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Working Paper

Can Growth Be Both Wage-Led and Profit-Led? Investigating Growth-Inequality-Cycles through Spectral Analysis

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Abstract

Profit-led (wage-led) demand and a profit-squeeze (wage-squeeze) distribution generate counterclockwise (clockwise) cycles in the wage share-growth plane. If the wage-led demand effect or the profit-squeeze distribution effect prevails, growth and the wage share are positively correlated. Conversely, if the profit-led demand effect or the wage-squeeze distribution predominates, the correlation is negative. The relative strength of each effect can be determined by the relative phase difference between the wage share and growth. Decomposing the wage share and growth rates for 20 countries using wavelet analysis, we find that in most countries the wage share and growth are positively correlated in the long run, but negatively correlated in the short run. The results suggest that causality runs in both directions, i.e., that both demand and distributional effects operate. In the short run, the profit-led demand effect and the wage-squeeze distribution effect are the most prevalent. In the long run, we find wage-led/wage-squeeze cycles in the majority of countries, with the demand effect usually being more pronounced. In addition, some countries underwent a shift in the growth regime and in the direction of the cycles.

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1 Introduction

The interdependent relationship between income distribution and economic activity has long been at the center of Political Economy. This relationship is characterized by complex, bidirectional causality. On one hand, the income distribution can influence economic growth, with changes in the wage share either stimulating aggregate demand (in a wage-led regime) or dampening it (in a profit-led regime). On the other hand, economic growth can alter income distribution by influencing real wages and productivity, for instance through strengthening or weakening workers' bargaining power or by incentivizing labor-saving investments.

These bidirectional effects are captured in two prominent Post-Keynesian frameworks: the neo-Kaleckian model and the neo-Goodwin cycle model. The neo-Kaleckian approach primarily focuses on how income distribution affects aggregate demand and growth, allowing for both wage-led and profit-led regimes. The neo-Goodwin model, building on Goodwin's growth cycle model (Goodwin 1967), emphasizes the cyclical interaction between distribution and economic activity. When combined, profit-led demand and profit-squeeze distribution regimes can result in counter-clockwise Goodwin cycles (Goodwin 1967; Barbosa-Filho and Taylor 2006). Conversely, wage-led demand and wage-squeeze distribution lead to clockwise cycles (Kiefer and Rada 2015).

Ultimately, whether a country's growth model is wage-led or profit-led is an empirical question. Research on this issue has produced a large body of literature with mixed and often contradictory results. Strikingly, these conflicting findings appear to be systematically related to the methodological approach employed (Blecker 2016; Blecker and Setterfield 2019). Studies using the structural approach, which estimates the effects of income distribution on individual components of aggregate demand, more frequently find wage-led growth. In contrast, aggregative or systems approaches, which estimate the overall effect of distribution on demand often using simultaneous equation models, typically yield profit-led estimates.

These conflicting empirical findings highlight two major challenges in the current literature. First, the structural approach often assumes exogenous impacts of wage shares on growth, risking endogeneity bias. Second, while aggregative approaches account for simultaneity, they primarily focus on short-term effects, overlooking long-term dynamics.

This paper addresses these challenges by applying a novel methodological approach: spectral analysis through wavelet transformation. Our method enables a detailed examination of the bidirectional causality between income distribution and growth, addressing the potential endogeneity bias. Moreover, it clarifies how this relationship can manifest differently across various temporal dimensions within the same country, extending beyond the short-term focus of many existing studies.

We employ the wavelet transform, a technique previously utilized by Charpe et al.

(2020), Santos and Araujo (2020), and Barrales and von Arnim (2017). This allows us to decompose growth rates and wage share time series into their respective time-scale components. By analyzing the relative phase angles, we can examine the relationship between these variables across various time scales, offering a more granular understanding of their dynamic interplay.

Analyzing data from 20 countries, we find a general positive correlation between the wage share and growth in the long term, contrasting with a negative correlation in the short term. These results indicate the presence of both demand and distributional effects, with short-term dynamics dominated by profit-led demand and wage-squeeze effects, and long-term trends characterized by wage-led demand and profit-squeeze cycles. Notably, some countries exhibit shifts in their growth regimes and cycle directions, suggesting the potential for structural changes in economic dynamics over time.

This paper contributes to the literature in several ways. First, we extend previous wavelet analyses of wage share and economic growth beyond their typical focus on the US, examining 20 developed and emerging countries over extended time periods. This broader scope allows for more comprehensive insights into the growth-distribution nexus across diverse economic contexts. Second, we propose a novel approach to interpreting cyclical lead-lag structures within a Goodwin-like framework, addressing limitations in causal interpretations found in previous wavelet studies. This methodological innovation enhances our ability to draw intuitive causal inferences from spectral analysis results, particularly in the context of distribution-demand cycles. Third, our findings highlight limitations in dominant methodological approaches. We demonstrate that the assumption of unidirectional causality in structural approaches is overly simplistic. More significantly, we show that aggregative/systems approaches, by focusing predominantly on short-term effects, overlook crucial aspects of the growth-distribution relationship that manifest over longer horizons. Our results reveal that these long-term dynamics often exhibit an inverse relationship to short-term effects, underscoring the importance of a multi-temporal perspective.

The remainder of this paper is structured as follows: Section 2 reviews related studies. Section 3 explains how wage-led/profit-led demand combined with wage-squeeze/profit-squeeze distribution generate cycles, and how the relative phase angle affects cycle shape. Sections 4 and 5 describe the method (wavelet transform) and data for the empirical analysis. Section 6 presents the results, discussed and concluded in Section 7.

2 Literature review

In the extensive body of research on wage-led and profit-led regimes and distribution cycles, only a handful of studies have employed wavelet analysis to explore the relationship. One of these studies, conducted by Charpe et al. (2020), utilized wavelet analysis to inves-

tigate the relationship between real GDP per capita and the labor share using historical data from Piketty and Zucman (2014) for the United States, the United Kingdom, and France. Their findings revealed a positive correlation in the long run (> 32 years) and a negative correlation in the short run. As for causality, they contend that inequality drives growth, given that the labor share precedes growth in time. In a similar vein, Santos and Araujo (2020) also discovered a positive correlation in the long run and a negative correlation in the short run when examining the relationship between employment, income distribution, and capacity utilization in the US economy from 1967 to 2016.

In contrast, Barrales and von Arnim (2017) found differing correlations in the long run when they analyzed the cyclical relationship between the income-capital ratio, the output gap, and the employment rate with the functional income distribution in the United States between 1948 and 2011. Specifically, their results show a positive correlation in the long run only after 1980, while it is negative before. Their approach involved decomposing time series into wavelets of varying periodicity, through which they identified counterclockwise Goodwin cycles in all three variables in relation to the wage share. The change in correlation from negative to positive corresponds with the transition of the longest cycle, which spans 60 years and breaks off from 1980.

3 Theory

The relationship between functional income distribution and growth is characterized by reciprocal causality. On the one hand, income distribution affects consumption and investment, and thus economic growth. On the other hand, the economic activity feeds back on the income distribution by influencing real wages and productivity, e.g. by strengthening or weakening the bargaining power of workers or by stimulating labor-saving investments. We refer to the former as the *demand effect* and the latter as the *distribution effect*.

Both effects can be positive or negative, depending on whether the wage share and growth move in the same or opposite direction (see Table 1). The demand effect is positive if an increase (decrease) in the wage share leads to an increase (decrease) in aggregate demand. Accordingly, demand is *wage-led*. Conversely, growth is *profit-led* and the demand effect is negative if an increase (decrease) in the wage share leads to a decrease (increase) in aggregate demand. In parallel, the distributional effect is positive if a rise in economic expansion increases the wage share. This is the case when real wages rise faster than productivity. Since this implies a fall in the profit rate, this scenario is referred to as a *profit-squeeze*. If, conversely, productivity rises faster than real wages in an upswing, the wage share falls and the distribution effect is negative. By analogy, this case is referred to as a *wage-squeeze*.

In combination, the two effects can lead to different dynamics that are either unstable when they mutually reinforce each other, or stable when the direction of the effects

Correlation / Causality	Positive	Negative
Wage Share → Growth	wage-led demand effect	profit-led demand effect
Growth → Wage Share	profit-squeeze distribution effect	wage-squeeze distribution effect

Table (1) Reciprocal effects between income distribution and growth.

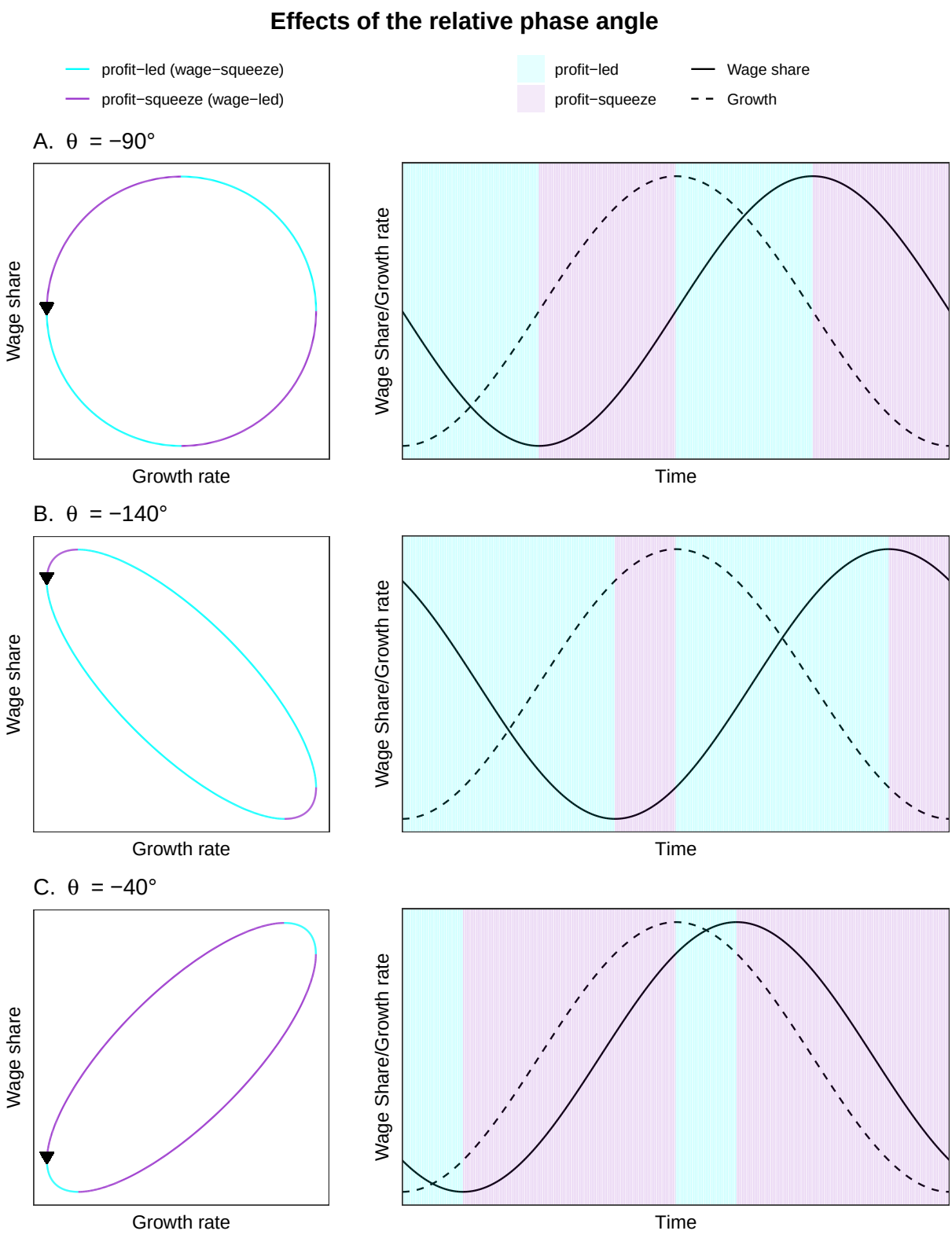
is opposite. Since neither permanently rising nor falling wage rates and growth rates can be observed in reality, we limit ourselves here to the two stable cases: 1) profit-led demand with a profit-squeeze distribution and 2) wage-led demand with a wage-squeeze distribution. Both cases lead to stable cycles, which can be modeled with Lotka-Volterra differential equations in the manner of Goodwin (1967) and Barbosa-Filho and Taylor (2006). Case 1) generates a counterclockwise cycle, case 2) a clockwise cycle.

Figure 1A illustrates the traditional Goodwin cycle, where demand is profit-led and the distribution exhibits a profit-squeeze. Starting at the arrow, a declining wage share causes economic activity to rise due to the profit-led demand effect. Rising growth rates, in turn, strengthen the bargaining power of workers so that real wages rise faster than productivity (profit-squeeze). The resulting rise in the wage share (corresponding to a falling profit share) lowers economic activity due to profit-led demand. In the downturn, capitalists reduce production further and/or raise prices, so that the wage share falls again (we call this inverse profit-squeeze) and the economy returns to its starting point.

Analogously, a clockwise cycle occurs when demand is wage-led and the distribution exhibits a wage-squeeze. If we start at the arrow again and follow the cycle clockwise this time, the rising wage share initially causes an increase in economic activity due to the wage-led demand effect. Increasing economic growth causes productivity to rise faster than real wages, e.g. due to labor-saving investments, so that the wage share falls (wage-squeeze). A falling wage share dampens wage-led demand, so that growth declines. In the subsequent recession, the (inverse) wage-squeeze effect causes the wage share to rise, since nominal wages are fixed, so that capitalists bear the bulk of the burden.

The cycle therefore results from an interplay of the demand effect and the distribution effect. Figure 1A shows a cycle in which demand and distribution effects alternate over the cycle, but the magnitude of the individual phases is somewhat equal. The correlation between the wage share and growth is therefore close to 0, as the two effects offset each other.

Things are different when one of the effects is stronger. Figure 1B illustrates the situation where the profit-led demand segments are longer than the profit-squeeze segments. Thus, over the entire cycle, the negative demand effect is more dominant than the positive distribution effect, so that the wage share and growth are negatively correlated on an



Notes: The figure shows how different relative phase angles between the wage share and growth change the figure in the phase space (left) and in the time plot (right).

Figure (1) Effects of the relative phase angle

aggregate scope. The correlation is also negative in the clockwise equivalent case, that is, when the wage-squeeze distribution effect prevails over the wage-led demand effect. Conversely, distribution and economic activity are in aggregate positively correlated when profit-squeeze (wage-led) phases are more relevant than profit-led (wage-squeeze) phases (Figure 1C).

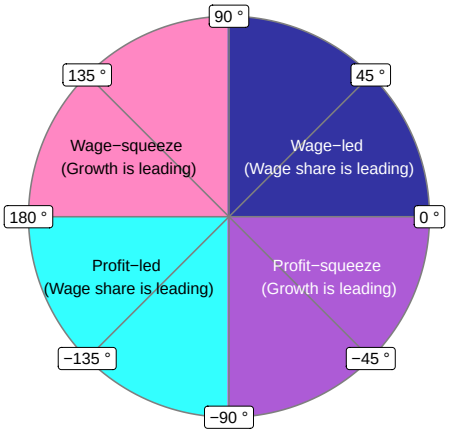
The relative strength of the effects is given by the relative phase relationship, i.e., by the lead-lag structure of the two variables. When growth precedes the wage share by 90° or one quarter of a cycle, the classic Goodwin cycle emerges (Figure 1A on the right side). Conversely, the inverse Goodwin cycle occurs when the wage share leads growth by 90°.

Distribution and growth are positively correlated if the absolute value of the phase relationship is less than 90°. If the wage share precedes, overall the wage-led demand effect dominates; on the other hand, if economic growth leads the wage share, the profit-squeeze distribution effect prevails.[1] An extreme case occurs when the phase angle is 0, i.e., the wage share and growth evolve in phase. In this case, the variables are perfectly positively correlated, but it cannot be distinguished whether it is due to the wage-led demand effect or the profit-squeeze distribution effect.

Wage share and growth are negatively correlated when the phase angle is between (negative) 90° and 180°. If the wage share lags the inverted growth time series, the wage-squeeze distribution effect prevails; conversely, the profit-led demand effect dominates. At a phase relationship of 180°, the wage share and growth are perfectly out of phase, meaning they are perfectly negatively correlated. The relationship between the relative phase angle, lead-lag structure, and dominant effect is summarized in figure 2.

The preceding considerations assume that there is a single cycle with a specific period length. However, it is also possible that cycles with different period lengths occur simultaneously and overlap. In addition, demand and distribution effects may have changing direction over different time horizons. Therefore, for the empirical analysis it is necessary to distinguish cycles of different scales using spectral analysis. The next part describes the wavelet analysis used in this study, which allows us to determine the relative phase differences for different frequencies and times. Since previous wavelet studies have interpreted the relative phase differences discordantly to some extent, the preceding theoretical considerations also serve as a proposal for an unambiguous interpretation, embedded in the heterodox theory of growth and distribution cycles.

[1] It is worth noting that the identification of the dominant effect aligns with the concept of Granger causality, where a dominant wage-led effect implies that the wage share Granger causes growth and vice versa.



Notes: The figure shows the relationship between relative phase angle, lead-lag structure, and dominant demand or distribution effect at the unit circle.

Figure (2) Relative phase and dominant demand or distribution effect

4 Method

Wavelet analysis is a technique derived from spectral analysis that allows us to decompose the time series of growth rates and wage share into their time scale components and determine the relationship as a function of different time scales using the relative phase angles. It builds upon the short-time Fourier transform, offering a more flexible approach known as multi-resolution analysis. Unlike the short-time Fourier transform, which utilizes a fixed window length, the wavelet transform employs short windows for high frequencies (short cycles) and long windows for low frequencies (long cycles). Therefore, the wavelet transform has better frequency resolution at low frequencies and better time resolution at high frequencies than the short-time Fourier transform.

While wavelet analysis has long been prevalent in disciplines such as engineering, physics, mathematics, geophysics, and signal analysis, it has only recently gained popularity in economics and finance. Most studies using wavelet analysis are in finance, exploring asset volatility and prices. However, the method is increasingly being employed in macroeconomics to identify cyclical patterns, structural breaks, and common trends in the relationships between key economic variables such as GDP, inflation, productivity, and unemployment. Gallegati and Semmler (2014) showcase several applications in finance and macroeconomics.

Mathematically, the wavelet transform is given by:

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t) \frac{1}{\sqrt{|s|}} \psi^* \left(\frac{t-\tau}{s} \right) dt \tag{1}$$

where ψ^* is the complex conjugate mother wavelet function that is scaled (e.g. changed in frequency) by the parameter s and shifted over time by τ. There are a variety of

different mother wavelet functions that have different characteristics with respect to the time-frequency resolution trade-off. In this study, we utilize the Morlet mother wavelet, which is a popular choice for analyzing time series data due to its ability to capture both frequency and time information effectively. The Morlet wavelet is defined as:

$$\psi_{w_0}(t) = \pi^{-\frac{1}{4}} e^{-\frac{t^2}{2}} e^{iw_0 t} \tag{2}$$

To investigate the relationship between two time series, we utilize the wavelet coherency method. Wavelet coherency measures the squared correlation between two time series in the time-frequency domain, assisting in identifying regions where the series exhibit a high degree of similarity. Mathematically, the wavelet coherency is given by:

$$\rho_{xy}(\tau, s) = \frac{|S(W_x(\tau, s)S(W_y(\tau, s))|^2}{S(P_x(\tau, s))S(P_y(\tau, s))} \tag{3}$$

where $P_x(\tau, s) = \frac{1}{s}|W_x(\tau, s)|^2$ is the power spectrum of the time series $x(t)$, and S represents the smoothing operation in both time and frequency domains. The wavelet coherency ranges from 0 to 1, with values closer to 1 indicating a stronger correlation between the two time series in the time-frequency domain.

The relative phase difference between the two wavelet transforms provides the information about the temporal relationship between the time series. The relative phase difference is defined as:

$$\Theta_{xy}(\tau, s) = arctan\left(\frac{Im(W_{xy}(\tau, s))}{Re(W_{xy}(\tau, s))}\right) \tag{4}$$

where Im denotes the imaginary part, and Re represents the real part of the cross wavelet transform. The relative phase difference, $\Theta_x(\tau, s)$, describes the time lag between the two time series in the time-frequency domain as described in section 3. Understanding the relative phase difference can help identify and interpret the dominant demand or distribution effect in the cycle between the income distribution and growth in the time-frequency domain.

Furthermore, it is possible to filter the time series according to certain cycle lengths. After wavelet transforming the data into the time-frequency space, distinct frequency bands can be separated by examining wavelet coefficients that correspond to desired time scales or frequency ranges. This is achieved by retaining only the coefficients of interest and nullifying the others, effectively isolating the target frequency components. Ultimately, applying an inverse wavelet transform reconstructs a filtered version of the original time series, which contains solely the targeted frequency bands.

5 Data

In our empirical analysis, we use the annual data from the *Historical Factor Shares Database (1875-2018)* by Bengtsson and Waldenström (2018b) for the income distribution. The Historical Factor Shares Database is the most recent and, with 20 countries, the largest currently available dataset for wage shares. A comprehensive discussion on the capital/wage shares data, covering concepts and measurement issues, can be found in the appendix of Bengtsson and Waldenström (2018a). The data used in the Historical Factor Share Database are derived primarily from the national accounts of the various countries. The researchers adjust the sum of employee compensation for the income of the self-employed, generally by assuming a fixed distribution between labor and capital income.

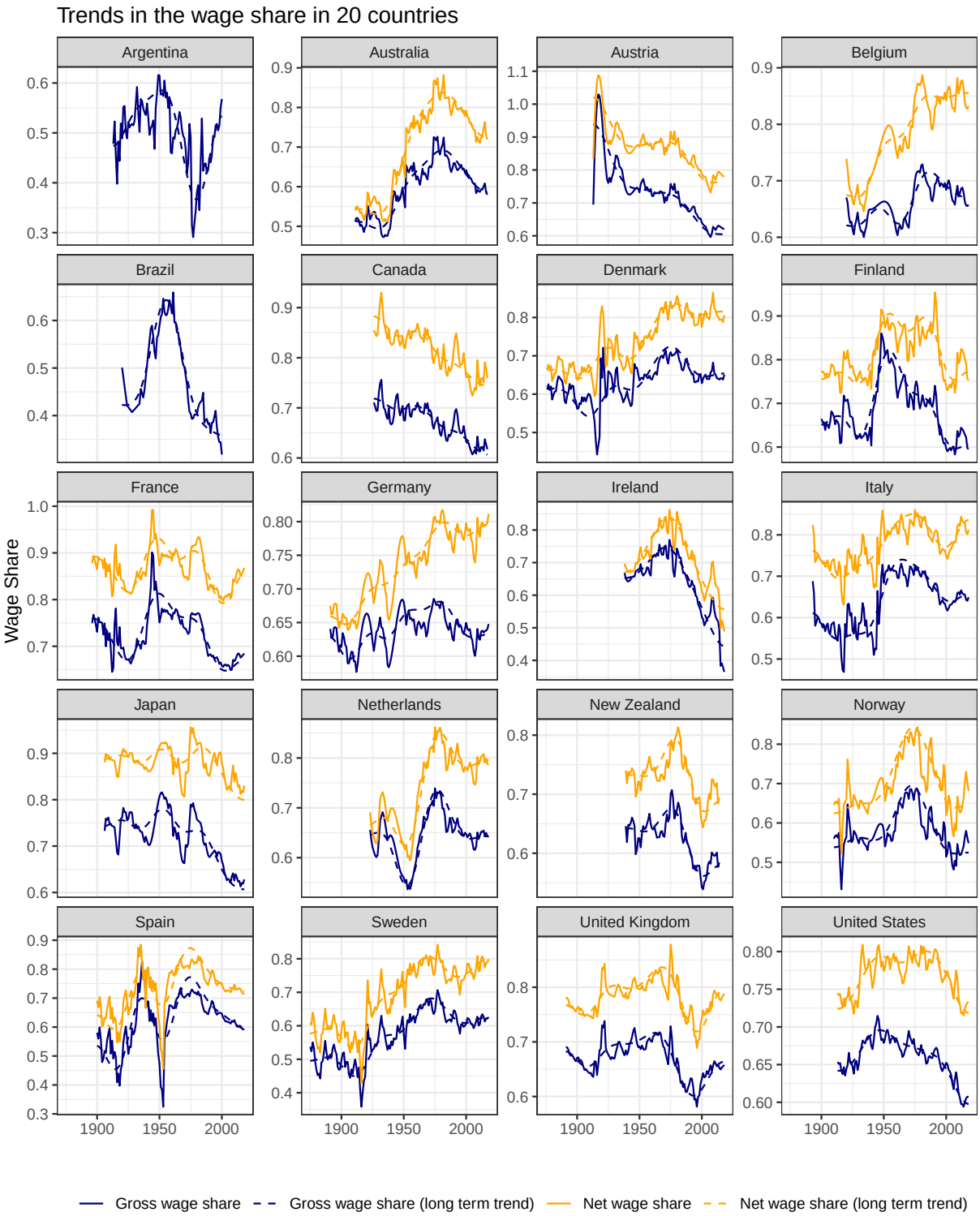
For 18 of the 20 countries (excluding Argentina and Brazil), the database also includes the net wage share, which represents wage income relative to net value added (excluding depreciation). Some argue that the net wage share is a better measure of income distribution because depreciation falls outside the distributional struggle between labor and capital. However, the authors acknowledge that depreciation introduces an additional layer of uncertainty to the data. Therefore, we use the gross wage share for the empirical analysis and apply the net wage ratios as a robustness check.

Figure 3 shows the evolution of the wage share in the 20 countries, together with the long-run trend that includes all cycles longer than 32 years (obtained by wavelet filtering). It shows the well-known fact that inequality has increased in most countries since the 1980s. Moreover, it illustrates that the wage share is subject to large fluctuations in the long run. The wage share in all countries contains long-run cycles that account for a large part of the total variance, highlighting the importance of analyzing the long run cycles.

For economic activity, we use annual growth rates of real GDP per capita to account for changes in inflation and population size. The data are taken from the Maddison Project Database (Bolt and van Zanden 2020), a widely recognized source for historical GDP data, which offers a comprehensive and consistent set of estimates for real GDP per capita.

6 Results

Figure 4 displays the results of the wavelet coherence analysis. The vertical axis shows time, and the horizontal axis tracks the cycle length ($= 1/frequency$). The cycle length is given in years, with high numbers corresponding to the long term (slow fluctuations) and low numbers to the short term (rapid fluctuations). The coherency spectra shows the squared local correlation between the wage share and economic growth in the time-



Notes: The figure shows the development of the gross and net wage share of the 20 countries examined. The dashed lines show the long-term trend.

Figure (3) Trends in the wage share in 20 countries

frequency space. Warm colors stand for high correlation, while cold colors indicate low correlation. Figure 4 shows that covaried cyclical components are observed in all countries with varying cycle lengths, including both short cycle lengths in the range of the typical business cycle and significantly longer cycles. Of particular interest are the cycles that exhibit high coherency and, more importantly, are stable over a long period of time.

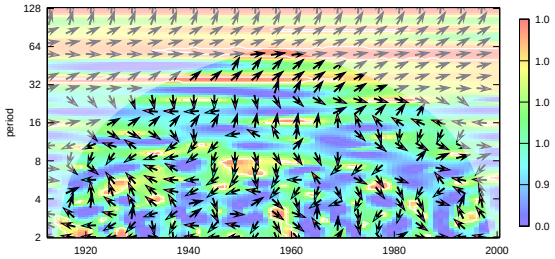
The arrows show the phase relationship between income distribution and growth for specific cycle lengths and time periods, offering insights into the correlation between the wage share and growth as well as the dominance of either distributional or demand effects in certain frequency ranges. To interpret the arrows correctly, they must be weighted with the coherency. Thus, arrows in areas with high coherency (warm colors) hold the most significance for phase relationships.

We first address the question of whether the wage share and growth are positively or negatively correlated at different time scales and later distinguish between demand and distributional effects, as conceptualized in section 3. All arrows that tend to point to the right (dark blue and magenta) indicate a positive correlation, while those that tend to point to the left (cyan and pink) signify a negative correlation. Perfectly horizontal arrows indicate that the variables are moving fully in phase ($\rightarrow$) or out of phase ($\leftarrow$). Figure 4 shows that distribution and growth in the long run tend to be positively correlated in most countries, i.e. that the arrows in the upper half of the figures tend to point to the right in areas of high coherency. The correlation is stable in most countries over the period studied. The situation is different for shorter cycle lengths, where the direction of the arrow and thus the direction of the correlation changes over time. In general, however, the correlation between distribution and growth in the short run is predominantly negative in most countries.

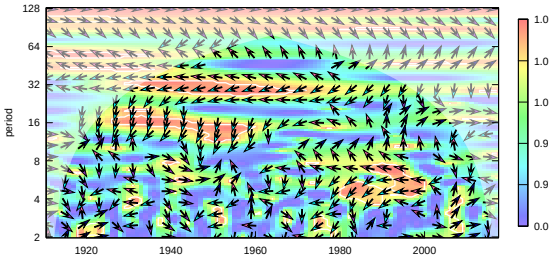
To further investigate this observation, we filter the time series by short, medium, and long cycle lengths and then calculate the correlation coefficient for each country and time horizon. Spectral analysis allows a formal definition of the different time horizons in terms of frequency. For the country overview (later we adjust the cutoff frequencies depending on the country), we define the long term as all cycles longer than 32 years. The medium term contains the cycles between 12 and 32 years and the short term all cyclical fluctuations below 12 years.

Figure 5 shows the correlation between distribution and growth for each country for the long, medium, and short term. In the long run, growth and the wage share are positively correlated in the majority of countries. The exceptions are the Netherlands, New Zealand, Ireland, Austria and Belgium, 5 rather small and export-oriented countries. In the United Kingdom, the correlation coefficient is slightly negative, but close to 0. The highest positive correlation can be found in Brazil, Italy, the USA, Australia, Finland, and Germany. In the short run, growth and income distribution are negatively correlated in almost all countries, although the coefficients are relatively small in most countries.

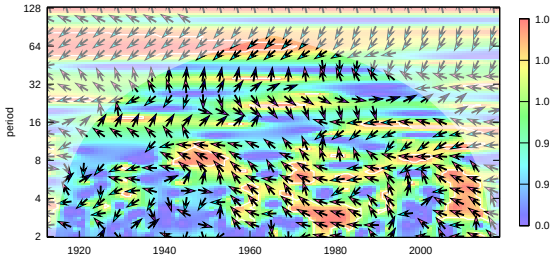
(a) Argentina



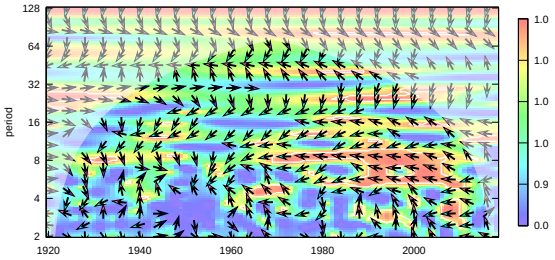
(b) Australia



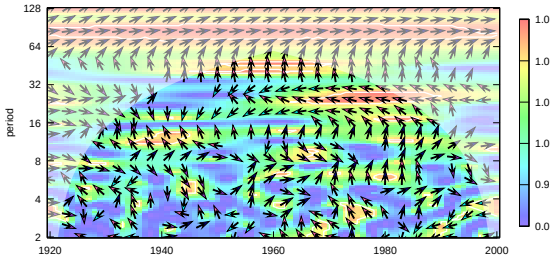
(c) Austria



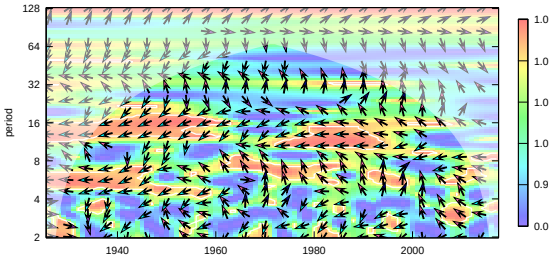
(d) Belgium



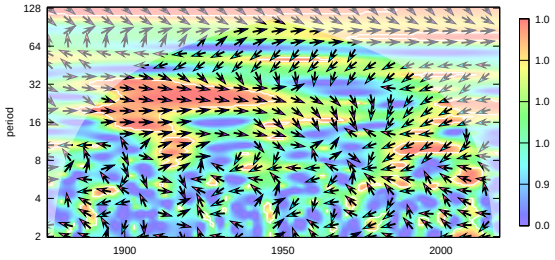
(e) Brazil



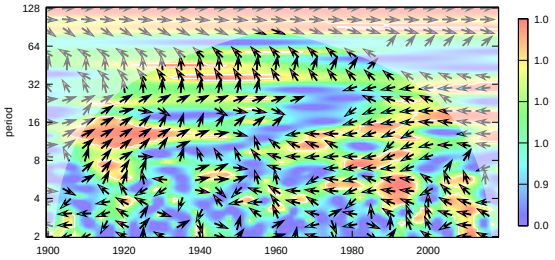
(f) Canada



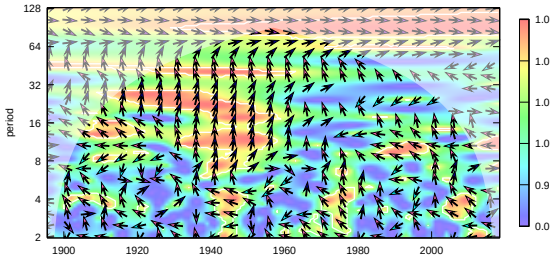
(g) Denmark



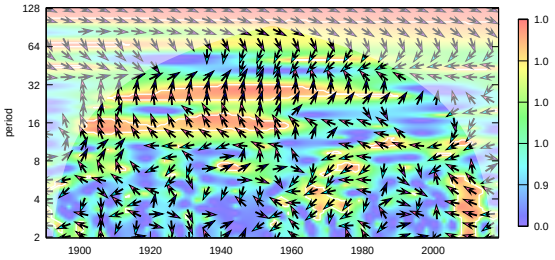
(h) Finland

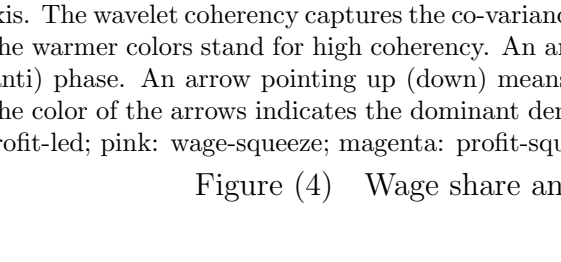


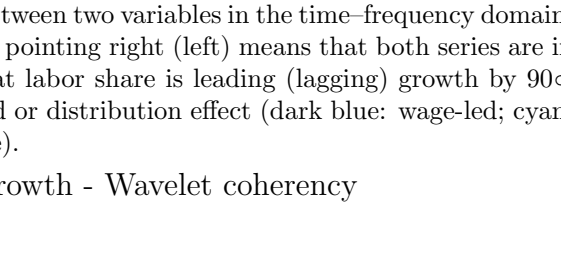
(i) France



(j) Germany



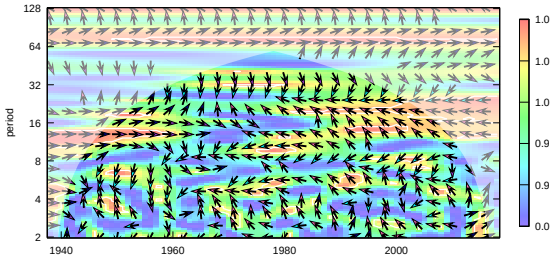




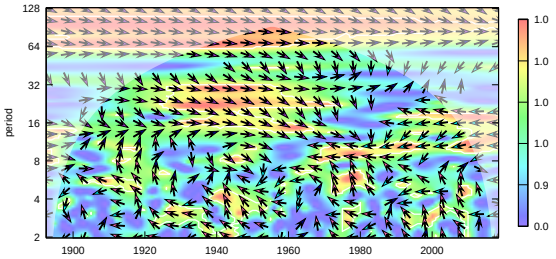
Notes: The figures display the time on the horizontal axis and the cycle length (in years) on the vertical axis. The wavelet coherency captures the co-variance between two variables in the time–frequency domain. The warmer colors stand for high coherency. An arrow pointing right (left) means that both series are in (anti) phase. An arrow pointing up (down) means that labor share is leading (lagging) growth by 90∘. The color of the arrows indicates the dominant demand or distribution effect (dark blue: wage-led; cyan: profit-led; pink: wage-squeeze; magenta: profit-squeeze).

Figure (4) Wage share and growth - Wavelet coherency

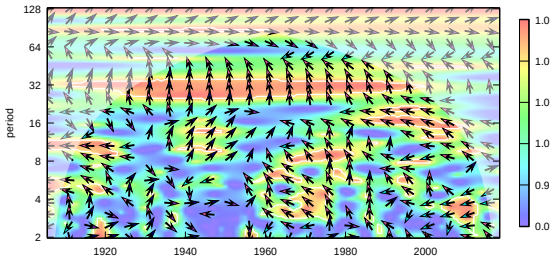
(k) Ireland



(l) Italy



(m) Japan



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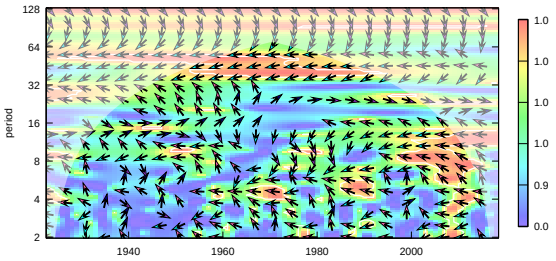

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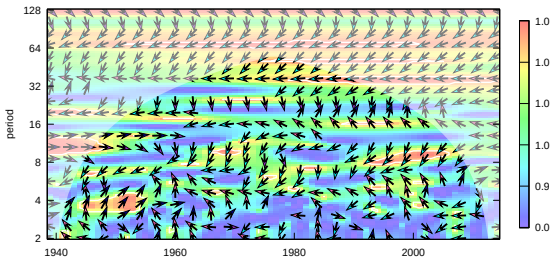
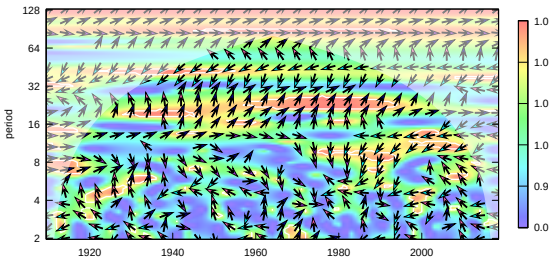
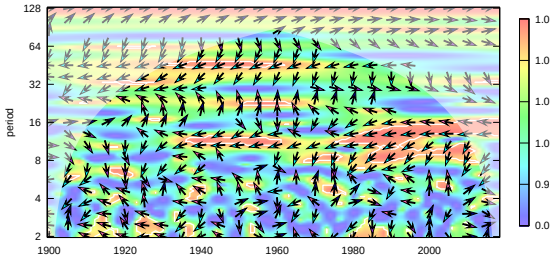


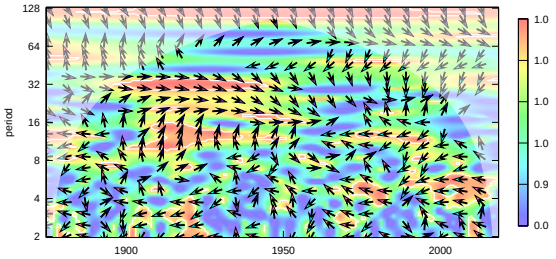
(p) Norway



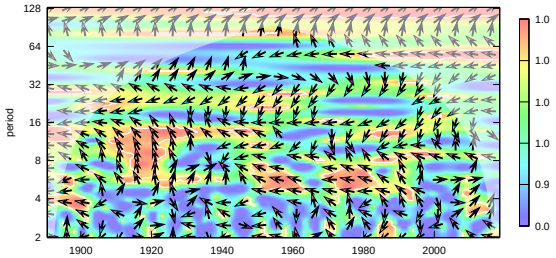
(q) Spain



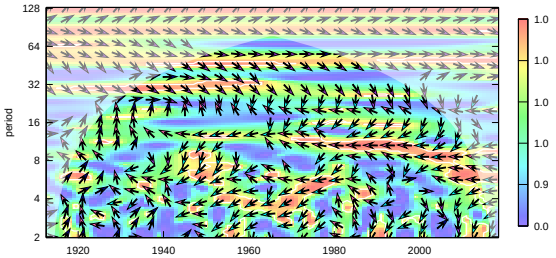
(r) Sweden



(s) United Kingdom

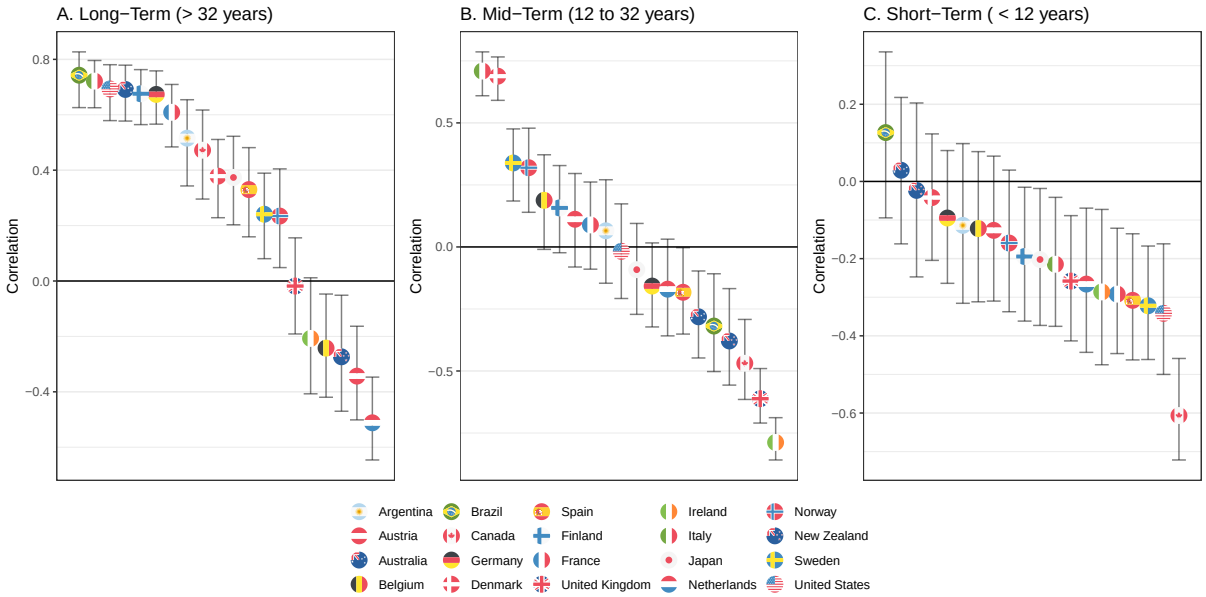


(t) United States



Notes: The figures display the time on the horizontal axis and the cycle length (in years) on the vertical axis. The wavelet coherency captures the co-variance between two variables in the time–frequency domain. The warmer colors stand for high coherency. An arrow pointing right (left) means that both series are in (anti) phase. An arrow pointing up (down) means that labor share is leading (lagging) growth by 90◦. The color of the arrows indicates the dominant demand or distribution effect (dark blue: wage-led; cyan: profit-led; pink: wage-squeeze; magenta: profit-squeeze).

Figure (4) Wage share and growth - Wavelet coherency



Notes: The figures show the correlation coefficients between the wavelet filtered gross wage share and the per capita GDP growth rates of the countries studied for the long-, medium-, and short-term. The error bars show the 95% confidence interval.

Figure (5) Correlation between the gross wage share and growth rates in the long-, medium-, and short-term

The highest negative correlation is observed in Canada, followed by the USA, Sweden, and Spain. The medium term represents a kind of transitional phase between the long and the short term, in which the correlation is still strongly positive in some countries but negative in the majority.

The results do not change qualitatively if we look at the net wage share instead of the gross wage share, even though there are quantitative differences for some countries (see Figure 7 in the appendix). For instance, the correlation with the net wage share is higher for the USA and lower for Germany. In the United Kingdom, the correlation is now positive. Only Austria, Netherlands, and New Zealand still show a significantly negative correlation.

We now turn to the interpretation of the relative phase relationship based on the considerations in section 3 with respect to the wage-led/profit-led demand effect and the wage-squeeze/profit-squeeze distribution effect. For a better representation, the respective arrows are in distinct colors, with the colors and angles corresponding to Figure 2. Dark blue arrows pointing to the upper right (↗) represent a dominant wage-led effect, cyan arrows pointing to the lower left (↙) a dominant profit-led effect. Pink arrows pointing to the upper left (↖) indicate a dominant wage-squeeze effect, while magenta arrows pointing to the lower right (↘) indicate a dominant profit-squeeze effect.

In the short term, all four effects are found in most countries. However, the profit-led and wage-squeeze effects predominate in the majority of cases, consistent with the negative correlation in the short run. This indicates that the negative correlation cannot

be attributed to profit-led demand alone, but that a wage-squeeze distribution effect, e.g., labor-saving investment in booms and nominally fixed wages in recessions, also contributes to the negative correlation. Moreover, the dominant effects frequently alternate in the short term, making it difficult to provide a detailed interpretation in a country overview.

Given the complexity and short-term fluctuations, we shift our focus to the long run. For this purpose, we filter the long-run cycles of the time series and plot the obtained time series in an empirical phase space in Figure 6. It shows long-term growth rates on the horizontal axis and the long-term wage share on the vertical axis. Along with the coherency plot, it assists in identifying the dominant demand or distribution effect. We select the crossover frequency to capture those frequency bands that exhibit similar characteristics. The cut-off frequency may therefore vary from country to country, but is in the range of cycle length from 20 to 40 years. A uniform cutoff frequency of e.g. cycle lengths of 32 years barely changes the result, but makes some cycles more difficult to spot. The results are summarized in Table 2.

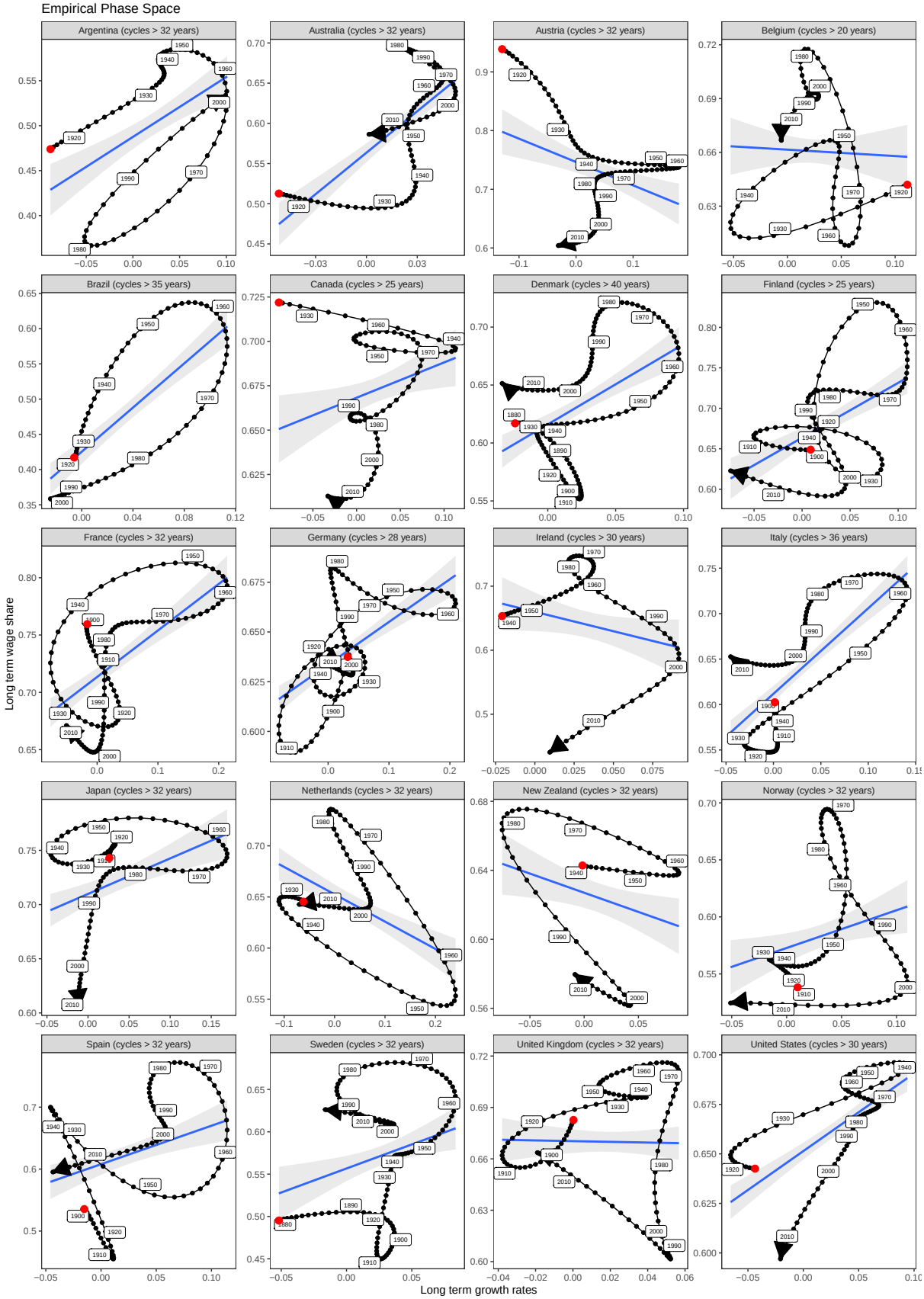
Several countries exhibit distinct long-term cycles, although some are interrupted by wars, policies, or other reasons. The majority of countries exhibit predominantly wage-led/wage-squeeze cycles. In the UK, one can observe about two and a half large wage-led/wage-squeeze cycles in the long run. The first cycle ends with the abrupt recession after World War II, which leads into an inverse wage-squeeze phase in which productivity falls faster than nominally fixed wages. The second cycle lasts until about 1970. From 1970 to 1990, the long-term component of the wage share declines sharply, while long-term growth remains at a high level. During this period, labor-saving investments of the wage-squeeze phase and the wage-led demand shortfall roughly balance each other out. In the long-run downturn starting in 1990, the wage share rises again due to the inverse wage-squeeze effect.

France goes through several clockwise cycles, with the wage-squeeze distribution effect predominating until about 1940, and the wage-led demand effect thereafter. Similar to the United Kingdom, the wage share drops extremely from 1980 and 2000 without having too much effect on growth. In Japan, about two wage-led/wage-squeeze cycles unfold from 1920 to 1985, before a policy of wage restraint interrupts the cycle and leads to a phase in which the wage share falls extremely and growth declines. Germany goes through about 3 clockwise cycles until 1970, with long wage-led demand phases and short wage-squeeze distribution phases. Between 1970 and 2000, there is a short intermediate phase during which the direction of the cycle reverses and the profit-led demand effect predominates. A similar pattern can be observed in Finland.

In Ireland, the super-long term exhibits a clockwise wage-led/wage-squeeze cycle interspersed with a short profit-led/profit-squeeze cycle between 1960 and 1980. Argentina and Brazil show stable clockwise cycles dominated by the wage-led effect. Canada goes through three clockwise cycles, with the wage-squeeze distribution effect predominating

Country	Time period	Correlation	Dominant effect
Argentina	1913-2000	+	wage-led
Australia	1911-2017	+	
Austria	1913-1940	-	profit-led
	1940-1980	0	
	1980-2018	+	wage-led
Belgium	1920-1955	+	wage-led
	1955-2018	-	profit-led
Brazil	1920-2000	+	wage-led
Canada	1926-1960	-	wage-squeeze
	1960-2017	+	wage-led
Denmark	1876-1940	-	wage-squeeze
	1940-2018	+	profit-squeeze
Finland	1900-1980	+	wage-led
	1980-2000	-	profit-led
	2000-2018	+	wage-led
France	1896-1940	-	wage-squeeze
	1940-2018	+	wage-led
Germany	1891-1970	+	wage-led
	1970-2000	-	profit-led
	2000-2018	-	wage-squeeze
Ireland	1938-2018	-	wage-squeeze/wage-led
	1960-1980	-	profit-led
Italy	1893-1940	+	wage-led
	1940-1985	+	profit-squeeze
	1985-2018	+	wage-led
Japan	1920-1985	0	wage-led/wage-squeeze
	1985-2018	+	wage-led
Netherlands	1923-2000	-	profit-led
	2000-2018	0	
New Zealand	1939-2014	-	profit-led
Norway	1910-2018	+	
Spain	1900-1940	-	profit-led
	1940-1995	+	profit-squeeze
	1995-2018	-	wage-led
Sweden	1875-1940	+	wage-led
	1940-2018	0	profit-led/profit-squeeze
United Kingdom	1891-1940	+	wage-led
	1940-1980	+	wage-led
	1980-2018	-	wage-squeeze
United States	1913-1940	+	wage-led
	1940-1970	+	profit-squeeze
	1970-2018	+	wage-led or profit-squeeze

Table (2) Correlation and dominant effects in the long run



Notes: The figures show the long-term cycles in the empirical phase space. The wage share is shown on the vertical axes, growth on the horizontal axes. Red dots show the beginning of the time series. The blue regression line indicates whether the wage share and growth are positively or negatively correlated.

Figure (6) Empirical phase space: long-term cycles

until 1960 and the wage-led demand effect thereafter.

In only two countries does the profit-led demand effect predominate in the long term. The Netherlands goes through one and a half large counterclockwise cycles in which profit-led phases predominate. From the mid-1930s to the early 1950s, a fall in the wage share in the profit-led demand regime leads to an increase in growth rates. The trend reverses from the mid-1950s to 1980, with a rising wage share dampening long-term growth. The third profit-led phase is found between 1980 and 2000, in which a falling wage share spurs growth again until the correlation breaks from 2000 onward. A similar pattern is found in New Zealand.

Spain exhibits two incomplete profit-led/profit-squeeze cycles. The first incomplete cycle ends in 1936 and is characterized by a rising wage share accompanied by weak demand in the profit-led regime in the first decades of the 20th century. From 1940 onward, a long counterclockwise cycle follows, in which the profit-squeeze phases predominate, followed by a sharp drop in long-term growth rates and the wage share in the mid-1990s.

Like Spain, more countries exhibit a change in demand and distribution regimes. Italy goes through a clockwise wage-led/wage-squeeze cycle between 1900 and 1940, which is then superseded by a counterclockwise cycle dominated by the profit-squeeze effect until about 1985. High growth rates allow for an increasing wage share until about 1960. From around 1965, the long-term growth trend reverses and depresses the wage share. The effect seems to be reinforced by demand changing to wage-led from the 1980s onward, so that both wage share and growth rates fall until the 2000s, until a slight wage-squeeze effect then occurs.

The U.S. has a half cycle dominated by the wage-led effect until about 1940, which then turns into a counterclockwise cycle dominated by the profit-squeeze effect from 1940 to 1970. The cycle is terminated in 1970 by a sharp drop in the wage share and growth. In Austria, there are two phases in which the long-term wage share falls sharply. From 1910 to 1940, profit-led demand leads to increasing economic activity. From 1980 onward, demand becomes wage-led and induces declining growth rates. From 1940 to 1980, the wage share remains stable and does not correlate with growth rates.

In Denmark, the phases in which economic activity affects the wage share predominate over the entire period, though the effect reverses from wage-squeeze to profit-squeeze by 1940. In Belgium, the wage-led demand effect predominates in the clockwise cycle until around 1955, after which the cycle reverses and demand becomes profit-led. Sweden exhibits a similar pattern, although the change in the demand regime already began around 1940. Last, but not least, different effects exist in Australia and Norway, with no single effect predominating, though the overall correlation is positive.

7 Conclusion

Decomposing the wage share and growth rates for 20 countries using wavelet analysis, we find that in most countries the wage share and growth are positively correlated in the long run, but negatively correlated in the short run. Our results suggest that causality runs in both directions. Growth affects income distribution via the distribution effect (wage or profit squeeze), while distribution feeds back to growth via the wage-led or profit-led demand effect. In the short run, all four effects usually operate simultaneously, though the profit-led demand effect and the wage-squeeze distribution effect are the most important overall. In the long run, while there may be notable variations among different countries and timeframes, the majority of countries display clockwise cycles, where the wage-led demand effect tends to be the most dominant factor in most cases. Moreover, some countries experienced a shift in their growth regime and the direction of the cycles, which requires further examination.

Note that we do not attempt to prove a causal effect, but strive for a causal interpretation based on widely accepted heterodox theory. In a bivariate investigation, it is always possible that third variables interfere. Stockhammer and Michell (2017), for example, show that the interaction of distribution and growth with financial fragility results in pseudo-Goodwin cycles without requiring demand to be profit-led. To control for third variables, a revival of Granger's spectral analysis methods for three or more variables (Granger 1969) could be fruitful for future studies.

Nonetheless, our results are largely consistent with those of conventional methods and the few wavelet analyses to date. Our study contributes to this literature by examining a larger set of countries and a longer time period. Our results confirm the positive correlation in the long run and negative correlation in the short run between the wage share and growth found by Charpe et al. (2020) and Santos and Araujo (2020). Moreover, we can confirm Barrales and von Arnim (2017) in that we also find a long profit-led/profit-squeeze Goodwin cycle in the U.S. between 1950 and 1980. However, the long-term analysis shows that the period is rather the exception and that at earlier and later times the cycle runs clockwise.

Our results are also largely consistent with the wide range of results obtained by conventional methods for determining the growth regime. Studies using the structural approach closely match our long-run results in that they find wage-led regimes in most countries (see Blecker and Setterfield (2019) for an overview). For small countries such as the Netherlands, Austria or Ireland, structural estimates frequently find that the profit-led effect predominates due to the foreign trade channel (Hein and Vogel 2008; Stockhammer and Wildauer 2016; Onaran and Obst 2016). Likewise, we find a negative correlation for these and other small countries in the long run. However, our analysis suggests that growth also affects the wage share and that estimates using the structural approach are

most likely subject to endogeneity problems. Studies using the aggregative approach match well with our short-term results. Most aggregative estimates (often for the U.S. only) find clockwise cycles indicating profit-led demand (Barbosa-Filho and Taylor 2006; Kiefer and Rada 2015). However, for methodological reasons, the aggreative approach only analyzes the short run and can therefore only provide an incomplete picture.

In light of our findings, which reveal that the wage-led demand effect is predominant in the long run for most countries, there are important policy implications. Firstly, while a policy of wage restraint may yield higher growth rates in the short run through increased investment and/or the external trade channel, it can lead to a race to the bottom and weakened growth in the long run. This is especially significant given the recent downward trend in the wage share observed in many countries. Consequently, to promote more equitable income distribution and robust growth, higher wage growth is beneficial in the long run in most countries. Secondly, considering these long-term outcomes, it is advisable to mitigate the incentive structures that result in countercyclical fluctuations in the wage share and growth during the short and medium term. This can be accomplished through various measures, such as implementing automatic stabilizers or establishing stable wage-setting institutions, like strong labor unions or nationwide collective bargaining agreements.

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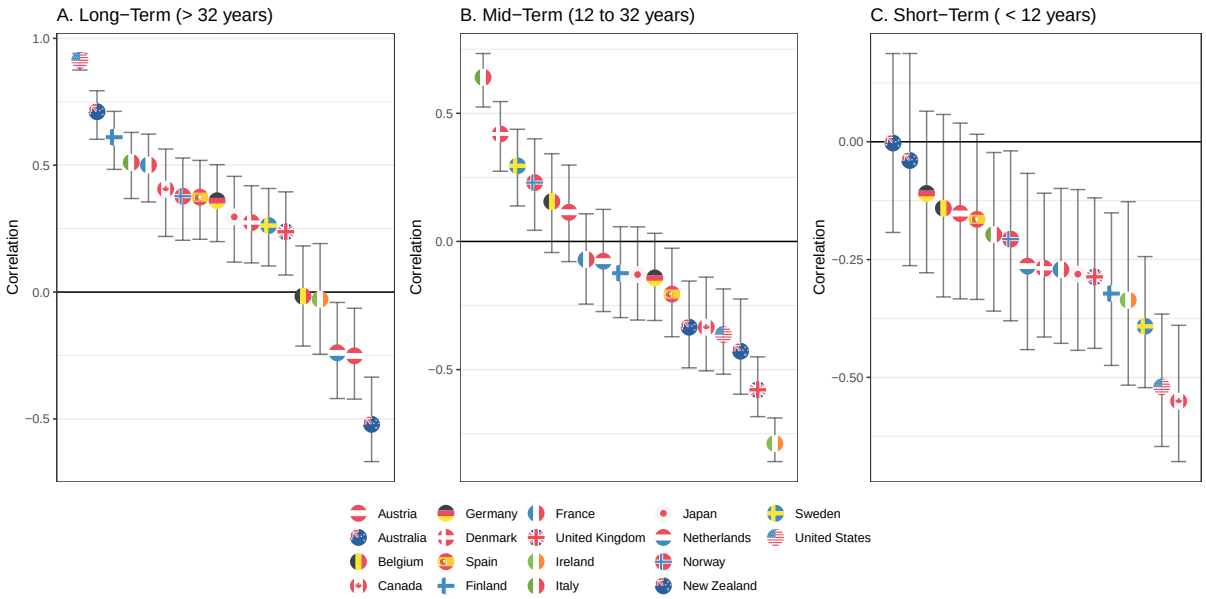
A Appendix



Notes: The figures show the correlation coefficients between the wavelet filtered net wage share and the per capita GDP growth rates of the countries studied for the long-, medium-, and short-term. The error bars show the 95% confidence interval.

Figure (7) Correlation between the net wage share and growth rates in the long-, medium-, and short-term