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Trends in Economic Inequality: Are U.S. states growing apart?

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Abstract

Using quarterly real GDP data from 2005 to 2019 for all U. S. states from the Bureau of Economic Analysis, we construct an economic inequality measure which is additively decomposable into within and between-region inequality. We find increases in economic disparity in terms of total real GDP across the states. The results show that states belonging to the South and West regions are growing apart, contributing significantly toward the level of total economic disparity in the country. However, in terms of per-capita real GDP, economic disparity across states is much smaller. The results emphasize the role of population dynamics in mitigating economic disparity across U. S. states.

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For $x \geqslant 0^n$, we denote $\sum_{i=1}^{n} x_i$, the sum of all coordinates, by $|x|$ and $\frac{|x|}{n}$, the mean, by $\bar{x}$. We use notation $(x;y)$ to denote the combination vector $(x_1,\cdots,x_n,y_1,\cdots,y_m)$ where $x \in \mathbb{R}^n$ and $y \in \mathbb{R}^m$. A partition of vector $y \in \mathbb{R}^n$ into $l \geqslant 2$ smaller vectors is denoted by $\left(y^{(1)},\cdots,y^{(l)}\right)$ where $y^{(1)}$, $y^{(l)}$ are the sub-vectors.

2.2 Theil index and its decomposition

Following Foster (1983), we introduce the notion of an inequality measure which permits both the population size and total income to be variable. For a given population size $n \geqslant 1$, consider the set $D^n := \{x \in \mathbb{R}^n : x > 0^n\}$ of n-income distributions. Each n-distribution y specifies a scheme of allocating total income of $|y|$ among a population consisting of n persons. The term inequality index is used to denote a function $I^n : D^n \to \mathbb{R}$ which describes comparisons of inequality for any given level of population n. The inequality measure provides a comparison of inequality across different population sizes. It is defined on $\mathscr{D} := \bigcup_{n=1}^{\infty} D^n$, the set of all distributions.[1]

The inequality measure of our interest is the Theil measure introduced in Theil (1967). The Theil measure is defined as $I : \mathscr{D} \to \mathbb{R}$, whose indices are defined as follows:

$$I^n(y) = \sum_{i=1}^{n} \frac{y_i}{|y|} \ln\left(n\frac{y_i}{|y|}\right), y \in D^n. \tag{1}$$

It is easy to infer that the smallest value for the Theil index is zero, indicating perfect equality. Further, the upper bound of the index is the natural logarithm of the sample size and is therefore the index I^n, which could increase unboundedly with the sample size n.

Theil (1967) demonstrated that in a sample comprising of multiple groups of income generators, the inequality measure $I^n(y)$, as defined in (1), can be expressed by the sum of two separate terms. The first term, "within group" inequality, is defined as the sum of inequality levels of each group weighted by the share of income it generates as a proportion of the total income of the sample. The second term, "between-group" inequality, captures the inequality in a "smoothed" income distribution where the mean income of the group is treated as the income of the group.[2] Following Foster (1983), we express the decomposition in formal terms as follows. Let the aggregate population of size n be partitioned in $l \geqslant 2$ groups having n_1, $\cdots$, n_l (with $n_1 + \cdots + n_l = n$) members respectively. Let the income distributions of the smaller groups be $y^{(i)} \in D_{n_i}$ $(i = 1,\cdots,l)$. Then the Theil inequality index $I^n(y)$ can be decomposed as

$$I(y) = \sum_{i=1}^{l} \left(\frac{|y^{(i)}|}{|y|} I(y^{(i)})\right) + I(\bar{y}^{(1)}u^{n_1};\bar{y}^{(2)}u^{n_2};\cdots;\bar{y}^{(l)}u^{n_l}), \tag{2}$$

where $y = \left(y^{(1)};\cdots;y^{(l)}\right)$.

[1] Put differently, while the inequality index takes the population size as given and fixed, the inequality measure is defined over all possible population sizes and income distributions.

[2] For example, if $y = (1,3,5,7,3)$, and y is partitioned into two sets $y^{(1)} = (1,3)$ and $y^{(2)} = (5,7,3)$. The decomposability property implies that $I(y) = \left(\frac{4}{19}\right) I(y^{(1)}) + \left(\frac{15}{19}\right) I(y^{(2)}) + I(2,2,5,5,5)$.

2.3 Data

We use quarterly real GDP and real GDP per-capita data by state from the Bureau of Economic Analysis to construct the economic disparity measure and subsequently decompose it into within and between-region disparity.

We use (1) to calculate the Theil index and its decomposition to measure overall economic disparity across the fifty U.S. states. Then, we decompose the Theil index into within and between measures for four U.S. regions (Northeast, South, Midwest, and West) applying (2).

3 Results

The panels in Figure 1 show economic inequality calculated from (1) and its decomposition using total state-level real GDP data; i.e., it displays disparity in real GDP levels within the four regions (Northeast, South, Midwest, and West) as well as between the regions as calculated from (2).[3] Panel A displays the overall economic disparity across fifty U.S. states over the sample period. Panels B, C, D and E display the contributions of economic disparity within the West, South, Northeast, and Midwest regions to overall economic disparity as seen in Panel A. Panel F displays the contribution of disparity between the four regions to overall economic disparity. Put differently, Panels B, C, D, E, and F are decompositions of the economic disparity observed in Panel A. It is important to emphasize that the sum of within and between disparities exactly equal the total economic disparity measure in Panel A.

Panel A of Figure 1 shows that economic disparities across the fifty states were roughly constant from 2005 to 2010 but have subsequently increased. This confirms that not all the U.S. states have experienced the same level of growth in total real GDP and that states within the U.S. have been growing at different rates over the last ten years. Interestingly, as seen in Panel B, most of the increase in overall economic disparity is driven by economic disparity within the West region. From 2013 to 2019, we observe an increased contribution to overall disparity (43.5% to 46%) from variations in economic disparity within the West region. Similarly, as shown in Panel C, the contributions of economic disparity within the South to overall economic disparity increased consistently (23% to 26%) over the sample period. Altogether, economic disparities within the South and West regions contribute 72% of the overall economic disparity across U.S. states. As such, this indicates that states within these two regions are driving most of the economic disparity in the United States. Note, the contribution of overall economic disparity in the U.S. attributed to disparities within the Northeast region has decreased from 23% to roughly 20% as shown in Panel D. Disparity within the Midwest region accounts for less than 10% of the overall economic disparity in the United States as seen in Panel E. Note, in Panel F, over the entire sample period, differences between regions have a negligible contribution toward overall economic disparity in the U.S. We believe the results are insightful. States in the South and West regions are diverging in terms of total real income, contributing significantly to overall economic disparity in the U.S. However, we find that states within the Midwest and Northeast are very similar in terms of real GDP growth.

Lastly, we estimate the economic disparity from (1) using per-capita state level real GDP data. As seen in Figure 2, we do not observe increasing economic disparities across the fifty states in per-capita terms. Specifically, the estimated Theil index remains very close to zero, indicating

[3] We report the set of Theil index values and corresponding decompositions in the appendix.

non-divergence of per-capita income across U.S. states over the sample period 2005 to 2018. This suggests that dynamics in population growth across U.S. states play a significant role in eliminating economic divergence between the states.

4 Conclusion

Recently, many authors have argued that there are parts of the United States that have been economically left behind. Research indicates that globalization, technological change, education, and politics are some of the causes leading certain regions to grow apart from the rest of the United States. In particular, the Midwest has suffered from the loss of manufacturing jobs that have been offshored in the past couple decades. The Northeast's manufacturing base has also declined (see Austin et al. (2018) and Nunn et al. (2018)). The South and West regions have fared better due to heavier reliance on the technology industry (Silicon Valley in California) and services (tourism in Florida, banking in Charlotte, North Carolina). Perhaps, in the future, the Midwest and Northeast economies will expand more heavily into tech and services, but, for now, they are behind relative to the South and West.

In this paper, we show that economic disparities in terms of total real GDP across the fifty states were relatively constant from 2005 to 2010. However, since 2010, we observe increases in economic disparity across states within certain regions. The results suggest that not all U.S. states have experienced the same level of growth in total real GDP, suggesting that states within the U.S. have been growing apart within the last ten years. Specifically, states that belong to the South and West regions are growing apart, contributing significantly to overall economic disparity within the United States. However, we find little evidence of disparity in terms of per-capita real GDP across U.S. states. This result emphasizes the role of population dynamics across U.S. states in eliminating economic disparities in per-capita terms across the fifty states.

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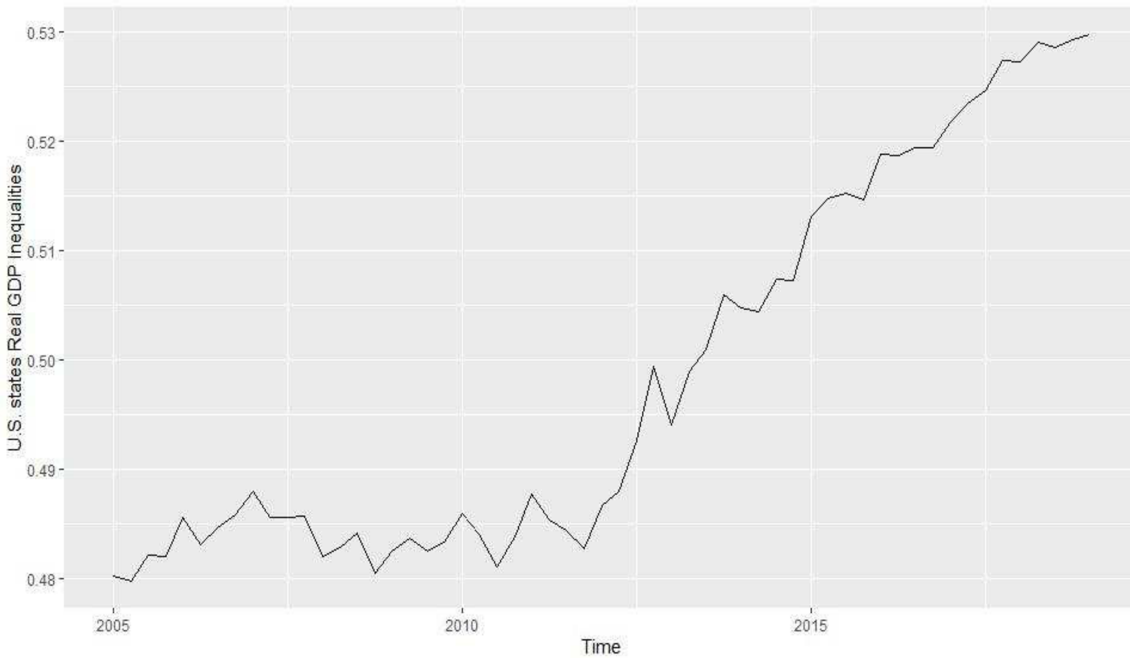
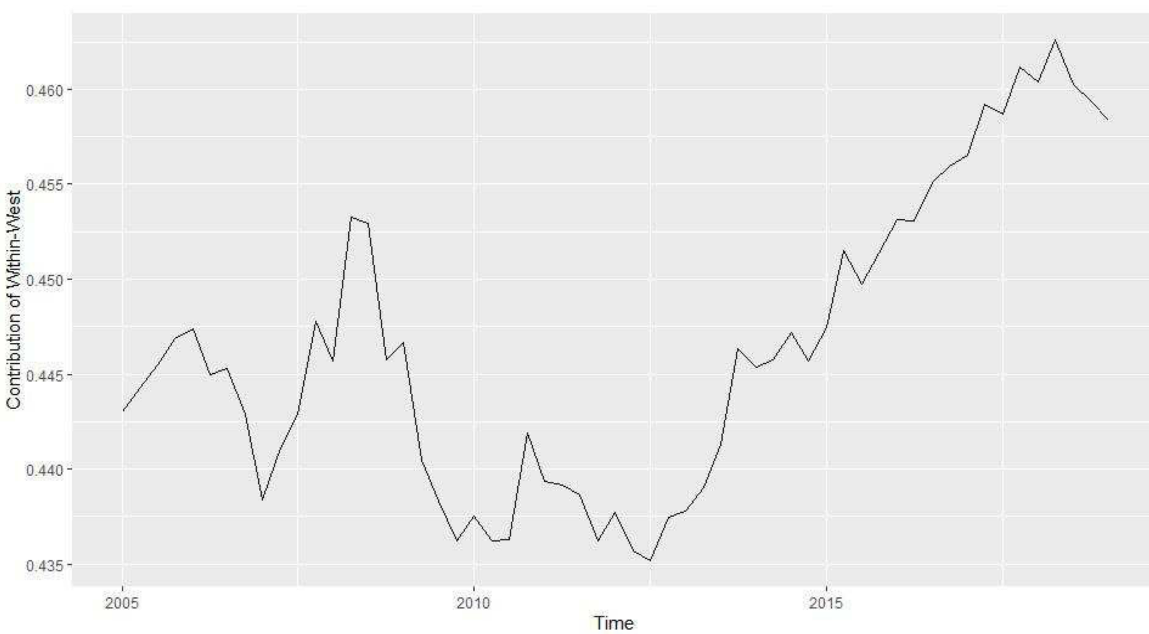
Figure 1: Theil Index measure and its decomposition using U.S. states level Real GDP

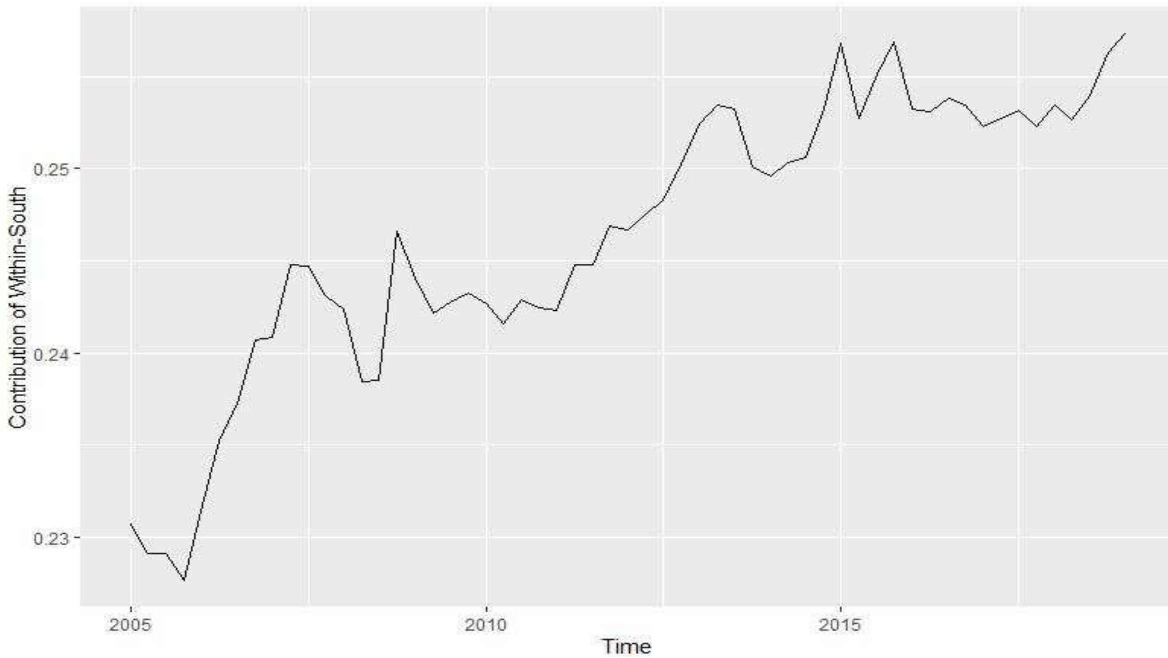
Panel A: Theil Index using U.S. state Real GDP



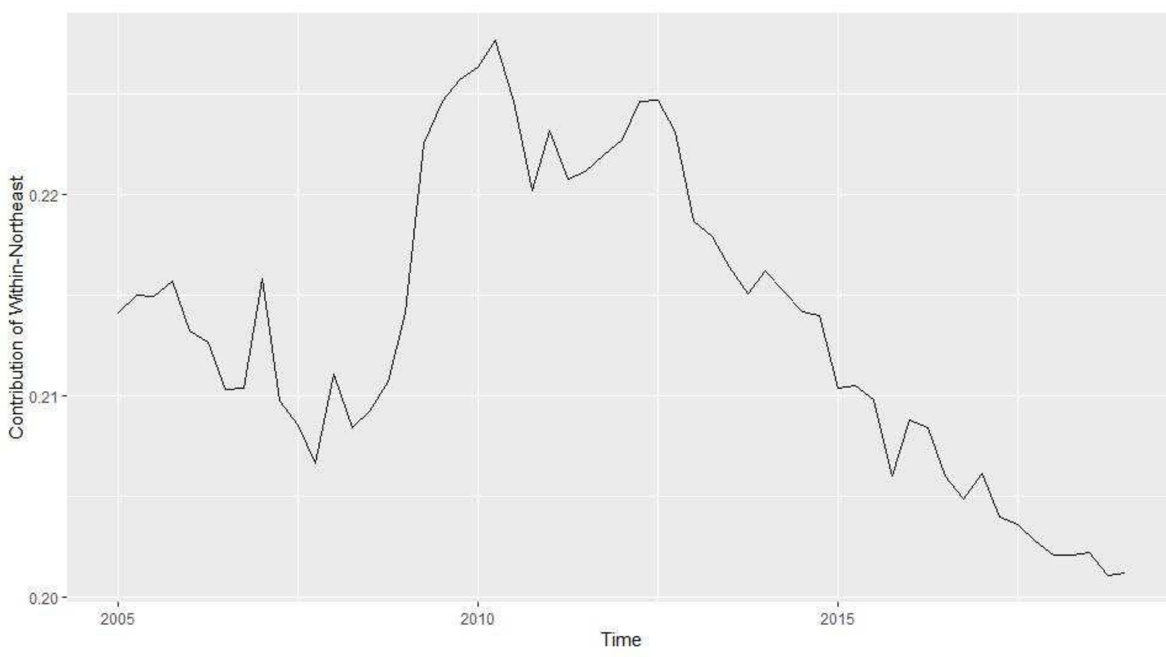
Panel B: Contribution of Within West region inequality towards the overall Theil Index



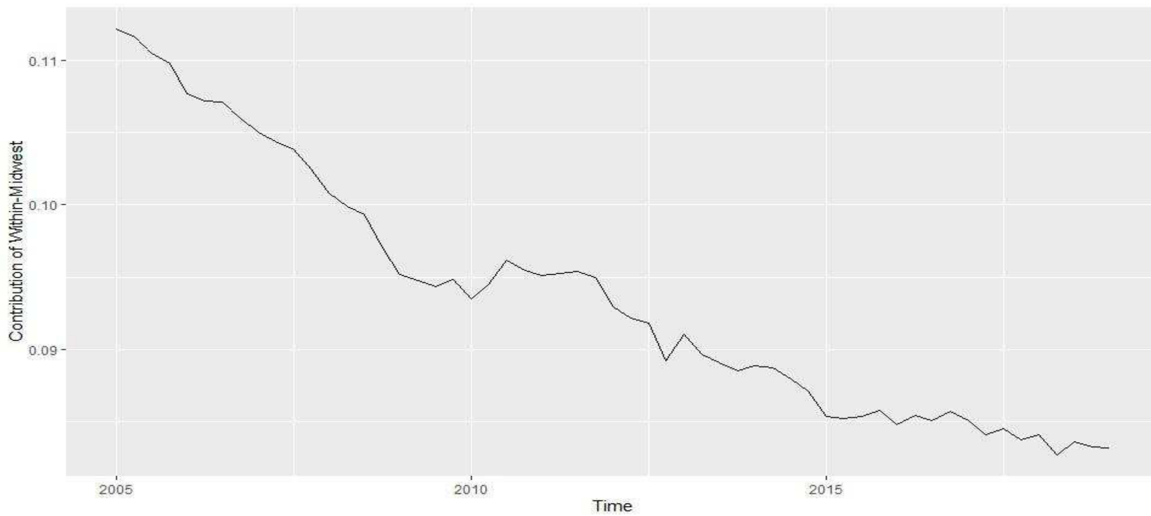
Panel C: Contribution of Within South region inequality towards the overall Theil Index



Panel D: Contribution of Within Northeast region inequality towards the overall Theil Index



Panel E: Contribution of Within Midwest region inequality towards the overall Theil Index



Panel F: Contribution of between region inequalities towards the overall Theil Index

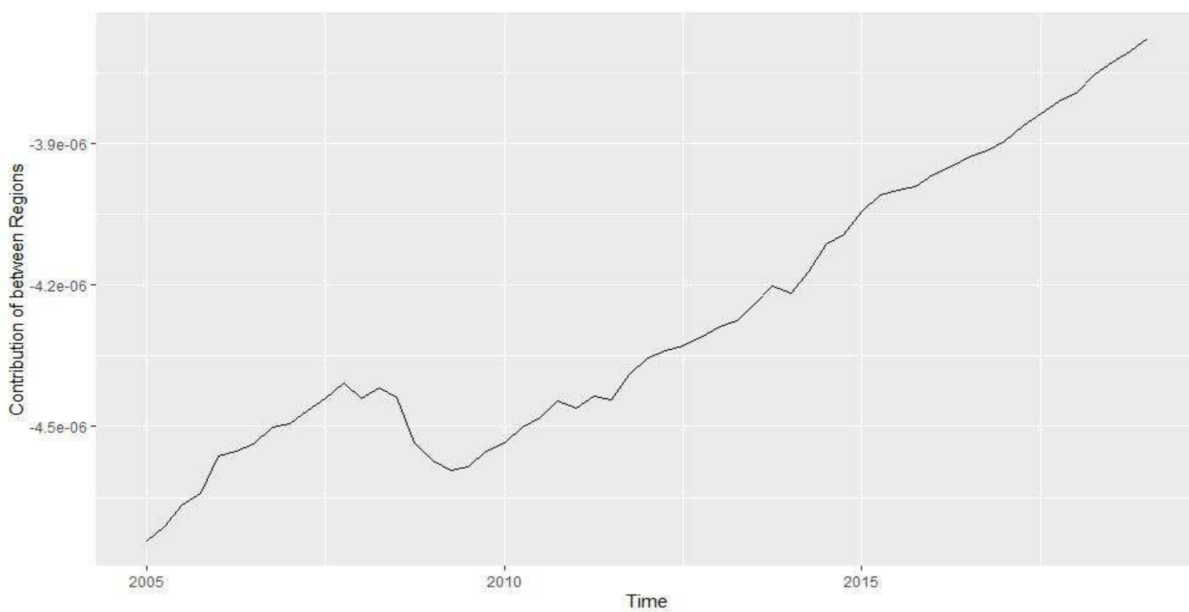
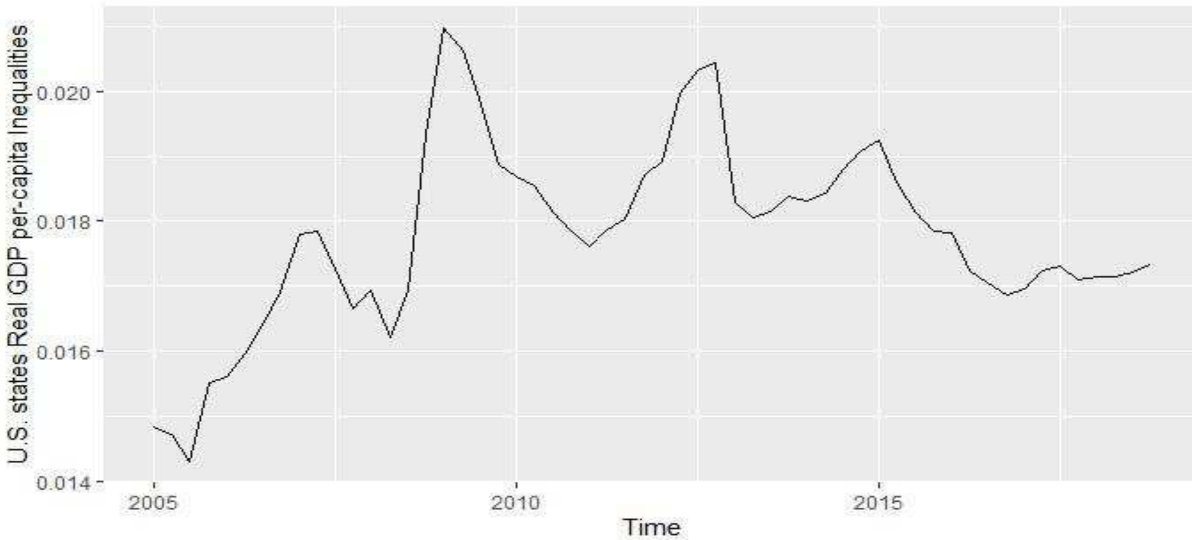


Figure 2: Theil Index measure using U.S. states level Real GDP per capita



Appendix

Table 1: Theil Index measure and its decomposition using U.S. state level Real GDP

		Decomposition of Theil Index across US regions				
	Theil Index	Within Northeast	Within Midwest	Within South	Within West	Between Regions
2005						
Qtr1	0.491	0.103	0.054	0.111	0.213	(0.000)
Qtr2	0.491	0.103	0.054	0.110	0.213	(0.000)
Qtr3	0.493	0.104	0.053	0.111	0.215	(0.000)
Qtr4	0.493	0.104	0.053	0.110	0.215	(0.000)
2006						
Qtr1	0.497	0.104	0.052	0.113	0.217	(0.000)
Qtr2	0.494	0.103	0.052	0.114	0.215	(0.000)
Qtr3	0.496	0.102	0.052	0.115	0.216	(0.000)
Qtr4	0.497	0.102	0.052	0.117	0.215	(0.000)
2007						
Qtr1	0.499	0.105	0.051	0.118	0.214	(0.000)
Qtr2	0.496	0.102	0.051	0.119	0.214	(0.000)
Qtr3	0.496	0.101	0.050	0.119	0.215	(0.000)
Qtr4	0.496	0.100	0.050	0.118	0.217	(0.000)
2008						
Qtr1	0.493	0.102	0.049	0.117	0.215	(0.000)
Qtr2	0.494	0.101	0.048	0.115	0.219	(0.000)
Qtr3	0.495	0.101	0.048	0.115	0.219	(0.000)
Qtr4	0.493	0.101	0.047	0.118	0.214	(0.000)
2009						
Qtr1	0.495	0.103	0.046	0.118	0.216	(0.000)
Qtr2	0.497	0.108	0.046	0.117	0.213	(0.000)
Qtr3	0.496	0.108	0.046	0.117	0.212	(0.000)
Qtr4	0.497	0.109	0.046	0.118	0.211	(0.000)
2010						
Qtr1	0.500	0.110	0.045	0.118	0.213	(0.000)
Qtr2	0.497	0.110	0.046	0.117	0.211	(0.000)
Qtr3	0.494	0.108	0.046	0.117	0.210	(0.000)
Qtr4	0.496	0.107	0.046	0.117	0.214	(0.000)
2011						
Qtr1	0.500	0.109	0.046	0.118	0.214	(0.000)
Qtr2	0.497	0.107	0.046	0.119	0.213	(0.000)
Qtr3	0.496	0.107	0.046	0.119	0.212	(0.000)
Qtr4	0.494	0.107	0.046	0.119	0.211	(0.000)

2012						
Qtr1	0.498	0.108	0.045	0.120	0.213	(0.000)
Qtr2	0.500	0.110	0.045	0.121	0.213	(0.000)
Qtr3	0.505	0.111	0.045	0.122	0.214	(0.000)
Qtr4	0.512	0.111	0.045	0.125	0.218	(0.000)
2013						
Qtr1	0.506	0.108	0.045	0.125	0.216	(0.000)
Qtr2	0.511	0.109	0.045	0.126	0.219	(0.000)
Qtr3	0.512	0.108	0.045	0.127	0.221	(0.000)
Qtr4	0.517	0.109	0.045	0.127	0.226	(0.000)
2014						
Qtr1	0.516	0.109	0.045	0.126	0.225	(0.000)
Qtr2	0.515	0.109	0.045	0.126	0.225	(0.000)
Qtr3	0.518	0.109	0.045	0.127	0.227	(0.000)
Qtr4	0.518	0.109	0.044	0.128	0.226	(0.000)
2015						
Qtr1	0.524	0.108	0.044	0.132	0.230	(0.000)
Qtr2	0.526	0.108	0.044	0.130	0.232	(0.000)
Qtr3	0.526	0.108	0.044	0.131	0.232	(0.000)
Qtr4	0.525	0.106	0.044	0.132	0.232	(0.000)
2016						
Qtr1	0.530	0.108	0.044	0.131	0.235	(0.000)
Qtr2	0.529	0.108	0.044	0.131	0.235	(0.000)
Qtr3	0.530	0.107	0.044	0.132	0.236	(0.000)
Qtr4	0.530	0.106	0.045	0.132	0.237	(0.000)
2017						
Qtr1	0.532	0.108	0.044	0.132	0.238	(0.000)
Qtr2	0.534	0.107	0.044	0.132	0.240	(0.000)
Qtr3	0.535	0.107	0.044	0.133	0.241	(0.000)
Qtr4	0.538	0.107	0.044	0.133	0.243	(0.000)
2018						
Qtr1	0.538	0.107	0.044	0.134	0.243	(0.000)
Qtr2	0.540	0.107	0.044	0.134	0.245	(0.000)
Qtr3	0.539	0.107	0.044	0.134	0.243	(0.000)
Qtr4	0.540	0.106	0.044	0.136	0.243	(0.000)
2019						
	0.541	0.107	0.044	0.136	0.243	(0.000)

Table 2: Theil Index measure and its decomposition using U.S. state level Real GDP per capita

		Decomposition of Theil Index across US regions				
	Theil Index	Within Northeast	Within Midwest	Within South	Within West	Between Regions
2005						
Qtr1	0.009	0.003	-0.003	0.006	0.004	0.000
Qtr2	0.009	0.003	-0.004	0.005	0.004	0.000
Qtr3	0.009	0.003	-0.003	0.005	0.004	0.000
Qtr4	0.010	0.003	-0.003	0.007	0.004	0.000
2006						
Qtr1	0.010	0.003	-0.003	0.006	0.004	0.000
Qtr2	0.011	0.003	-0.003	0.006	0.005	0.000
Qtr3	0.011	0.003	-0.003	0.006	0.005	0.000
Qtr4	0.011	0.003	-0.003	0.006	0.005	0.000
2007						
Qtr1	0.012	0.004	-0.003	0.006	0.006	0.000
Qtr2	0.012	0.003	-0.003	0.006	0.006	0.000
Qtr3	0.012	0.003	-0.003	0.005	0.006	0.000
Qtr4	0.011	0.003	-0.003	0.005	0.006	0.000
2008						
Qtr1	0.011	0.004	-0.003	0.005	0.006	0.000
Qtr2	0.011	0.003	-0.003	0.005	0.005	0.000
Qtr3	0.012	0.003	-0.002	0.005	0.006	0.000
Qtr4	0.013	0.003	-0.003	0.005	0.008	0.000
2009						
Qtr1	0.015	0.003	-0.002	0.005	0.009	0.000
Qtr2	0.015	0.003	-0.003	0.006	0.008	0.000
Qtr3	0.014	0.003	-0.003	0.006	0.007	0.000
Qtr4	0.013	0.003	-0.003	0.006	0.007	0.000
2010						
Qtr1	0.012	0.003	-0.003	0.006	0.006	0.000
Qtr2	0.012	0.003	-0.003	0.005	0.006	0.000
Qtr3	0.012	0.003	-0.003	0.005	0.006	0.000
Qtr4	0.012	0.003	-0.002	0.005	0.006	0.000
2011						
Qtr1	0.012	0.003	-0.002	0.006	0.006	0.000
Qtr2	0.012	0.003	-0.002	0.005	0.006	0.000
Qtr3	0.012	0.003	-0.002	0.006	0.006	0.000
Qtr4	0.013	0.003	-0.001	0.005	0.006	0.000
2012						
Qtr1	0.013	0.003	-0.001	0.005	0.006	0.000

Qtr2	0.014	0.003	-0.001	0.005	0.007	0.000
Qtr3	0.015	0.003	0.000	0.005	0.006	0.000
Qtr4	0.014	0.003	0.000	0.005	0.006	0.000
2013						
Qtr1	0.012	0.003	-0.001	0.005	0.006	0.000
Qtr2	0.012	0.003	-0.001	0.005	0.005	0.000
Qtr3	0.012	0.003	-0.001	0.004	0.005	0.000
Qtr4	0.013	0.003	-0.001	0.005	0.005	0.000
2014						
Qtr1	0.013	0.003	-0.001	0.005	0.005	0.000
Qtr2	0.013	0.003	0.000	0.005	0.005	0.000
Qtr3	0.013	0.003	0.000	0.005	0.005	0.000
Qtr4	0.013	0.003	0.000	0.005	0.005	0.000
2015						
Qtr1	0.013	0.003	-0.001	0.006	0.005	0.000
Qtr2	0.013	0.003	-0.001	0.006	0.005	0.000
Qtr3	0.012	0.003	-0.001	0.005	0.005	0.000
Qtr4	0.012	0.003	-0.001	0.005	0.005	0.000
2016						
Qtr1	0.012	0.003	-0.001	0.005	0.005	0.000
Qtr2	0.011	0.003	-0.001	0.005	0.005	0.000
Qtr3	0.011	0.003	-0.001	0.005	0.005	0.000
Qtr4	0.011	0.003	-0.001	0.005	0.005	0.000
2017						
Qtr1	0.011	0.003	-0.002	0.005	0.005	0.000
Qtr2	0.011	0.003	-0.002	0.005	0.005	0.000
Qtr3	0.011	0.003	-0.002	0.005	0.005	0.000
Qtr4	0.011	0.003	-0.002	0.005	0.005	0.000
2018						
Qtr1	0.011	0.003	-0.002	0.005	0.005	0.000
Qtr2	0.011	0.003	-0.002	0.005	0.005	0.000
Qtr3	0.011	0.003	-0.002	0.005	0.005	0.000
Qtr4	0.011	0.003	-0.002	0.005	0.005	0.000