682	MT	0.32428	NC
18	0.375	0.33934	IA	0.33676	TN	0.34445	WI
19	0.39583	0.35956	GA	0.35694	MN	0.36495	VA
20	0.41667	0.37981	KY	0.37719	MD	0.38552	MO
21	0.4375	0.40007	OK	0.39755	GA	0.40626	SC
22	0.45833	0.42064	NJ	0.41794	FL	0.42705	UT
23	0.47917	0.44142	CO	0.43841	MO	0.44787	CO
24	0.5	0.46226	WY	0.45891	NJ	0.46869	TN
25	0.52083	0.48315	MT	0.47958	AL	0.48964	MA
26	0.54167	0.50411	MO	0.50024	WI	0.51065	MN
27	0.5625	0.52519	ID	0.52110	ID	0.53172	OR
28	0.58333	0.54632	LA	0.54233	CA	0.55284	ID
29	0.60417	0.56768	NM	0.56362	KY	0.57403	LA
30	0.625	0.58911	WI	0.58492	CO	0.59525	PA
31	0.64583	0.61060	PA	0.60649	NM	0.61648	IN
32	0.66667	0.63214	MN	0.62815	OK	0.63783	AL
33	0.6875	0.65369	FL	0.65003	OR	0.65931	FL
34	0.70833	0.67533	MD	0.67224	IN	0.68100	WV
35	0.72917	0.69708	TX	0.69449	DE	0.70295	OH
36	0.75	0.71901	UT	0.71678	PA	0.72495	AZ
37	0.77083	0.74117	OR	0.73921	NY	0.74698	CT
38	0.79167	0.76340	CA	0.76166	UT	0.76921	DE
39	0.8125	0.78589	DE	0.78460	OH	0.79148	MD
40	0.83333	0.80863	IN	0.80758	AZ	0.81375	NJ
41	0.85417	0.83149	WV	0.83082	LA	0.83624	CA
42	0.875	0.85443	NY	0.85410	NV	0.85888	WA
43	0.89583	0.87758	WA	0.87765	TX	0.88159	TX
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Figure 3
Coefficient of Variation and Atkinson $e=100$
Price Adjusted Earnings Series

This result has important implications for the practice of using summary inequality measures to inform processes of income convergence. While the trend in the Atkinson index appears volatile, its linear trend is relatively flat, suggesting neither an increase or decrease in inequality. That is, poorer states are not catching up with richer states in terms of earnings per worker given that the Atkinson index with an inequality aversion parameter of 100 puts greater weight on the lower part of the distribution. However, the fact that the linear trend of the unweighted coefficient of variation displays a statistically significant negative slope does suggest a decline in inequality. In other words, when equal weight is attached to transfers across the entire distribution, the summary measure indicates a decline in inequality. Consequently, the convergence implication suggested by the coefficient of variation measure is nullified by the fact that poorer states are not catching up with richer states as suggested by the Atkinson index.

CONCLUSION

The Deller et al. article provides suggestive evidence that regional and temporal price adjustments substantially alter trends in state per capita income identified by commonly used summary measures. It thus provides a counter to previous analyses identifying a process of regional income divergence. In this paper we have attempted to demonstrate that the convention in the literature of relying on summary inequality measures is supported by very weak rules of evidence. More transparent results are available to the researcher using a simple tool of inequality analysis such as the Lorenz curve. The Deller et al. article goes on to suggest the policy implications of examining the price adjusted data regarding income inequality generally and the process of income convergence more specifically. This paper takes issue with the policy implications derived from the analysis. Specifically, the price adjusted analysis provides insights toward selecting more appropriate data to examine the income convergence hypothesis. In fairness to the Deller et al. article it should be noted that the literature they rebut has also accepted the per capita income measure as appropriate to address issues of regional convergence.

Reliance on a single summary inequality measure (Amos 1988, 1989; Coughlin and Mandelbaum 1988, 1989; Garnick 1990; Redman, Rowley and Angle 1992)—or even the construction of several of the most commonly used measures (Deller et al. 1996)—cannot provide 'clear and convincing' evidence of a pattern of increasing or declining inequality. The approach used in the Deller et al. article allows the authors to conclude that the pattern of increasing inequality in the 1980s disappears for four of the five popular inequality measures used in the literature they rebut after controlling for regional cost-of-living differentials. The approach does not allow a more general statement.

Our results suggest there is much to be gained by routinely examining Lorenz curves to determine if an unambiguous statement can be made and, if not, identifying those parts of the distribution commanding a lesser share of total

income. Most importantly, the examination of Lorenz curves allows examining information from the entire distribution in a meaningful way—a rare opportunity in most empirical work. This is an important addendum to a debate meant to inform best practice in the analysis of regional inequality.

We have demonstrated that the policy implications from articles which either identify a process of divergence or convergence through the use of summary measures should be used cautiously for a number of reasons. There is no theoretical or empirical support for equating decreases in regional income inequality using summary measures with regional income convergence. The process of regional convergence requires that poorer states catch up with richer states. This may or may not be indicated by an overall decrease in income inequality. Yet, even if one does identify a genuine empirical process of income convergence, the question remains whether the data series used is appropriate to inform the capital deepening hypothesis of the theory. In the Deller et al. article, the argument that price differentials do matter raises questions as to the appropriateness of the total income measure for testing the theoretical basis of convergence through capital deepening. Our analysis of earnings per worker data suggests that the widely accepted process of income convergence over the 1970s may be a spurious result driven by unearned sources of income.

As a research note the Deller et al. article is effective in demonstrating that state price differentials do matter in the examination of regional inequality. In challenging the conventional presumption that these differentials can be disregarded, the article opens up the literature on regional convergence to productive criticism and prods regional scientists to develop more valid regional price indexes. It is in this same vein that this paper is directed. By using more transparent analysis of income inequality—thus replacing the reliance on summary measures which may mask important details—researchers will be motivated to ask tough questions regarding the observed trends. This same transparency is likely to raise questions as to the appropriateness of the various measures used. This can only increase the power of empirical tests confirming or disconfirming a theory of substantial policy importance.

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