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Does Labour Work?

A Macroeconomic Perspective on Work Time Reduction

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Abstract

We conduct an empirical study on work time reduction and its accompanying macroeconomic outcomes across countries. Specifically, we frame the analysis in the context of neoclassical and post-Keynesian economic theory, and their differing predictions on work time reduction, real GDP growth, unemployment and functional distribution. We employ a structural vector autoregression (SVAR) analysis on country-level quarterly panel data. Modelling structural relationships between our macroeconomic variables, we find that a negative shock to work time induces growth, reduces unemployment and leaves functional inequality unaffected during the years to follow. Thus, we corroborate the positive effects of work time reduction described in the literature. For data and code, see digital appendix.

We wish to dedicate this thesis to our respective parents, Nicole and Roger, and Artur and Ewa, for all your support throughout the years. We also want to thank our respective partners, Linnéa and Sigrid; we couldn't have done it without you.

We'd also like to thank our supervisor Christer Ljungwall – your encouragement and advice have been a priceless source of confidence and motivation.

Jack and Paul

Introduction

Work time reduction has, since the beginning of the international labour movement, been an important topic for workers and legislators (ILO, 2022). Legislation regulating the length of the working day, the workweek, and vacation time has been, to varying degrees, implemented in countries around the world (De Spiegelaere and Piasna, 2017). At the same time, child labour has in large parts of the globe been outlawed and restricted, while the pension age has generally decreased. The result has been a global, but not universal, decrease in annual- and lifetime work hours (Lee et al., 2007). However, popular neoclassical macroeconomic models predict a decreased output and growth as a result of diminishing work time (Kapteyn et al., 2004). This claim has in later years been contested by modern Keynesian models (Bhaduri and Marglin, 1990; Cárdenas and Villanueva, 2021).

We aim to contribute to the empirical knowledge of work time reduction and its relation to growth, the unemployment rate, and functional income inequality. Specifically, our topic of interest is how shocks in labour time are associated with these variables in the time periods thereafter (compare with Brancaccio et al. (2017) and Atems and Jones (2015)). Following the reasoning in Cárdenas and Villanueva (2021, p. 338) we hypothesize:

> *A decrease in work time is associated with an increase in real GDP growth, a decrease in the unemployment rate and an increase in the wage share.*

Work time reduction and the effects thereof have clear relevance for future policy decisions. Legislation restricting work hours, both by introducing rest days, and rest periods, and by restricting the working day became more common during the first half of the 20$^{\text{th}}$ century. However, this trend has stagnated since the 1950s (De Spiegelaere and Piasna, 2017). While some organizations, political parties, and academics have recently proposed national policies of reduced working hours, the reaction has been mixed (Paulsen, 2014; Paulsen, 2017). One such critique is the question of growth and the actual impact on important outcomes such as wage share and unemployment. At the same time, a closer study of working time and its relationship to output could be a part of the discussion between neoclassical and modern Keynesian theories.

Literature Review

Work time reduction has rich and varied literature, beginning already with Marx's *Capital*, where he studies the effect of work time legislation on British industry (1867). Marx focused on the effects on labourers by the then extending working day and the increasing intensity of work. These types of micro effects regarding individuals' health and well-being are present in modern literature as well, with Tucker and Folkard (2012) showing adverse health effects related to longer working hours, and Lepinteur (2019) found increased well-being and satisfaction correlated with shorter work hours. Similarly, Golden (2012) studies firm and sector level productivity in relation to work time, which tends to increase with work time reduction. This idea of moderating work time to increase productivity is long-established, even dating back to Adam Smith:

> *"It will be found, I believe, in every sort of trade, that the man who works so moderately as to be able to work constantly not only preserves his health the longest, but, in the course of the year, executes the greatest quantity of work."* (Smith, 1776, p. 139)

In general, the literature seems to focus on these types of microeconomic outcomes (Cárdenas and Villanueva, 2021, p. 334). More than just in academic settings, research on the micro effects of work time reduction has also been performed by think tanks (Schor et al., 2022), and experiments have been conducted in Finland, Sweden and Iceland (Nätti and Anttila, 1999; Barck-Holst et al., 2020; Haraldsson and Kellam, 2021). Though these microeconomic studies can provide a foundation for theory, the connection to specific macroeconomic outcomes is not self-evident. With regard to our macroeconomic focus, Keynes might be the quintessential theorist. In his text on the "economic problem", he states:

> *"I draw the conclusion that, assuming no important wars and no important increase in population, the economic problem may be solved, or be at least within sight of solution, within a hundred years. This means that the economic problem is not – if we look into the future – the permanent problem of the human race."* (Keynes, 1931, p. 360)

which indicates a belief that labour and production would eventually decouple (to borrow the popular term from climate policy). In this light, one could read his general theory as a short-run solution to what technological change would solve in the long run (Keynes, 1936; Paulsen, 2017). This larger discussion is brought up by Cárdenas and Villanueva in their article on work time reduction in Spain, where they simulate the effects of a reduction from a 40 to a 35-hour work week (2021). They follow a modern application of Keynes demand-driven model for growth developed by Bhaduri and Marglin (1990), predicting that a reduction in work time increases growth and the wage share, and decreases unemployment.

Macroeconomic literature that considers work time reduction, growth, and inequality, focuses either on specific industries like Glosser and Golden (1997), or on general topics of inequality like Atems and Jones (2015). Glosser and Golden find that average work hours drove growth in American industries pre-1979, but not thereafter, indicating some kind of structural break. They do not hypothesize a broader theoretical reason for this, nor relate the result to other economies. Atems and Jones instead look at the relationship between income inequality and growth, arguing that increased inequality hinders growth. Both of these works use vector autoregression (VAR) models to study the specific impact of work time and inequality, something we will follow.

A relevant case study in the context of work time reduction is the French implementation of a 35-hour work week. Zaichao et al. (2013) use a synthetic control to estimate the effect of the reform in France, concluding that: "[The] reduction in working time reduced France's annual unemployment rate by 1.58% [...] and raised real GDP growth rate by 1.36% from 2000 to 2007"(Zaichao et al., 2013, p. 898). Employing a VAR analysis, similar results are found by Schreiber and Logeay (2006).

Moving on to general labour regulation literature, Brancaccio et al. (2017) question the neoclassical outlook on employment protection. They argue that the observed effects of structural labour market reforms[1] are not entirely consistent with the predictions made by the economic arguments that motivate them. For instance, one such prediction is that reducing labour market rigidity promotes growth and increases inequality (Brancaccio et al., 2017, p. 3). Fundamentally, such neoclassical "general equilibrium" reasoning implies that growth and the wage share (that is, the functional distribution of income) are strictly linked. This reasoning is the basis for the deregulation policies that have in recent history dominated labour markets in high-income countries. The consensus has been so prolific, that Howell et al. (2007) dubbed it the "OECD-IMF orthodoxy". However, Brancaccio et al. (2017) argue that the empirical evidence for this is weak. They find that while labour market regulation generally correlates negatively with inequality, there is no significant association with growth.

In short, work time reduction literature has primarily focused on modelling, simulation, and case studies. The bulk of research considers microeconomic outcomes like worker health and satisfaction or firm productivity. In terms of macroeconomic outcomes, often, the variables of interest are unemployment and actual hours worked (Kapteyn et al., 2004). Thus, there is a gap in the literature: there does not seem to be a substantial body of research on labour time and its impact on macroeconomic outcomes across countries.

Theoretical Framework

We compare two frameworks for the analysis of the link between work time and macroeconomic outcomes. In neoclassical models, economic output is primarily determined by the factor inputs of capital and labour, where either varies only in magnitude (that is, the number of labourers or amount of capital employed in production) and cost. In the long run, growth is determined by the economy's optimal capacity. Conversely, Keynesian and post-Keynesian models posit that growth is primarily driven by aggregate expenditure, that is, consumption and investment (Cárdenas and Villanueva, 2021; Harcourt and Kriesler, 2013). In either case, growth is ultimately constrained by the level of technological advancement. The sections below compare the two frameworks, with special attention to work time, growth, unemployment and functional inequality. For schematic representations over the two frameworks, see Figure 1 and Figure 2 for the neoclassical and post-Keynesian theory respectively.

The work share hypothesis

Historically, work time reduction has been achieved by a legislative reduction of the *standard unit* of work time (Paulsen, 2017). For instance, the working day or week. However, *lifetime* work time can

[1]Generally, policies that ease hiring and firing constraints.

be reduced by increasing time spent in education[2], decreasing the pension age, and increasing the right to paid vacation. In terms of outcomes, different kinds of work time reduction are not necessarily equivalent. Perhaps the most attractive benefit of a reduction of the standard unit of work time stems from the idea of work sharing (Cárdenas and Villanueva, 2021). We state the work share hypothesis as:

> *A decrease in work hours results in a decrease in the unemployment rate.*

The underlying reasoning is that the demand for labour must be distributed among the available workforce (Kapteyn et al., 2004, p. 293-294). In contrast, a reduction in lifetime work time results in a contraction of the available workforce. This subtlety is a consequence of the standard definition of unemployment and is important to keep in mind. To this end, we focus our study on a reduction in the standard unit of work time.

The two frameworks presented differ in their ability to reconcile with this hypothesis, where neoclassical theory predicts it to be false, while post-Keynesian theory treats it as an empirical question. These nuances, and more, are detailed in the section below.

Neoclassical and supply-side economics

Traditionally, neoclassical literature is critical of work time reduction, seeing it as an increase in the cost of labour (Cárdenas and Villanueva, 2021, p. 334). Following supply-side logic, increased cost leads to decreased output. This prediction leans on the assumption that the economy initially operates at maximum capacity – a function of the amount of capital and labour used in the production process. This follows from Say's Law, which posits that supply creates its own demand, and follows from the fact that production requires expenditure (one's expenditure is another's income). If income is always spent (as either consumption or investment), then supply generates its own demand (Harcourt and Kriesler, 2013). In this regard, Say's law implies that the economy always operates at maximum employment, an assumption that Solow himself calls unrealistic (Solow, 1956, p. 91-92).

Bracketing out the issues with Say's law, empirical evidence indicates that hourly wages do in fact decrease with work time, as shown by Kapteyn et al. (2004). However, Kapteyn et al. do contest the point that unemployment should decrease with work time reduction, as is otherwise often assumed or argued (Cárdenas and Villanueva, 2021). The notion that work time reduction does not decrease unemployment, and may even increase it, is based on the work of Calmfors and Hoel (1988), where firms' behaviour is modelled under a work time reduction policy. In Calmfors' and Hoel's words:

> *"[When] firms choose a profit-maximizing level of output, the cost increase due to a reduction in normal working time produces, in addition, a negative scale effect on employment."* (Calmfors and Hoel, 1988, p. 60)

[2] An interesting side note is that in advanced economies, time spent in education increases beyond the legislated minimum (i.e., endogenously). Though not explored in this paper, this presents some interesting avenues for further research.

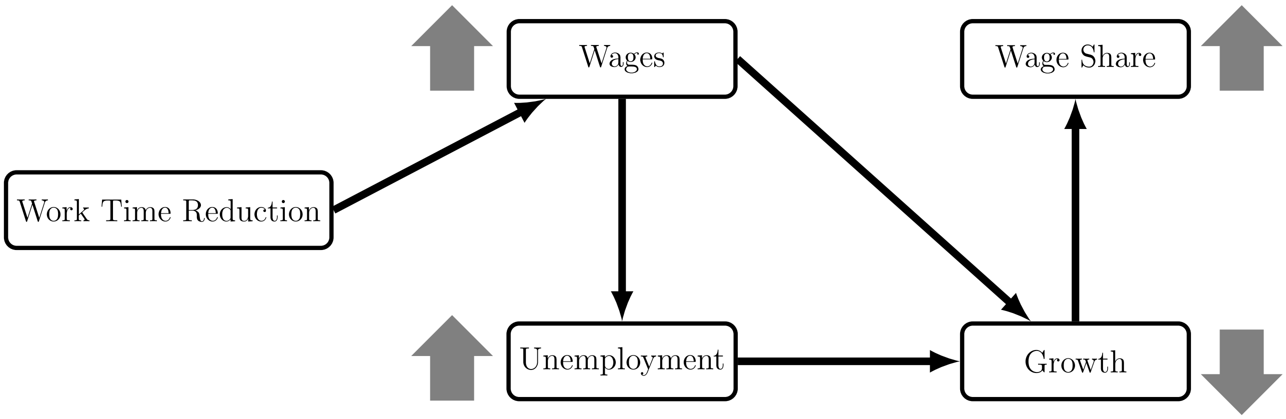

Figure 1: Schematic representation of the neoclassical hypothesis. Gray arrows show the direction of change.

Another interesting result is that if output[3] is fixed and firms are assumed to be cost-minimizing, demand for overtime would increase. In either case, work time reduction does not result in a decrease in unemployment. (Calmfors and Hoel, 1988, p. 52). Following this, Calmfors and Hoel conclude that reducing the length of the working day is not an advisable policy for decreasing unemployment. Kapteyn et al. expand this by pointing out that a reduction in standard working hours would likely increase wages (2004, p. 296). This follows from the argument that a shift in the supply of labour (measured in aggregate labour time) should lead to a new equilibrium price level. Moreover, an increase in the demand for labour may have positive effects on unions' bargaining power, resulting in a complementary upward pressure on wages (Kapteyn et al., 2004). Employing an autoregressive distributed lag model, Kapteyn et al. conduct a study on a panel of 16 OECD countries. They conclude that:

> *"[An] exogenous reduction in working hours causes an increase in the real wage rate and, consequently, eliminates most of the positive direct effect of a reduction in working hours on the employment rate.""* (Kapteyn et al., 2004, p. 307)

Accordingly, they argue that the negative effect on unemployment should be accompanied by an increase in inflation. Given governments' inflation preferences, monetary policy responses to this inflationary pressure are expected to increase unemployment, offsetting the initial gains (Kapteyn et al., 2004, p. 298). Following this line of reasoning, unemployment should remain unaffected, while the wage share should increase. This follows from general neoclassical reasoning that decreased inequality suppresses profits and growth. To conclude, the neoclassical perspective is mainly founded on the idea that profit-maximizing firms would, in reaction to the increased cost of labour from work time reduction, scale back their output. The effect would be a negative or insignificant effect on employment. At large, this would imply a reduction in growth and an increased wage share. This is the neoclassical hypothesis:

> *A decrease in standard working hours results in an increased unemployment rate, increased wage share and a decreased growth rate.*

[3]Operating time is also fixed, a necessary constraint for their model.

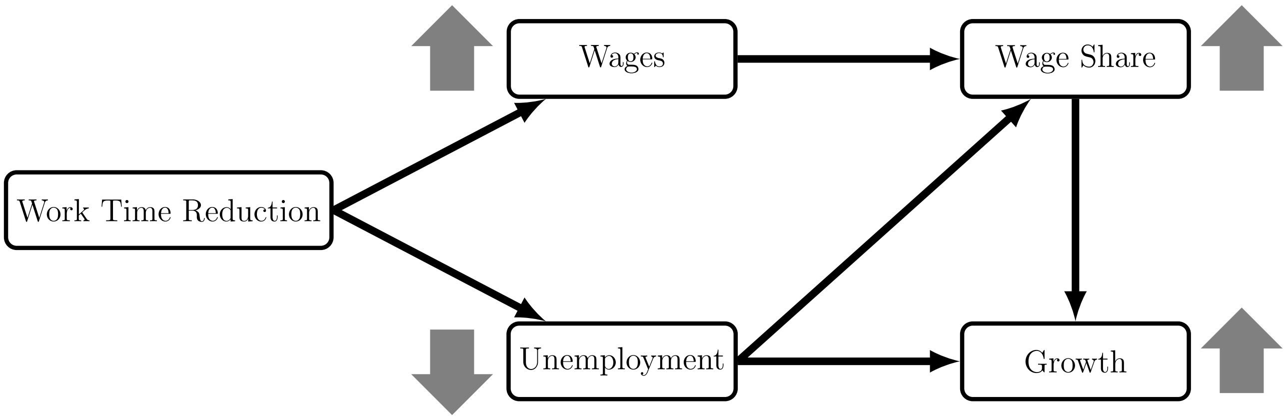

Figure 2: Schematic representation of the post-Keynesian hypothesis. Gray arrows show the direction of change.

Post-Keynesian and demand side economics

Post-Keynesian reasoning begins with the work share hypothesis. If work time can be substituted with more workers, then unemployment is expected to decrease following an initial reduction in work time (Cárdenas and Villanueva, 2021, p 336-338). Assuming the reduction is implemented with no reduction in pay, a decreased unemployment rate should increase the wage share. Decreased unemployment affects output and growth by decreasing excess capacity in the system (moving the economy closer to optimal output) and by increasing effective demand. In this context, outcomes may be more favourable than those predicted by neoclassical theories (Cárdenas and Villanueva, 2021).

A key point of contention between the two frameworks is work time reduction's effect on employment (which essentially reduces into a debate over why unemployment exists). In neoclassical economics, the economy is modelled to be functioning at full employment. If the economy is under-employing its workers, reasoning implies that the cause is restrictive legislation (Brancaccio et al., 2017, p. 35). Like Keynes, post-Keynesians challenge this application of Say's law. To reformulate, the post-Keynesian thesis is that *demand creates its own supply* (Keynes, 1936, p. 26).

By Keynesian reasoning, income is divided between consumption, and savings, where savings is not necessarily equivalent to future consumption or investment (Harcourt and Kriesler, 2013, p. 126-127). Liquid assets – as means for insuring against uncertainty – amount to an extraneous form of consumption, resulting in demand which does not generate employment. In a world where people demand nonproducibles like liquid assets, supply does not generate equal demand. Instead, demand becomes the limiting factor for output. To restate, Say's law does not hold in this context.

Not including consumption of nonproducibles, labourers either spend their wages on consumption or invest them back into the economy. In the short run, consumption drives growth, but in the long run, investment does. Hence, there are two channels through which labour determines output: labour's contribution to production and wage-driven consumption and investment.

Keynesian reasoning suggests that work time reduction results in increased employment, as firms must meet the short-run demand by hiring more labour (Cárdenas and Villanueva, 2021). Generally, modern Keynesian theories agree with traditional reasoning except for two points: wages and productivity. As Cárdenas and Villanueva (2021) argue, and empirical evidence suggests (Hunt, 1999), wages increase with work time reduction. This translates to higher consumption, partly because of increased wages and partly because of decreased unemployment. On the topic of productivity, we expect an increase following work time reduction, from a reduction of work-related injuries (Golden, 2012; Tucker and Folkard, 2012).

In the long run, this induces output, as savings and investment in absolute and relative terms should increase, as well as the productivity of labour. The important takeaway is that an economy that underutilizes its capital and labour in the short term also suffers less growth in the long term (Harcourt and Kriesler, 2013, p. 64-65). Using less capital than possible results in a "smaller rate of formation of fresh capital", and long-term unemployment diminishes the labour force. In that way, the short term impacts the long term.

This perspective of long-term growth can also be seen as a development question, where some post-Keynesian theorists differentiate between *supply regimes* and *demand regimes* in stages of development (Harcourt and Kriesler, 2013, p. 541-544). In this context, supply regimes are economies that are constrained by the availability of capital, where unemployment is a consequence of this shortage. In these economies, Say's law could reasonably hold. However, if the work share hypothesis also holds, unemployment should decrease and growth should increase as the available capital is better utilized by the workforce.

In high-income countries, this reasoning suggests, unemployment is instead a consequence of a shortage of effective demand. These are called demand regimes. In such cases, work time reduction increases growth through an increased wage share, which in turn drives growth.

To conclude, the modern Keynesian hypothesis is:

> *Work time reduction decreases unemployment, increases the wage share, and increases growth.*

Data

To test these hypotheses, we construct a balanced panel of 18 OECD countries (indexed i) over 88 quarters (indexed t), ranging from the first quarter of 2000 to the fourth quarter of 2021. We do this for our four variables of interest: work hours, GDP growth, unemployment, and wage share. Summary statistics per country can be found in Table 2. The data used does not contain sensitive or personal information, so any larger discussion of ethics is omitted.

We obtain data for work hours from ILOSTAT's Short-Term Labour Force Statistics database (ILOSTAT, 2023*a*). ILOSTAT mainly sources data on average work hours from national labour force surveys

(ILOSTAT, 2023*b*), which are standardized for most of the panel members[4]. ILOSTAT reports the data as the average weekly number of hours at work in the main paid job. Importantly, ILO measures *hours actually worked*, defined following SNA (UN, 2008) standards:

> *"The concept of hours actually worked is defined as the time spent in a job for the performance of activities that contribute to the production of goods and/or services during a specified short or long reference period. It applies to all types of jobs and is not linked to administrative or legal concepts of working time."* (ILO, 2013, p. 92)

That is, it does not include:

> *"(a) Annual leave, public holidays, sick leave, parental leave or maternity/paternity leave, other leave for personal or family reasons or civic duty; (b) Commuting time between work and home when no productive activity for the job is performed; (c) Time spent in certain educational activities; (d) Longer breaks distinguished from short resting time when no productive activity is performed (such as meal breaks or natural repose during long trips)."* (ILOSTAT, 2023*c*)

In short, the definition captures average work hours per person, reported in weekly-average for the quarter and country in question. There is however some issue of measurement bias. For instance, country or period-specific attitudes may bias populations' reports of perceived work time in different directions. In general, labour force and household surveys suffer issues "related to periodicity, geographic coverage or worker coverage"(ILO, 2013, p. 99). These issues are potential limitations to consider when interpreting our results.

Specifically, we consider the series "mean weekly hours actually worked per employed person by sex and economic activity"[5] and collapse it by sex and economic activity. Hence, let $H_{i,t}$ be defined as *mean weekly hours actually worked per employed person in country i measured at quarter t*. In general, it is the availability of work hours that restricts the length of our panel. To account for seasonality, we let $h_{i,t}$ denote the first-difference value of work hours between corresponding quarters of subsequent years (Kilian and Lütkepohl, 2017, p. 664-666). That is:

$$h_{i,t} = H_{i,t} - H_{i,t-4}, \quad \forall\, i, t > 4 \tag{1}$$

Next, we obtain real GDP growth ($g_{i,t}$) data from the OECD.Stat's Quarterly National Accounts database (OECD.Stat, 2023). Specifically, we consider the expenditure approach real GDP series; defined by the System of National Accounts as "the sum of the gross value added at factor cost *plus* all taxes on products, *less* all subsidies on products, *plus* all other taxes on production, *less* all other

[4] In some cases, the labour force surveys are complemented with microdata.
[5] ILOSTAT code: HOW_TEMP_SEX_ECO_NB_Q.

subsidies on production"(UN, 2008, p. 105). OECD seasonally adjusts these series using the TRAMO-SEATS method (OECD.Stat, 2008) and reports growth between corresponding quarters of subsequent years[6] (that is, year-on-year).

There is an important note to be made about geography: this includes international transfers related to factor costs and counts all *resident* producers. If a resident producer has production outside of the national borders, this is counted, while a non-resident producer within the country's border is not. This, together with the fact that consumption of fixed capital is included in the measure, makes it differ from national income, something we will return to when discussing the wage share.

We also use OECD data on nominal GDP, exchange rates and population to group the countries into high and low-income countries, ranked by real GDP per capita measured in 2015 US dollars. Here low versus high income is a relative measure within our selection of countries. An issue with grouping countries by income is that the grouping might be different at the beginning of the time period than at the end. Fortunately, in our sample, the low and high-income groups are constant over time (though the internal ranking does vary). Our ranking is presented in Table 1.

Table 1: Country grouping by real GDP per capita.

Low income	High income
Estonia	Italy
Poland	Australia
Hungary	Belgium
Slovak Republic	Finland
Czech Republic	Austria
Slovenia	Ireland
Portugal	Netherlands
Greece	Denmark
Spain	Norway

Data for unemployment ($U_{i,t}$) is obtained from OECD.Stat's Key Short-Term Economic Indicators database, reported in seasonally adjusted quarterly levels[7](OECD.Stat, 2023). The Labour Force Surveys follow ILO's suggested definition of unemployment, which is as follows:

> *The unemployed comprise all persons of working age who were: a) without work during the reference period, i.e. were not in paid employment or self-employment; b) currently available for work, i.e. were available for paid employment or self-employment during the reference period; and c) seeking work, i.e. had taken specific steps in a specified recent period to seek paid employment or self-employment.* (ILOSTAT, 2023*b*)

Simply put, the unemployed (per the definition above) divided by the labour force (defined as the total number of employed and unemployed individuals in a country) gives the unemployment rate. As noted above, this definition depends on the definition of the labour force. If we decrease the labour force by increasing time spent in education or decreasing the pension age, then this might change the

[6]OECD.Stat subject: B1_GE, measure: GYSA.
[7]OECD.Stat subject: Labour Force Survey - Quarterly Rates, measure: Level, ratio or index.

unemployment rate as well. This definition also crucially depends on the definition of "taken specific steps" to seek paid employment, which varies slightly between countries (ILOSTAT, 2023*b*).

Being based on survey data, this figure has similar issues to average weekly work hours, which need to be taken into account when considering the results. In the same way as with work hours, and to make the series compatible, we let $u_{i,t}$ denote the first-difference value of unemployment between corresponding quarters of subsequent years. That is:

$$u_{i,t} = U_{i,t} - U_{i,t-4},\ \forall\, i, t > 4 \tag{2}$$

Finally, we define wage share as the fraction of GDP attributed to compensation for labour. We obtain data for nominal seasonally-unadjusted quarterly levels[8] of GDP (expenditure approach as above) and wages and salaries (the D11 series). That is:

$$S_{i,t} = \frac{D11_{i,t}}{GDP_{i,t}}, \tag{3}$$

Where $S_{i,t}$ denotes wage share. D11 encompasses all wages and salaries paid to employed and self-employed persons, including payments made to third parties on behalf of the worker[9]. This definition can be compared with the one made by the World Inequality Database (WID):

$$\frac{\text{pure labour income} + 70\% \text{ of mixed income}}{\text{national income} - \text{taxes on products}}, \tag{4}$$

where mixed income is that of the self-employed (World Inequality Database, 2022, p. 51). National income, for WID, is defined as GDP less consumption of fixed capital plus net foreign income. This is preferred to GDP, as national income represents income within a nation, rather than the value of production within its borders. These measures are not equal in an open economy, so defining wage share as wages over GDP, while traditional, might be misleading. However, a benefit of our definition is that financial transfers over borders are included, which could be seen as the "third profit"[10].

While the WID definition is in many ways preferable, we use wages over GDP. Because our theoretical framework makes explicit predictions for production, results based on output connect better to our theory.

We let $s_{i,t}$ denote the first-difference value of wage share between corresponding quarters of subsequent years. That is:

$$s_{i,t} = S_{i,t} - S_{i,t-4},\ \forall\, i, t > 4 \tag{5}$$

[8]OECD.Stat measure: CQR.
[9]For instance, income-tax and voluntary social benefits.
[10]Not wholly unlike Adam Smith's division into profits, wages and rent.

Table 2: Summary statistics per country, year-on-year values.

	Growth (g)				Unemployment (u)				Wage Share (s)				Work Hours (h)			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
AUS	2.75	1.69	-5.77	10.30	-0.06	0.70	-2.45	1.84	-0.13	0.98	-4.14	3.14	-0.14	0.35	-1.39	1.37
AUT	1.33	3.01	-13.57	12.49	0.11	0.77	-1.43	2.40	0.06	0.81	-3.36	3.87	-0.46	1.03	-5.33	0.81
BEL	1.51	2.76	-12.79	14.60	-0.03	0.79	-1.63	1.57	-0.04	0.76	-2.11	2.22	-0.12	0.45	-1.60	0.90
CZE	2.53	3.41	-10.78	9.13	-0.28	0.97	-1.90	3.07	0.22	0.58	-1.32	1.64	-0.27	1.16	-3.63	4.40
DNK	1.28	2.40	-6.32	9.03	0.04	0.90	-1.53	3.13	0.02	1.09	-3.04	3.68	-0.08	0.56	-1.40	1.10
EST	3.70	5.70	-18.67	13.52	-0.38	2.68	-5.23	8.67	0.11	1.35	-3.29	4.51	-0.04	1.24	-3.40	4.55
FIN	1.33	3.12	-8.91	7.09	-0.10	0.84	-1.70	2.50	0.09	0.76	-1.23	2.81	-0.15	0.49	-1.30	1.10
GRC	-0.07	5.63	-15.59	14.63	0.17	2.54	-4.17	7.33	0.25	1.19	-3.11	4.02	-0.17	1.55	-9.23	8.43
HUN	2.47	3.89	-13.20	17.56	-0.10	0.98	-2.97	2.27	0.08	1.10	-3.39	3.23	-0.24	0.89	-2.91	2.07
IRL	5.19	6.28	-9.65	26.65	0.09	1.81	-2.20	6.63	-0.53	1.91	-7.75	3.81	-0.16	0.44	-1.20	1.30
ITA	0.12	3.62	-17.77	16.76	-0.03	0.93	-1.37	2.53	0.16	0.38	-0.50	1.39	-0.16	0.81	-3.70	3.20
NLD	1.34	2.50	-8.55	10.28	0.03	0.93	-1.33	2.30	-0.06	0.92	-3.11	3.74	-0.08	0.37	-1.00	0.70
NOR	1.58	1.94	-5.35	6.54	0.06	0.62	-1.60	1.53	0.02	2.13	-8.14	4.52	-0.15	0.67	-2.20	1.50
POL	3.69	2.62	-7.25	12.02	-0.61	1.72	-4.73	2.70	-0.07	1.03	-2.77	2.36	-0.05	0.43	-1.10	1.90
PRT	0.58	3.74	-17.78	17.03	0.06	1.52	-2.70	3.30	-0.06	0.96	-2.56	4.99	-0.06	0.58	-1.50	2.50
SVK	3.58	3.84	-9.31	13.94	-0.57	1.56	-3.33	4.90	0.10	0.93	-1.96	2.82	-0.39	1.44	-6.19	5.52
SVN	2.37	4.12	-11.57	15.72	-0.10	1.00	-2.27	2.43	0.07	1.17	-3.37	4.55	0.12	1.72	-4.19	8.13
ESP	1.26	4.37	-21.94	17.88	0.14	2.37	-2.83	7.47	-0.04	0.87	-2.42	3.29	-0.12	0.45	-1.20	0.90
Total	2.03	4.01	-21.94	26.65	-0.09	1.47	-5.23	8.67	0.01	1.13	-8.14	4.99	-0.15	0.92	-9.23	8.43

Table 3: Stationarity test results.

	Growth	Unemployment	Wage share	Work Hours
Levin-Lin-Chu	-6.8533***	-5.7530***	-8.1186***	-12.3710***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Harris-Tzavalis	0.7094***	0.9107***	0.6027***	0.2653***
	(0.0000)	(0.0000)	(0.000)	(0.0000)
Im-Pesaran-Shin	-10.7187***	-3.6360***	-13.2683***	-20.8405***
	(0.000)	(0.0001)	(0.0000)	(0.0000)
Hadri Lagrange	-15.7612***	- 20.6253***	8.7641***	2.7346***
	(0.0000)	(0.0000)	(0.000)	(0.0031)

P-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Stationarity

An important aspect of conducting a SVAR analysis, the model that we will be using, is considering the stationarity of the data in question. If our processes are non-stationary (in this context, covariance stationary), we risk obtaining spurious results. Specifically, exogenous or deterministic variables might be attributed high explanatory power where such does not exist (Wasserfallen, 1986, p. 507). We also risk obtaining non-stable solutions, and consequently non-interpretable results (Enders, 2004, p. 270). It is worth noting that this is not backed by an outright consensus and that there are opinions in the literature that non-stationary processes include information that treated data does not, and should thus be included in the analysis.

When testing panel data for stationarity, various tests may take different approaches to formulating hypotheses. We employ four distinct tests: Levin-Lin-Chu; Harris-Tzavalis, Im-Pesaran-Shin and Hadri Lagrange multiplier stationarity tests respectively. One important difference is that for the first three tests, the null hypothesis implies the existence of a unit root, while for the last the null implies that all members of the panel are stationary. The different tests have their strengths and weaknesses, for a closer discussion see Appendix A.1.

Results from our stationarity tests, per variable, are presented in Table 3. For all our tests, we reject the null hypothesis. This means that the first three tests indicate that our panel should be considered generated by a stationary process. In contrast, the Hadri Lagrange test implies that at least one member of the panel is non-stationary. While this might be worrisome at first glance, it is of little concern. As discussed by Pesaran, Harris-Tzavalis might be the more appropriate test when considering panels that do not have an infinite or large number of panels (2012, p. 546). Westerlund and Breitung on the other hand argue in favour of Levin-Lin-Chu or Im-Pesaran-Shin, on the basis that they have greater statistical power in many cases (2009). At the same time, the literature on the subject indicates that growth, inequality and unemployment are in fact stationary processes (the latter two in first differences) (Atems and Jones, 2015; Leybourne et al., 1996). In the end, we consider the data as a panel, and the literature indicates that the less restrictive tests are often preferred. We conclude that our processes are stationary.

Model and method

Based on the theory above, our system bears a number of interesting characteristics. First, all the variables in our analysis: growth, wage share, work time and unemployment, could reasonably be considered endogenous. Moreover, theory suggests that causal relationships exist between all four variables. Specifically, we expect our variables to be functions of themselves and each other, at present and earlier values. Ideally, a model should be constructed such that all these relationships, both contemporaneous and lagged, can be captured. To untangle this web of temporal causation and association, we employ a structural vector autoregressive (SVAR) model (Enders, 2004). In short, a SVAR model considers a set of series of endogenous variables and treats them symmetrically. In our case, the model becomes:

$$B\mathbf{y_{i,t}} = A_1\mathbf{y_{i,t-1}} + A_2\mathbf{y_{i,t-2}} + \cdots + A_p\mathbf{y_{i,t-p}} + \gamma\mathbf{D} + \boldsymbol{\varepsilon}_{i,t}, \tag{1}$$

$$\mathbf{y_{i,t}} = \begin{bmatrix} g_{i,t} \\ s_{i,t} \\ u_{i,t} \\ h_{i,t} \end{bmatrix} \quad \mathbf{D} = \begin{bmatrix} d_1 \\ d_2 \\ \vdots \\ d_k \end{bmatrix}. \tag{2}$$

Where $g_{i,t}$, $s_{i,t}$, $u_{i,t}$, and $h_{i,t}$ are defined as above. B and $A_1, \ldots, A_p$ are all 4×4 real matrices. We interpret B as the contemporaneous relationships between our variables, $A_1, \ldots, A_p$ are the lagged effects, p is the number of lags used in the model (specified below), and $\mathbf{D}$ is a vector of *deterministic* effects and country-specific dummy variables (Lütkepohl, 2005, p. 357-360). Finally, we assume $\boldsymbol{\varepsilon}_{i,t}$ to be a zero-mean process, cross-sectionally and temporally independent with covariance matrix Σ_ε. We specify our model such that these errors can be interpreted as structural "shocks". To this end, the errors are considered contemporaneously independent, so Σ_ε is diagonal - this is the *structural form.*

A useful property of SVAR is that a properly identified (detailed below) model can be used to compute impulse response functions (Enders, 2004, p. 272-277), yielding results with clear economic interpretations. An impulse response is the output produced by a dynamic system in response to a brief input signal. In our model, the input signal constitutes an instantaneous, exogenous shock (negative unity in magnitude) to one of the variables. The variables' subsequent responses can then be computed recursively. Before proceeding to estimation, two vital aspects remain to be specified: an appropriate set of restrictions identifying the model, and the selection of lag order.

Identification and specification

Though SVAR is a suitable model given our theoretical context, the method suffers a caveat. A SVAR model cannot be estimated − rather, it is identified from the underlying VAR model. This, which can be estimated by OLS, is called the reduced form:

$$\mathbf{y_{i,t}} = \beta_1 \mathbf{y_{i,t-1}} + \beta_2 \mathbf{y_{i,t-2}} + \cdots + \beta_p \mathbf{y_{i,t-p}} + \beta_\gamma \mathbf{D} + \boldsymbol{e}_{i,t}, \tag{3}$$

Where $\beta_i = B^{-1}A_i$ for $i = 1 \dots p$, $\beta_\gamma = B^{-1}\gamma$ and $\boldsymbol{e}_{i,t} = B^{-1}\varepsilon_{i,t}$ with error covariance matrix Σ_e. Although the reduced form can be estimated directly and has empirical relevance, it is not economically interpretable. By letting economic theory guide the identification process, we can recover meaningful results in the form of a structural model (Enders, 2004).

The problem stems from an incongruity between the reduced and structural forms − namely, our reduced form has 6 fewer parameters than the structural model[11]. The issue is that the reduced form is under-identified with respect to the structural model. We resolve the identification problem by setting certain restrictions on the structural model. To this end, we constrain 6 parameters to zero by making B lower triangular. This can be interpreted as setting a causal order on the contemporaneous relationships between the variables. Specifically, the first variable is allowed to contemporaneously affect the remaining variables, the second variable is allowed to contemporaneously affect variables 3 and 4, the third variable is allowed to contemporaneously affect variable 4, and finally, the fourth variable does not have any contemporaneous effects. To caution, note that this does not mean that the variables only affect each other in this order - these restrictions do not apply to the lagged effects.

Because the two frameworks differ in reasoning about production, different specifications of causal order are required. The distinction is that the neoclassical framework argues that production is driven by supply, while the post-Keynesian framework argues that production is driven by demand. Specifically, the neoclassical framework posits that the level of production contemporaneously affects unemployment and wages, that unemployment only contemporaneously affects wages, and that wages do not have any contemporaneous effects. Regardless of theoretical context, work time cannot affect the current values of the remaining variables. Hence, the neoclassical causal ordering is: growth, unemployment, wage share, and work hours. In the post-Keynesian case, the difference is that wages contemporaneously affect aggregate demand (ergo, the level of production and unemployment), so wage share is ranked first and the remaining variables are ordered like in the neoclassical case. Hence, the post-Keynesian causal

[11] Generally, for a SVAR model with n variables the reduced form has $\frac{n^2-n}{2}$ fewer parameters. See appendix A.2.

ordering is: wage share, growth, unemployment, and work hours. Explicitly, the two specifications are:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \begin{bmatrix} g_{i,t} \\ u_{i,t} \\ s_{i,t} \\ h_{i,t} \end{bmatrix} = A_1 \begin{bmatrix} g_{i,t-1} \\ u_{i,t-1} \\ s_{i,t-1} \\ h_{i,t-1} \end{bmatrix} + A_2 \begin{bmatrix} g_{i,t-2} \\ u_{i,t-2} \\ s_{i,t-2} \\ h_{i,t-2} \end{bmatrix} + ... + \boldsymbol{\varepsilon_{i,t}} \tag{4}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \begin{bmatrix} s_{i,t} \\ g_{i,t} \\ u_{i,t} \\ h_{i,t} \end{bmatrix} = A_1 \begin{bmatrix} s_{i,t-1} \\ g_{i,t-1} \\ u_{i,t-1} \\ h_{i,t-1} \end{bmatrix} + A_2 \begin{bmatrix} s_{i,t-2} \\ g_{i,t-2} \\ u_{i,t-2} \\ h_{i,t-2} \end{bmatrix} + ... + \boldsymbol{\varepsilon_{i,t}}, \tag{5}$$

where equation (4) is the neoclassical specification and equation (5) is the post-Keynesian specification. Finally, we use the Akaike Information Criterion (AIC) to determine the appropriate number of lags (colloquially, "lag length") for our models. AIC is a theoretical measure of the distance in information captured between models, given some dataset, and is standard in the literature (Atems and Jones, 2015; Burnham and Anderson, 2002). The advantage of using AIC over goodness-of-fit measures is that it allows an a priori ranking over a set of candidate models, rather than claiming a better or worse fit a posteriori. For all of our models, AIC determined the appropriate lag length to be four. To conclude, our fully specified structural form is:

$$B\mathbf{y_{i,t}} = A_1\mathbf{y_{i,t-1}} + A_2\mathbf{y_{i,t-2}} + A_3\mathbf{y_{i,t-3}} + A_4\mathbf{y_{i,t-4}} + \gamma\mathbf{D} + \varepsilon_{i,t}, \tag{6}$$

$$\mathbf{y_{i,t}} = \begin{bmatrix} g_{i,t} \\ u_{i,t} \\ s_{i,t} \\ h_{i,t} \end{bmatrix} \quad \mathbf{D} = \begin{bmatrix} d_1 \\ d_2 \\ \vdots \\ d_k \end{bmatrix},$$

where B is the contemporaneous coefficient matrix, specified with respect to framework, and $\mathbf{D}$ is a vector of country-specific dummy variables. When conducting robustness estimations with regard to the financial crisis and the COVID-19 pandemic, $\mathbf{D}$ includes dummy variables for these respective periods.

Estimation procedure

We begin by estimating the reduced form. We compute a least squares dummy variable (LSDV) panel regression, following Cagala and Glogowsky (2015), and obtain estimates for $\beta_1, \ldots, \beta_4$ and Σ_e.

While the reduced form estimates do not present any strictly economic interpretations, they remain relevant for forecasting and determining Granger causality. Granger causality is a measure of whether a process improves the prediction of another (Kilian and Lütkepohl, 2017, p. 49). The reduced form also lets us test model stability, that is, whether the impulse response functions converge (Kilian and Lütkepohl, 2017, p. 25). The impulse response functions are in turn estimated by using the structural estimates.

To estimate the structural model, we orthogonalize the structural shocks and recover Σ_ε. To this end, we Choleski decompose $\hat{\Sigma}_{\boldsymbol{e}}$ and obtain C such that $CC^T = \hat{\Sigma}_{\boldsymbol{e}}$, where C is lower-triangular. We normalize C to a unit diagonal to estimate the contemporaneous matrix B. Using the contemporaneous matrix we estimate Σ_ε, which in turn is diagonal. Thus, we get the estimates for the structural and reduced forms. For a detailed discussion of the estimation procedure, see Appendix A.3.

After recovering the structural form, we can compute the impulse response functions. Explicitly, we define the impulse response function as the Jacobian of $\boldsymbol{y_{i,t}}$ with respect to a structural shock $\varepsilon_{i,t}$. That is:

$$\theta_k := \frac{\partial \boldsymbol{y_{i,t+k}}}{\partial \boldsymbol{\varepsilon_{i,t}}}, \tag{7}$$

where in our case, θ_k is a 4×4 matrix, and $\theta_{jm,k}$ is the response, or marginal effect, in variable j to an impulse in variable m, k periods after the impulse. To observe the total effect of an impulse, consider the cumulative impulse response function Θ_t:

$$\Theta_0 = \theta_0 \tag{8}$$

$$\Theta_t = \Theta_{t-1} + \theta_t \quad t > 0 \tag{9}$$

The details of how we compute these functions can be found in Appendix A.3. Next, we estimate confidence intervals for the impulse response functions through bootstrapping. Specifically, we generate a new set of residuals by temporally resampling (with replacement, by country) our original reduced form residuals $\boldsymbol{e_{i,t}}$. The new set of residuals is then substituted into the estimated reduced form equation and new data is recursively generated:

$$\mathbf{y^*_{i,t}} = \hat{\beta}_1 \mathbf{y^*_{i,t-1}} + \hat{\beta}_2 \mathbf{y^*_{i,t-2}} + \hat{\beta}_3 \mathbf{y^*_{i,t-3}} + \hat{\beta}_4 \mathbf{y^*_{i,t-4}} + \hat{\beta}_\gamma \mathbf{D} + \mathbf{e^*_{i,t}}, \tag{10}$$

where $\hat{\beta}_1, \ldots, \hat{\beta}_\gamma$ are our estimates, $\mathbf{e^*_{i,t}}$ is the bootstrapped set of residuals, $\mathbf{y^*_{i,t}}$ is the generated data, $\mathbf{y^*_{i,t}} = 0$ for all t less than zero, and $\mathbf{D}$ is the vector of dummy variables. The new data is then used to re-estimate the reduced form equation (3) and compute new impulse response functions (Enders, 2004, p. 278). We repeat this process $10,000$ times to estimate the stepwise impulse response variances. These are then used to compute Hall's studentized percentile confidence intervals at the 95% level (Lütkepohl, 2005, p. 710-711).

Results

Let us begin by examining the reduced form regression results[12] in Table 5. Note that most variables' own lags are significant, with the exceptions of $\mathcal{L}^3 s$, $\mathcal{L}^2 u$ and $\mathcal{L}^3 u$, where $\mathcal{L}^i v$ is the i:th lag of variable v. Notably, work hours, specifically $\mathcal{L}^2 h$ and $\mathcal{L}^4 h$, are significant on growth and unemployment. Finally, note that for all lags, work hours do not have a significant effect on wage share.

Table 4: Results and p-values of test for Granger Causality.

	Growth	Unemployment	Wage share	Work Hours
Growth	229.00***	43.18***	6.98***	3.54***
	(0.0000)	(0.0000)	(0.0000)	(0.0070)
Unemployment	11.26***	1183.99***	0.56	2.44**
	(0.0000)	(0.0000)	(0.6884)	(0.0453)
Wage Share	0.44	2.74**	-13.27***	1.39
	(0.7782)	(0.0273)	(0.0000)	(0.2360)
Work Hours	8.88***	7.06***	0.91	93.19***
	(0.0000)	(0.0000)	(0.4592)	(0.0000)

P-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

While the significance of these estimates indicates that work hours can be used to predict growth and unemployment, and less so for the wage share, it should not be given an economic interpretation. That is, these associations are not necessarily causal. Testing this predictive capacity, we perform a joint Wald test for each variable's set of lags. Rejecting the null hypothesis implies that the regressor Granger causes the response variable (Kilian and Lütkepohl, 2017, p. 39). The results are summarized in Table 4.

Moving on, consider the cumulative responses to a negative unit impulse in work hours. As these are practically indistinguishable between the two specifications, we choose to only present the neoclassical plots. Also note that given the linearity of the model, a positive shock yields identical, but mirrored,

[12] Since model restrictions are imposed after the reduced form is estimated, the underlying measurables are the same.

,

Table 5: Reduced form LSDV regression estimates, country dummy variables not shown.

	Wage share	Growth	Unemployment	Work Hours
$\mathcal{L}^1 s$	0.518***	0.087	-0.045**	0.024
	(0.031)	(0.090)	(0.019)	(0.029)
$\mathcal{L}^2 s$	0.148***	0.033	0.032	0.016
	(0.035)	(0.102)	(0.022)	(0.033)
$\mathcal{L}^3 s$	0.067*	-0.047	0.006	0.022
	(0.036)	(0.106)	(0.023)	(0.034)
$\mathcal{L}^4 s$	-0.262***	-0.012	0.030	-0.059**
	(0.032)	(0.092)	(0.020)	(0.030)
$\mathcal{L}^1 g$	0.014	0.611***	-0.082***	0.018*
	(0.011)	(0.032)	(0.007)	(0.010)
$\mathcal{L}^2 g$	-0.016	0.189***	0.027***	0.001
	(0.013)	(0.039)	(0.008)	(0.013)
$\mathcal{L}^3 g$	-0.019	0.209***	0.009	-0.009
	(0.016)	(0.045)	(0.010)	(0.015)
$\mathcal{L}^4 g$	0.063***	-0.532***	0.030***	-0.028**
	(0.013)	(0.039)	(0.008)	(0.013)
$\mathcal{L}^1 u$	0.017	-0.283**	0.947***	0.040
	(0.044)	(0.128)	(0.028)	(0.041)
$\mathcal{L}^2 u$	-0.009	-0.037	0.045	-0.157***
	(0.062)	(0.179)	(0.039)	(0.058)
$\mathcal{L}^3 u$	0.014	0.320*	0.009	0.087
	(0.063)	(0.183)	(0.039)	(0.059)
$\mathcal{L}^4 u$	-0.042	-0.446***	-0.178***	0.015
	(0.043)	(0.126)	(0.027)	(0.041)
$\mathcal{L}^1 h$	0.002	0.079	0.043**	0.253***
	(0.028)	(0.081)	(0.018)	(0.026)
$\mathcal{L}^2 h$	0.040	-0.442***	0.057***	0.056**
	(0.029)	(0.085)	(0.018)	(0.027)
$\mathcal{L}^3 h$	0.028	-0.003	-0.031	0.235***
	(0.032)	(0.093)	(0.020)	(0.030)
$\mathcal{L}^4 h$	0.011	-0.223**	0.047**	-0.484***
	(0.032)	(0.093)	(0.020)	(0.030)
N	1440	1440	1440	1440
adj. R^2	0.451	0.706	0.874	0.288
F	35.861	102.939	295.869	18.132

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

impulse response functions. Figure 3 shows the cumulative response of growth, Figure 4 shows the cumulative response of unemployment, and Figure 5 shows the cumulative response of wage share.

The immediately interesting result is the positive effect on growth and the negative effect on unemployment. Specifically, a unit *decrease* in work hours results in a positive cumulative effect on growth of a magnitude of approximately 2 percentage points. Note that these are quarterly year-on-year growth rates, the cumulative impulse response should not be interpreted as accumulated growth[13], which itself is to the magnitude of approximately 0.5 percent. We also find that the same impulse results in a negative cumulative effect on unemployment, stabilizing at approximately -0.85 percentage points after 16 quarters. In both cases, the effects are statically significant at the 95% confidence level after two quarters. Finally, we note that the effect on wage share is not significant.

One thing to keep in mind when interpreting the effect of a shock in work hours is that it also affects the work hours variable itself. Looking at the cumulative response of work hours in Figure 6, we see that the response stabilizes around -1.1 hours. Also worth noting is that responses scale linearly with impulses, given the linearity of the model.

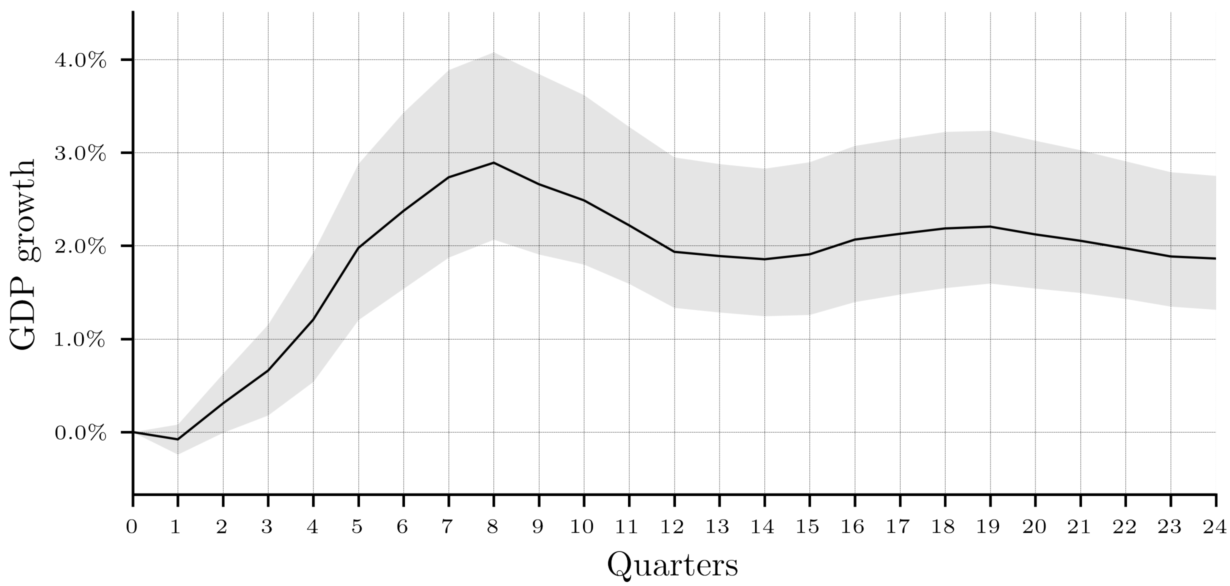

Figure 3: Cumulative impulse response of growth given a negative unit impulse in work hours, neoclassical specification.

Robustness and stability

First, all of our specifications and robustness estimations are confirmed stable. In total, we conduct three distinct robustness checks. The first is, clearly, the estimation of separate structural models for

[13] See Appendix A.4 for details.

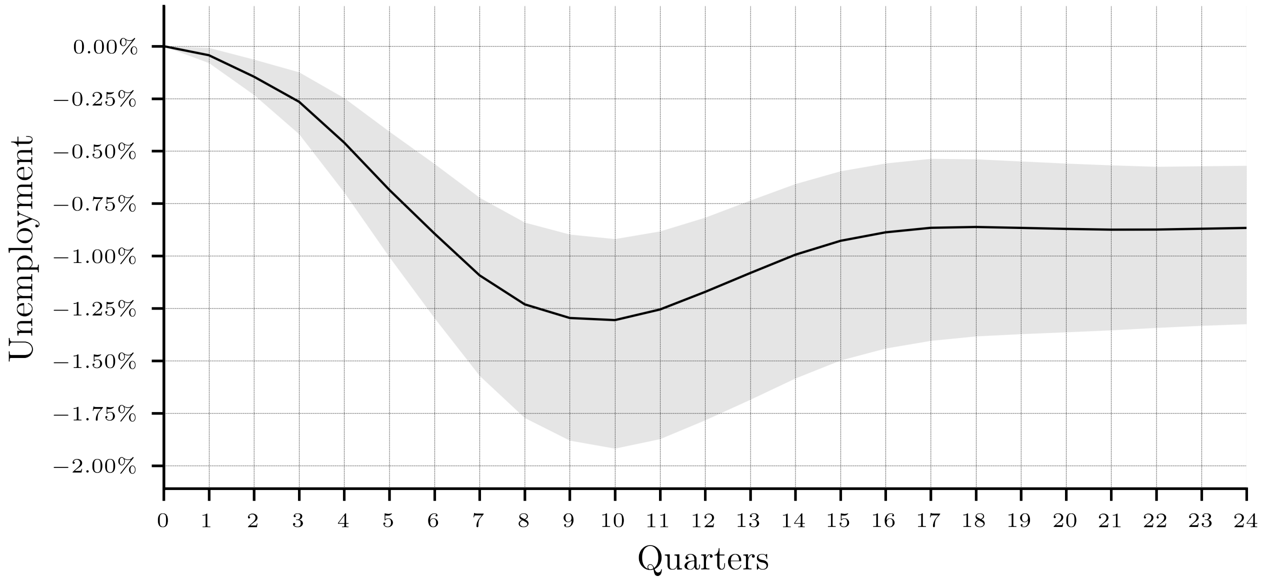

Figure 4: Cumulative impulse response of unemployment given a negative unit impulse in work hours, neoclassical specification.

the two theoretical frameworks. Since these produce nearly identical response functions for impulses in work hours, our results are robust with respect to the two specifications.

Next, post-Keynesian theory posits that economies behave differently at different stages of development. Following this, we estimate the models on data partitioned by income, as presented in Table 1. Figures 7, 8 and 9 depict the partitions' cumulative impulse responses. Note that growth's and unemployment's cumulative response is larger for the low-income group, and not significant for the high-income group. Though the wage share's response differs between the groups, it is not significant for either.

Hence, there seem to exist structural differences between the groups, at least by our data's account. Here, we observe an effect on unemployment, indicating work sharing, and an effect on growth, indicating a higher utilization of capacity. There is no clear difference in terms of supply contra demand regimes – rather, the low-income group sees a larger effect from work time reduction. At the same time, these countries have, on average, longer work hours, indicating diminishing returns from work time reduction.

For a final robustness check, we estimate models controlling for the two major systemic crises, namely the 2008 financial crisis and the COVID-19 pandemic. Specifically, the controlling dummy variables are set to 1 for the periods 2008Q1-2009Q4 and 2020Q1-2021Q4. This does not significantly alter the results.

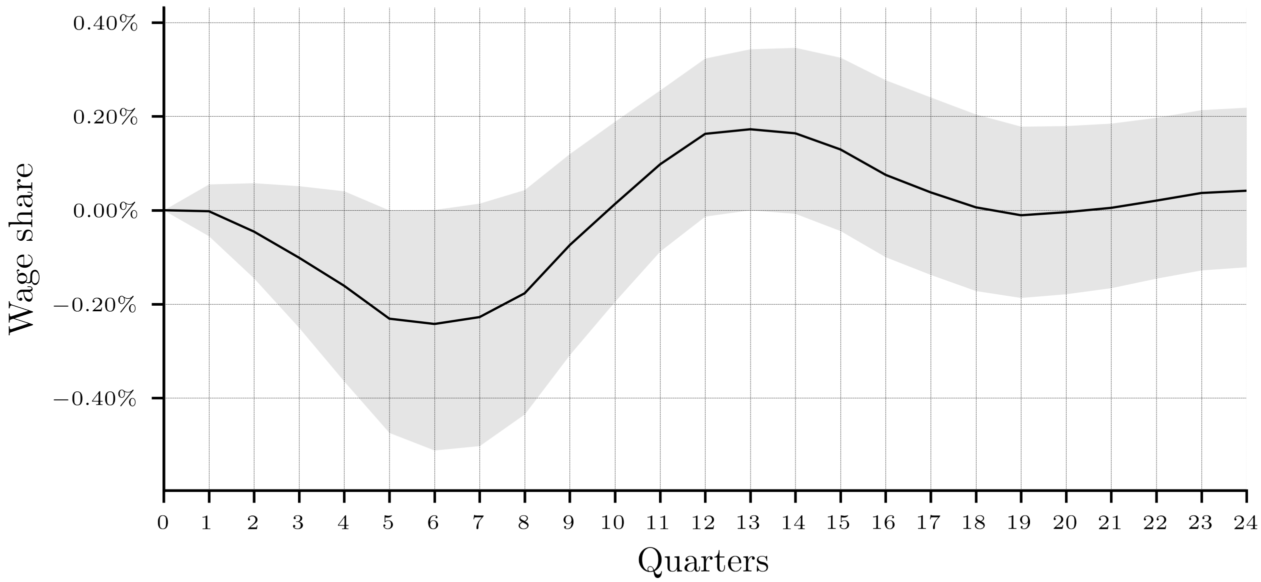

Figure 5: Cumulative impulse response of wage share given a negative unit impulse in work hours, neoclassical specification.

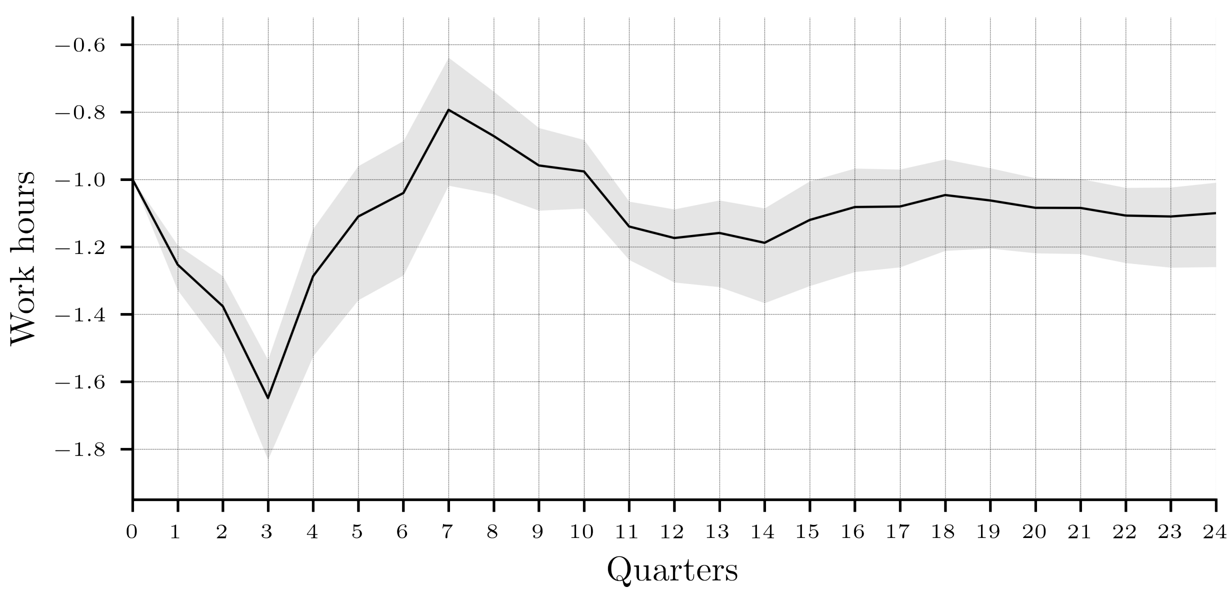

Figure 6: Cumulative impulse response of work hours given a negative unit impulse in work hours, neoclassical specification.

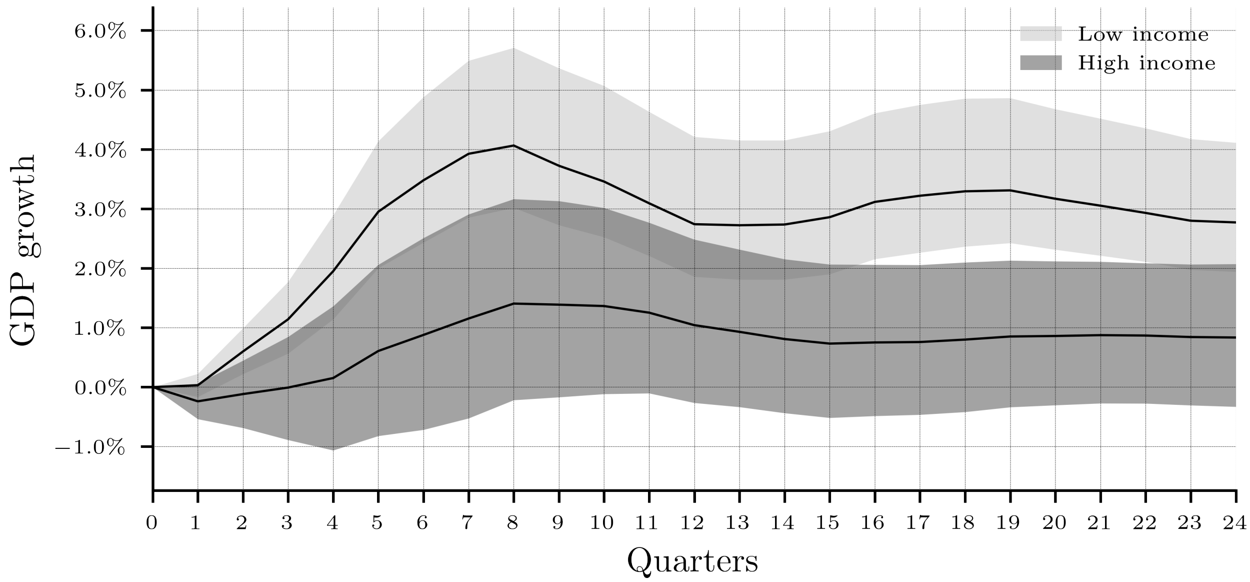

Figure 7: Cumulative impulse response of growth given a negative unit impulse in work hours, neoclassical specification, by income group.

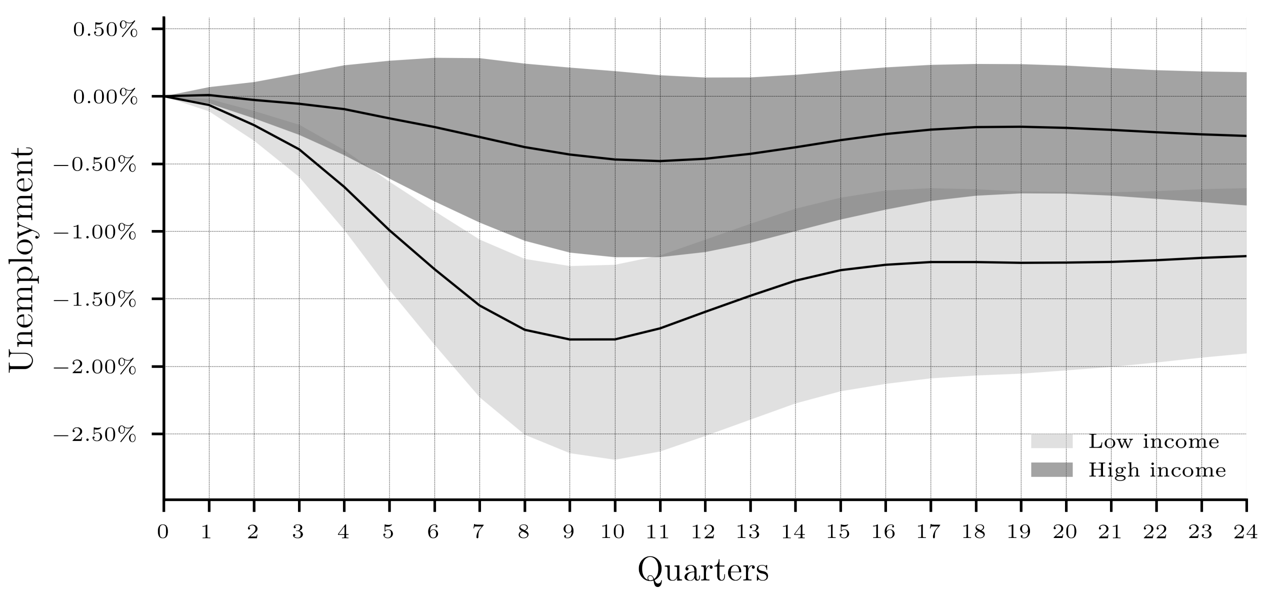

Figure 8: Cumulative impulse response of unemployment given a negative unit impulse in work hours, neoclassical specification, by income group.

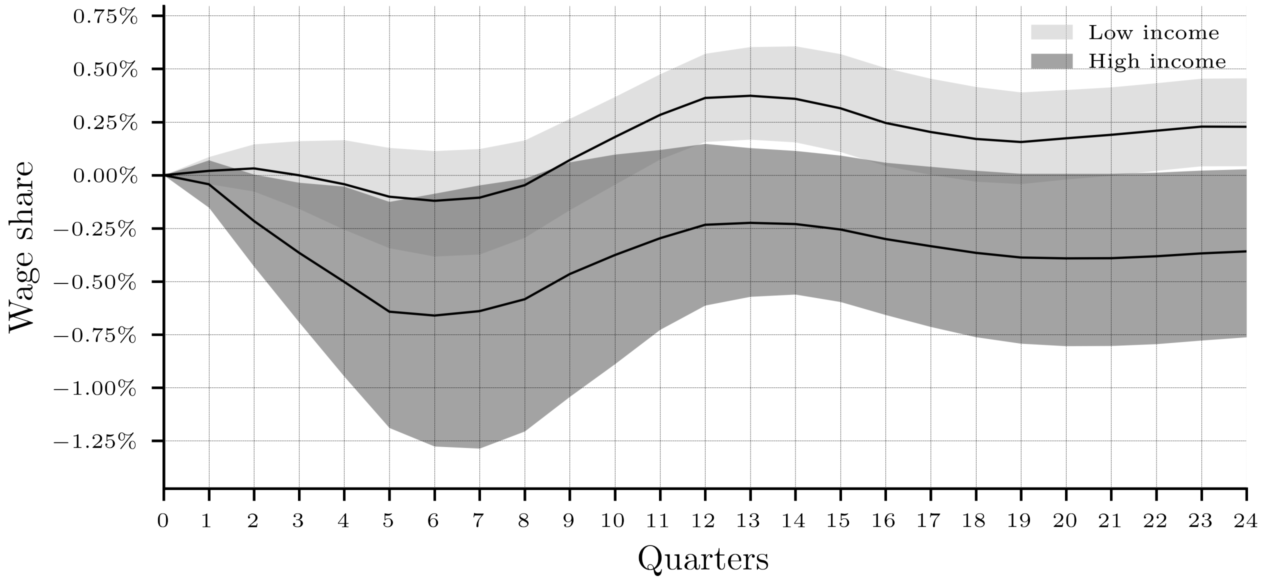

Figure 9: Cumulative impulse response of wage share given a negative unit impulse in work hours, neoclassical specification, by income group.

Discussion and conclusions

Connecting back to theory and our hypotheses, we can draw two main conclusions. First, our results lend evidence in favour of the work share hypothesis. That is, decreasing work hours decrease unemployment. Second, they support the post-Keynesian notion that work time reduction should increase growth. However, they do not indicate that this is driven by the hypothesized mechanism of increasing wage share, as wage share's impulse responses are not significant.

Moreover, as the marginal effect of a shock in work hours is transitory in all our macroeconomic variables, the effect should be considered to occur in the short run. This short-run effect can be connected to long-term outcomes within the post-Keynesian theory, where lower unemployment and greater growth in the short run lead to less long-term unemployment and a higher rate of capital formation (Harcourt and Kriesler, 2013, p. 541-544).

Elaborating on these relationships, future research could take several paths. One potential avenue could be to study the effect on various industries. Research such as that of Golden (2012) and Glosser and Golden (1997) looks at work time and its relationship with firm-level outcomes. A similar line of inquiry, more aligned with our subject, could instead focus on the production of goods. One might conjecture that service sectors, including the public sector, have a greater potential for work-sharing than the production sectors. Conducting a study comparing the two broad sectors could indicate whether that intuition holds. This could be done on both the aggregate level, and by micro comparison of different workplaces.

Other potential further research could attempt simulations based on our model, in line with Cárdenas and Villanueva (2021). Our estimates and similar linear models could be used to investigate the effect of a permanent exogenous change in work hours, which is a natural extension of our endogenous model.

We have thus modelled the effect of a shock in work hours – but is this helpful for policy? The issue is that when we orthogonalize our shocks we gain interpretability, but lose some validity. If work time reduction were implemented through legislation, arguably it would not amount to an exogenous structural shock. That is, we are not modelling the effect of a policy change. At the same time, our results indicate that reducing work time does not harm macroeconomic outcomes, but rather improves measures such as GDP and unemployment. Moreover, we see no significant distributional effects of decreased work hours.

As corroborating evidence for the work share hypothesis, our results should inspire greater confidence in policymakers seeking to implement these types of reforms. The variety of micro studies discussed above give reason to believe (the somewhat self-evident statement) that workers feel better and suffer fewer work-related injuries when they work less (Tucker and Folkard, 2012; Lepinteur, 2019). At the same time, firm-level productivity seems to remain constant or even increase, depending on the sector involved (Golden, 2012; Glosser and Golden, 1997). Our results fit well into this story, but at the aggregate level, which makes it easier to discuss the potential effect of reducing work hours. So, does labour work? It does – if we share it.

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Appendix

Stationarity tests

The stationarity tests we conduct specify two different null hypotheses and four different alternative hypotheses (there is no clear consensus on which tests are preferable). To illustrate, let us assume an underlying first-order autoregressive process with no deterministic component:

$$y_{it} = \rho_i y_{it-1} + \varepsilon_{it}, \tag{1}$$

which is equivalent to:

$$\Delta y_{it} = \alpha_i y_{it-1} + \varepsilon_{it}, \tag{2}$$

where $\alpha_i = \rho_i - 1$ and ε_{it} is assumed to be zero-mean, independent across t and i and identically distributed. We formulate our null hypotheses as:

$$H_0^a,\, H_0^b,\, H_0^c : \text{All panel members contain a unit root.} \tag{3}$$

$$H_0^d : \text{All panel members are stationary.} \tag{4}$$

The alternative hypotheses are:

$$\tag{5}$$

$$H_0^d : \alpha_i < 0 \quad \text{for all members in the panel.} \tag{6}$$

$$H_1^a : \alpha_i = \alpha < 0 \quad \text{for all members in the panel.} \tag{7}$$

$$H_1^b : \text{There exists an } i \text{ such that} \quad \alpha_i < 0. \tag{8}$$

$$H_1^c : \alpha_i < 0 \quad \text{for} \quad i = i, ..., N_1 \leq N \quad \text{such that} \quad \frac{N_1}{N} \to \delta \quad \text{as} \quad N_1, N \to \infty \tag{9}$$

$$H_1^d : \text{There exists an } i \text{ such that} \quad \alpha_i \geq 0 \text{ (Westerlund and Breitung, 2009).} \tag{10}$$

H_1^d is clearly the most restrictive, with the risk of rejecting time series that may have been generated by stationary processes. Conversely, H_1^b is quite lenient. It might however be more appropriate when considering panels that do not have an infinite, or large number of members (Pesaran, 2012, p. 546).

H_1^a and H_1^c offer a compromise, where H_1^c can imply some "degree" of stationarity for the sample. Though this is a convenient and reasonable way of reasoning about stationarity, H_1^a sometimes offers greater statistical power (Westerlund and Breitung, 2009).

Underidentification of the reduced form

Assume a SVAR model with n variables and l lags. The structural form is:

$$B\mathbf{y_{i,t}} = A_1\mathbf{y_{i,t-1}} + A_2\mathbf{y_{i,t-2}} + \cdots + A_l\mathbf{y_{i,t-l}} + \gamma\mathbf{D} + \boldsymbol{\varepsilon}_{i,t}, \tag{11}$$

Where $B, A_1, \ldots, A_l$ are all $n \times n$ matrices and γ is $k \times 1$. The covariance matrix Σ_ε is also $n \times n$. For the A matrices, there are $n^2 l$ free parameters. The B matrix has a unit diagonal and thus contains $n^2 - n$ free parameters. Σ_ε is diagonal by construction and thus contains n free parameters. In total, the structural form contains $n^2(l+1) + k$ free parameters. Now consider the reduced form:

$$\mathbf{y_{i,t}} = \beta_1\mathbf{y_{i,t-1}} + \beta_2\mathbf{y_{i,t-2}} + \cdots + \beta_l\mathbf{y_{i,t-l}} + \beta_\gamma\mathbf{D} + \boldsymbol{e}_{i,t}. \tag{12}$$

The β matrices contain $n^2 l$ free parameters, the vector of dummy variables contains k free parameters, and the symmetrical covariance matrix Σ_e contains $\frac{n^2+n}{2}$ free parameters. In total, the reduced form contains $n^2 l + \frac{n^2+n}{2} + k$ free parameters. Taking the difference gives:

$$\frac{n^2 - n}{2}. \tag{13}$$

Technical details of the estimation strategy

Some technical details of the estimation strategy are worth making explicit. First, after estimating our four reduced form regressions, we obtain our measurable error covariance matrix Σ_e, which we estimate by:

$$\hat{\Sigma}_{\boldsymbol{e}} = \frac{\hat{\boldsymbol{e}}_{\boldsymbol{i,t}}\hat{\boldsymbol{e}}_{\boldsymbol{i,t}}^T}{TI - np - I}, \tag{14}$$

where T is the number of time periods, I is the number of countries, n is the number of endogenous variables and p is the number of lags. Under the assumption that the errors are independent (temporally and panel-wise) and identically distributed, then the estimator for the covariance matrix is consistent (Kilian and Lütkepohl, 2017, p. 31). By construction, we have:

$$\boldsymbol{e}_{\boldsymbol{i,t}} = B^{-1}\boldsymbol{\varepsilon}_{\boldsymbol{i,t}}. \tag{15}$$

Thus,

$$\Sigma_e = \mathbb{E}[\boldsymbol{e_{i,t}} \boldsymbol{e_{i,t}^T}] = (B^{-1})\mathbb{E}[\boldsymbol{\varepsilon_{i,t}} \boldsymbol{\varepsilon_{i,t}^T}](B^{-1})^T = (B^{-1})\Sigma_\varepsilon(B^{-1})^T. \tag{16}$$

We also have that $\Sigma_e = CC^T$. By the uniqueness of the Choleski decomposition, we can identify:

$$C = B^{-1}\sqrt{\Sigma_\varepsilon} \tag{17}$$

Where $\sqrt{\Sigma_\varepsilon}$ is the element-wise square root of Σ_ε. As B is lower triangular by construction, the diagonal of C will be equal to the standard deviations of the structural shocks $\varepsilon_{i,t}$. This gives everything we need to compute our impulse response functions, which in practice is C and B^{-1}. Next, we follow the reasoning of (Kilian and Lütkepohl, 2017, p. 110). First, we transform our VAR(4) reduced model to its VAR(1) "companion" form:

$$\boldsymbol{Z_{i,t}} = \Gamma \boldsymbol{Z_{i,t-1}} + \boldsymbol{E_{i,t}}, \tag{18}$$

$$\boldsymbol{Z_{i,t}} = \begin{pmatrix} y_{i,t} \\ y_{i,t-1} \\ y_{i,t-2} \\ \vdots \\ y_{i,t-p+1} \end{pmatrix} \quad \Gamma = \begin{pmatrix} \beta_1 & \beta_2 & \dots & \beta_{p-1} & \beta_p \\ I & 0 & \dots & 0 & 0 \\ 0 & I & \dots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \dots & I & 0 \end{pmatrix} \quad \boldsymbol{E_{i,t}} = \begin{pmatrix} \boldsymbol{e_{i,t}} \\ 0 \\ 0 \\ \vdots \\ 0 \end{pmatrix}.$$

We recursively compute $\boldsymbol{Z_{i,t}}$ and obtain the VAR's moving average representation (Kilian and Lütkepohl, 2017, p. 111):

$$\boldsymbol{Z_{i,t+k}} = \Gamma^{k+1}\boldsymbol{Z_{i,t-1}} + \sum_{j=0}^{t} \Gamma^j \boldsymbol{E_{i,t+k-j}} \tag{19}$$

To transform back into our original form, we multiply by $J = [I, 0, \dots, 0]$ and get:

$$\boldsymbol{y_{i,t+k}} = J\Gamma^{t+1}\boldsymbol{Z_{i,t-1}} + \sum_{j=0}^{t} J\Gamma^j J^T \boldsymbol{e_{i,t+k-j}} \tag{20}$$

Impulse responses for our reduced system are then given by the Jacobian of $y_{i,t}$:

$$\frac{\partial \boldsymbol{y_{i,t+k}}}{\partial \boldsymbol{e_{i,t}}} = J\Gamma^k J^T := \boldsymbol{\phi_k} \tag{21}$$

Given that our processes are stationary, we can express $\mathbf{y_{i,t}}$ as the sum of responses from all shocks

(Kilian and Lütkepohl, 2017, p. 111):

$$y_{i,t} = \sum_{j=0}^{\infty} \boldsymbol{\phi_k e_{i,j}} = \sum_{j=0}^{\infty} \Theta_j \boldsymbol{\varepsilon_{i,j}}. \tag{22}$$

This step follows from $\boldsymbol{e_{i,t}} = B\boldsymbol{\varepsilon_{i,j}}$ and the definition $\theta_j := \boldsymbol{\phi_k} B^{-1}$. This last quantity is our structural impulse response function, where we specify B^{-1} such that the shocks are negative unity in magnitude (Kilian and Lütkepohl, 2017, p. 112).

Finally, we test model stability. Considering the moving average representation, we see that the limit behaviour of $Z_{i,t}$ depends on the properties of the companion matrix. Specifically, the system is stable if, and only if, all the companion matrix's eigenvalues are less than unity in absolute value (Kilian and Lütkepohl, 2017, p. 25).

Impulse response functions and interpretations

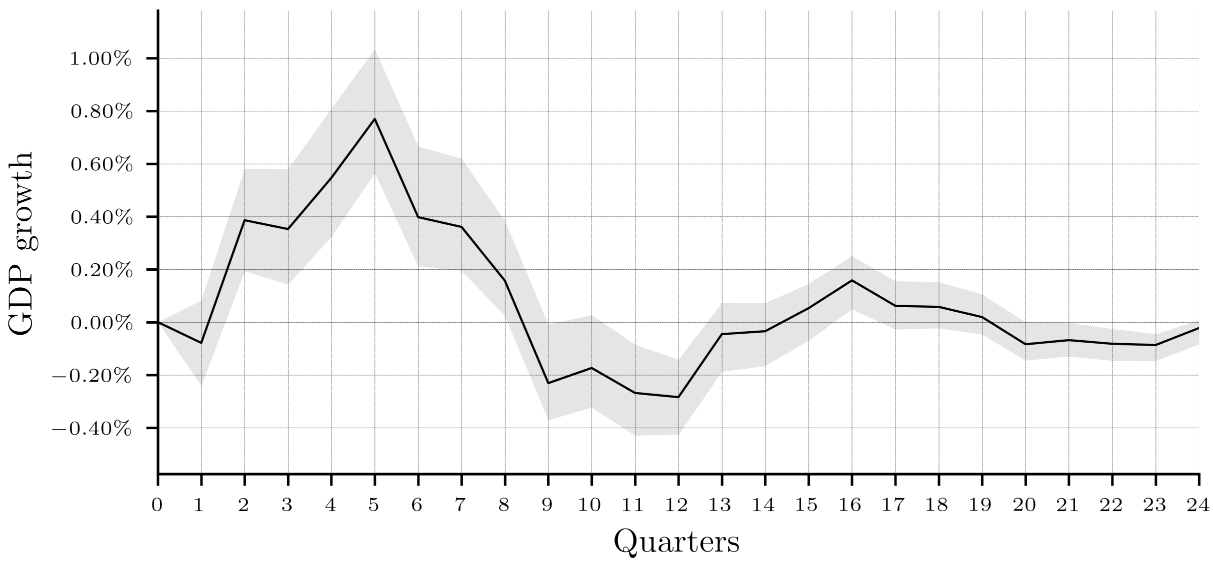

Figure 10: Impulse response function of growth given a negative unit impulse in work hours, neoclassical specification.

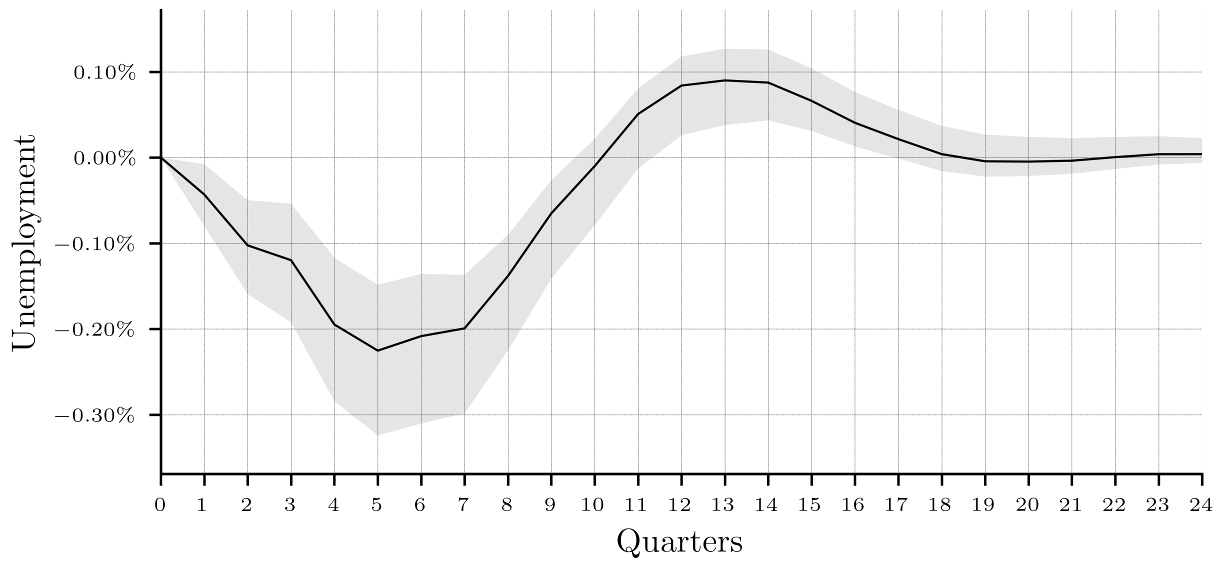

Figure 11: Impulse response function of unemployment given a negative unit impulse in work hours, neoclassical specification.

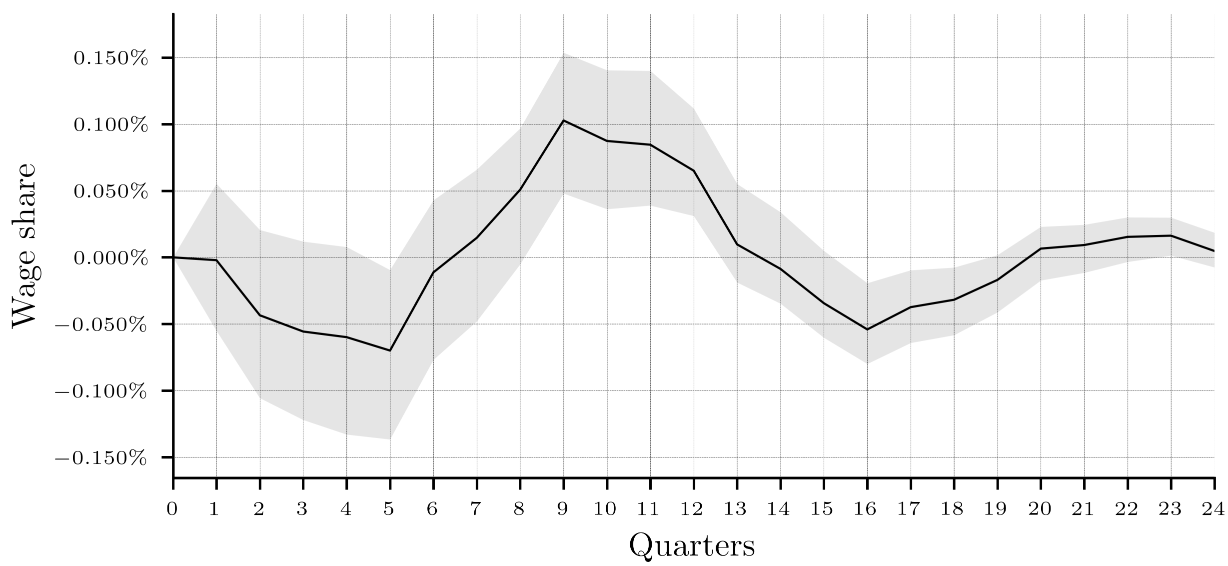

Figure 12: Impulse response function of wage share given a negative unit impulse in work hours, neoclassical specification.

Its important to caution that the cumulative impulse response functions' interpretations are sensitive to how the response variables are defined. Consider the cumulative impulse response function for unemployment:

$$\sum_{k=0}^{t} \frac{\partial \boldsymbol{u_{i,k}}}{\partial \boldsymbol{\varepsilon_{i,0}}} \quad = \quad \sum_{k=0}^{t} \frac{\partial \Delta_4 U_{i,k}}{\partial \boldsymbol{\varepsilon_{i,0}}} \quad = \quad \frac{\partial}{\partial \boldsymbol{\varepsilon_{i,0}}} \sum_{k=0}^{t} \Delta_4 U_{i,k} \tag{23}$$

Where $\Delta_4 = (1 - \mathcal{L}^4)$, and the last step follows from the stability of the reduced form. The final sum is a telescoping sum, which cancels out terms to:

$$\frac{\partial}{\partial \boldsymbol{\varepsilon_{i,0}}} \sum_{k=0}^{t} \Delta_4 U_{i,k} \quad = \quad \frac{\partial}{\partial \boldsymbol{\varepsilon_{i,0}}} \sum_{k=0}^{3} (U_{i,t+k} - U_{i,k}) \tag{24}$$

The final expression should be interpreted as the marginal effect of a structural shock on the difference between the quarterly unemployment rates in the first year and the $\frac{t}{4}$:th yearly period. This interpretation holds in a similar way for average weekly work hours and the wage share.

When considering growth, we cannot utilize the properties of the difference operator in the same way. Instead, we state:

$$\sum_{k=0}^{t} \frac{\partial \boldsymbol{g_{i,k}}}{\partial \boldsymbol{\varepsilon_{i,0}}} = \frac{\partial}{\partial \boldsymbol{\varepsilon_{i,0}}} \sum_{k=0}^{t} \boldsymbol{g_{i,k}}, \tag{25}$$

that is, this cumulative impulse response function should be interpreted as the marginal effect on the sum of growth rates. Because this only gives us the sum over years, it might be interesting to look at the impulse response functions (see Figure 10). The function shows a positive marginal effect during the first two years, negative during the six subsequent quarters, and then only slightly positive, before converging to zero. This is the effect over the business cycle discussed above. See Figure 11 and Figure 12 for unemployment's and wage share's impulse response functions.

To generate a cumulative impulse response function that is easier to interpret, we look at an accumulated year-on-year impulse response function. That is, we want a function where the value at time t gives the accumulated growth with respect to the initial corresponding quarter. We define:

$$\Psi_t = \prod_{i=0}^{\lfloor \frac{t}{4} \rfloor} \theta_{t-4i}, \tag{26}$$

where θ_t is the impulse response function in growth, transformed to decimal from percentages. See Figure 13 for the accumulated year-on-year impulse response function in growth.

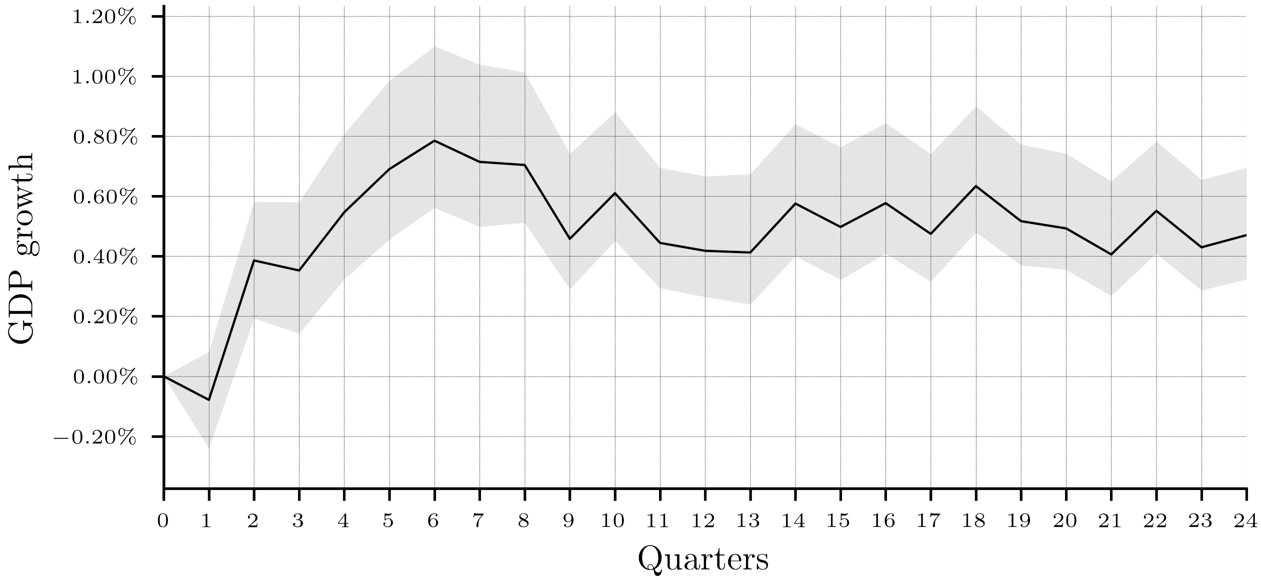

Figure 13: Accumulated impulse response of growth given a negative unit impulse in work hours, neoclassical specification.