Correction to: Causality Between Per Capita Real GDP and Income Inequality in the U.S.: Evidence from a Wavelet Analysis

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In the original publication of this article, Tables 5 to 10 have been published incorrectly. Now the tables and related content have been provided correctly in this erratum.

Correction 1: Under Abstract heading, the line starting from “Evidence that...” has been changed.

Evidence that per capita real GDP leads inequality at both high and low frequencies exists for the Top 1 and 10% measures of inequality with little evidence that inequality leads real GDP per capita.

Correction 2: Under Methodology: Wavelet Coherency and Phase Difference heading, the line in third paragraph starting from “If $\varphi_{xy} \in (0, \pi/2)$ ...” has been changed.

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If $\varphi_{xy} \in (0, \pi/2)$, then the series move in phase (positively co-move) with $y(t)$ preceding $x(t)$. If $\varphi_{xy} \in (\pi/2, \pi)$, then the series move out of phase (negatively co-move) with $x(t)$ preceding $y(t)$. If $\varphi_{xy} \in (-\pi, (-\pi)/2)$, then the series move out of phase with $y(t)$ preceding $x(t)$. Finally, if $\varphi_{xy} \in ((-\pi)/2, 0)$, then the series move in phase with $x(t)$ preceding $y(t)$.

Correction 3: The entire content under Main Analysis heading has been changed.

From 1983 to 2012, the US per capita real GDP and Atkin05 show a statistically significant high coherency across 1–2-year frequency band in Fig. 1. Figure 1 also shows positive correlations between the US per capita real GDP and Atkin05 over the short term and the long term.

Across the 2–4-year frequency band in Table 5, US per capita real GDP leads the Atkin05 inequality measure in 1917–1948 and 1977–2012, while the Atkin05 inequality measure leads US per capita real GDP in 1949–1976. The change in the direction of the causality from per capita real GDP leads to inequality leads in the late 1940s probably relates to a democratization of wealth in the post-war period. Also, stagnating real wages for the majority of the population despite increasing productivity. Across the 1–2-year frequency band, we see the causal link running from per capita real GDP to the Atkin05 inequality measure for the periods—1965–1973, 1978–1987, and 2011–2012 (see Table 5). The 1970s saw couple of oil price spikes as OPEC began affecting prices. After the 1973 oil shocks, productivity growth suddenly slowed and the oil price shocks led to higher unemployment and inflation.

The Gini coefficient exhibits a positive and statistically significant correlation with US per capita real GDP from 1917 to 1930 and from 1970 to 2012 in Fig. 2. Figure 2 also shows causality between US per capita real GDP and the Gini coefficient. Over the short term and the long term, the two series show positive correlation.

US per capita real GDP leads the Gini coefficient from 1967 to 1972 at high frequency in Table 6, while the Gini coefficient leads per capita real GDP from 1971 to 1982 at low frequency. The Vietnam War covered the 1967–1972 period which in turn productivity growth slowed. Also, as a consequence of fiscal and monetary policies during this War, the US experienced rising inflation and unemployment during most of the 1960s into the early

Table 5 Wavelet phase difference (logarithm of US per capita real GDP, logarithm of Atkinson Index)

	Period	Phase	Sign of co-movement	Causality
High frequency	1917–1964	$(0, \frac{\pi}{2})$, In-phase	+	Atkin05 $\rightarrow$ US per capita real GDP
	1965–1973	$(\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Atkin05
	1974–1977	$(0, \frac{\pi}{2})$, In-phase	+	Atkin05 $\rightarrow$ US per capita real GDP
	1978–1987	$(\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Atkin05
	1988–2010	$(0, \frac{\pi}{2})$, In-phase	+	Atkin05 $\rightarrow$ US per capita real GDP
	2011–2012	$(\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Atkin05
Low frequency	1917–1948	$(\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Atkin05
	1949–1976	$(0, \frac{\pi}{2})$, In-phase	+	Atkin05 $\rightarrow$ US per capita real GDP
	1977–2012	$(\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Atkin05

Table 6 Wavelet phase difference (logarithm of US per capita real GDP, logarithm of Gini coefficient)

	Period	Phase	Sign of co-movement	Causality
High frequency	1917–1966	$(0, \frac{\pi}{2})$, In-phase	+	Gini $\rightarrow$ US per capita real GDP
	1967–1972	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Gini
	1973–2012	$(0, \frac{\pi}{2})$, In-phase	+	Gini $\rightarrow$ US per capita real GDP
Low frequency	1917–1970	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Gini
	1971–1982	$(0, \frac{\pi}{2})$, In-phase	+	Gini $\rightarrow$ US per capita real GDP
	1983–2012	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Gini

Table 7 Wavelet phase difference (logarithm of US per capita real GDP, logarithm of Rmeandev)

	Period	Phase	Sign of co-movement	Causality
High frequency	1917–1965	$(0, \frac{\pi}{2})$, In-phase	+	Rmeandev $\rightarrow$ US per capita real GDP
	1966–1975	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Rmeandev
	1976–2012	$(0, \frac{\pi}{2})$, In-phase	+	Rmeandev $\rightarrow$ US per capita real GDP
Low frequency	1917–1948	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Rmeandev
	1949–2012	$(0, \frac{\pi}{2})$, In-phase	+	Rmeandev $\rightarrow$ US per capita real GDP

1980s. Moreover, OPEC oil price shocks also occurred during the 1970s, as noted above. We can see the temporary causality does not determine long-run causality (see Table 6).

From 1980 to 2012, US per capita real GDP and the Rmeandev inequality measure show a statistically significant high coherency across the 1–2-year frequency band (see Fig. 3) with an in-phase relation (see Table 7).

We observe across the 1–2-year frequency band in Table 7 an in-phase relationship in 1966–1975 with per capita real GDP leading. At low frequencies, we see the causal link running from per capita real GDP to Rmeandev from 1917 to 1948 and Rmeandev leads per capita real GDP from 1949 to 2012, which relates to compression in wages during the 1940s.

Theil index exhibits a strong positive correlation with US per capita real GDP from 1980 to 2012 across the 1–2-year frequency band in Fig. 4.

The phase difference shows causality between the US per capita real GDP and the Theil index in Table 8. Throughout the period from 1917 to 2012, per capita real GDP leads the Theil index at low frequency. This indicates that per capita real GDP positively affects income inequality (Theil). At high frequencies, per capita real GDP leads Theil index repeatedly from 1963 to 1972 (see Table 8), which also corresponds to the Vietnam War period.

Across the 1–2-year frequency band, two significant islands have high coherency between US per capita real GDP and the Top 10% around 1955 and from 1985 to 2012 in Fig. 5. Across the 2–3-year frequency band, we observe a significant island from 1945 to 1957 (see Fig. 5), which is related to the World War II as the Top 10% income share fell substantially during the World War II (Goldin and Margo 1992). We observe the consistent strong positive correlation between US per capita real GDP and inequality measures at the

Table 8 Wavelet phase difference (logarithm of US per capita real GDP, logarithm of Theil index)

	Period	Phase	Sign of co-movement	Causality
High frequency	1917–1962	$(0, \frac{\pi}{2})$, In-phase	+	Theil $\rightarrow$ US per capita real GDP
	1963–1972	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Theil
	1973–2012	$(0, \frac{\pi}{2})$, In-phase	+	Theil $\rightarrow$ US per capita real GDP
Low frequency	1917–2012	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Theil

Table 9 Wavelet phase difference (logarithm of US per capita real GDP, logarithm of Top 10%)

	Period	Phase	Sign of co-movement	Causality
High frequency	1917–1988	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Top 10%
	1989–2012	$(0, \frac{\pi}{2})$, In-phase	+	Top 10% $\rightarrow$ US per capita real GDP
Low frequency	1917–1973	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Top 10%
	1974–1978	$(0, \frac{\pi}{2})$, In-phase	+	Top 10% $\rightarrow$ US per capita real GDP
	1979–1984	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Top 10%
	1985–2012	$(0, \frac{\pi}{2})$, In-phase	+	Top 10% $\rightarrow$ US per capita real GDP

1–2-year frequency at the recent sample years (see Fig. 5). This may relate to the Tax Reform Act of 1986, which lowered the top tax rate and raised the bottom tax rate. As a result, income inequality leads US per capita real GDP in the recent sample years.

Table 9 shows causality between the US per capita real GDP and the Top 10%. At high frequency, per capita real GDP leads the Top 10% from 1917 to 1988. At low frequency, per capita real GDP leads the Top 10% from 1917–1973 to 1979–1984 (see Table 9).

In Fig. 6, we observe a statistically positive correlation from the 1926 to the 1949 between per capita real GDP and the Top 1% across the 2–3-year frequency band as during the Great Depression the Top 1% declined extensively.

At high frequency, per capita real GDP leads the Top 1% from 1917–1993 to 2003–2012 in Table 10. At low frequency, per capita real GDP leads the Top 1% from 1917–1983 to 1986–2012 (see Table 10).

Overall, we observe a positive correlation between per capita real GDP and income inequality. Also, we observe that the directions of short- and long-term causality vary. If we restrict our analysis to classical time series, we cannot find any information about frequency differences. To develop a deeper understanding of the relationships between US per capita real GDP and our measures of income inequality requires wavelet analysis.

Correction 4: Under Conclusion heading, the line in third paragraph starting from “An exception...” has been changed.

An exception is that per capita real GDP mainly leads the Top 1 and 10% inequality measures at both high and low frequencies.

Table 10 Wavelet phase difference (logarithm of US per capita real GDP, logarithm of Top 1%)

	Period	Phase	Sign of co-movement	Causality
High frequency	1917–1993	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Top 1%
	1994–2002	$(0, \frac{\pi}{2})$, In-phase	+	Top 1% $\rightarrow$ US per capita real GDP
	2003–2012	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Top 1%
Low frequency	1917–1983	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Top 1%
	1984–1985	$(0, \frac{\pi}{2})$, In-phase	+	Top 1% $\rightarrow$ US per capita real GDP
	1986–2012	$(-\frac{\pi}{2}, 0)$, In-phase	+	US per capita real GDP $\rightarrow$ Top 1%

Correction 4: Under Conclusion heading, the line in fourth paragraph starting from “In addition...” has been changed.

In addition, we find not only inequality matters for growth but also growth matters for inequality, especially the Top 1 and 10% income shares.