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Abstract

Using newly assembled data for 18 advanced economies between 1870 and 2020, I study how monetary policy affects wage inflation and unemployment and document two key findings regarding their tradeoff. First, the wage Phillips curve displays a time-varying slope. Second, the tradeoff becomes weaker in low price inflation environments due to a more pronounced unemployment response to monetary policy. These findings lend support to the idea that monetary policy has state-dependent effects with the central banks' ability in exploring the tradeoff being impaired by a low price inflation environment.

JEL classification: E24, E31, E52, N10.

Keywords: Phillips curve, Phillips multiplier, wage inflation, unemployment, monetary policy, economic history

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The relationship between the slack in the economy or unemployment and inflation was a strong one 50 years ago ... and has gone away. (...) At the end of the day, there has to be a connection because low unemployment will drive wages up. Powell (2019)

1 Introduction

The wage inflation-unemployment tradeoff claims that changes in monetary policy push wage inflation and unemployment in opposite directions (Mankiw 2001). Such relation is traditionally thought of in the form of a Phillips curve and is at the core of monetary policy (Barnichon and Mesters 2020; Eser et al. 2020). Over the last years, many have questioned the importance of the Phillips curve, arguing that it had flattened out of favor. A flatter Phillips curve suggests that economic activity has a smaller effect on inflation. Under this scenario, central bankers' ability to steer inflation with policy-induced changes becomes weaker. Nevertheless, is this weaker wage inflation-unemployment tradeoff unique to the last two decades? Does the strength of the tradeoff vary over time and differ across states of the economy?

In this study, I revisit the historical relationship between wage inflation and unemployment, which is the focus of Phillips' (1958) original work, to answer these two questions. My analysis proceeds in four steps. First, I assemble annual historical data on nominal wages and unemployment rates since 1870 for 18 advanced economies. Second, I uncover considerable variation in the wage Phillips curve slope over time and find that its recent flattening is not a unique feature of the last 150 years. Third, based on carefully identified monetary policy shocks, I show that monetary interventions have large and significant effects on wage inflation and unemployment rates. Finally, I show that changes in the price inflation environment possibly shape the wage inflation-unemployment tradeoff. The data suggest that the tradeoff is weaker in times of low price inflation, which is consistent with the New Keynesian model's predictions (Benati 2007).

I start by reporting time-varying estimates of a micro-founded panel wage Phillips curve, in the spirit of Galí (2011). I provide evidence that the wage Phillips curve has always been "alive and well". Interestingly, similar to the last two decades, it was flatter during the Gold Standard. This novel finding suggests that the recent weakening of the wage inflation-unemployment tradeoff is not a unique feature of the last 20 years. Thus, it is essential to use historical data to better understand what shapes the relationship between these two macroeconomic variables. Furthermore, I find that there is a correlation between periods characterized by a low price inflation and a flatter slope.

These results carry on in a setting without the straitjacket of any assumed functional relation between wage inflation and unemployment. To be precise, I estimate a Phillips multiplier in the spirit of Barnichon and Mesters (2020), which is related to the impulse response-based statistic presented in Galí and Gambetti (2020). The main idea is to trace the evolution over time of the dynamic wage inflation-unemployment multiplier by comparing their impulse response functions to a monetary policy shock. While on impact the multiplier is undetermined, at longer horizons the statistic becomes negative and statistically significant. Such a large negative tradeoff implies that a transitory policy-induced change in unemployment has a persistent effect on wage inflation and therefore, that central banks have sufficient ability to steer inflation with conventional monetary policy tools.

Finally, I test the hypotheses that the tradeoff is different for two different sub-samples and that low price inflation weakens the wage inflation-unemployment tradeoff using a state-dependent local projection instrumental variable approach. Both results support the hypothesis that, at longer horizons, the tradeoff is smaller during periods of low price inflation. Thus, reinforcing the idea that policymakers' ability to explore this tradeoff is impaired in a low inflation environment.

By revisiting the historical relationship between wage inflation and unemployment, this paper aims at contributing to three strands of literature. First, this study adds to the classical literature of the Phillips curve (Phillips 1958). Using long-run data for a panel of 18 countries, I expand the findings of a Phillips curve which is "alive and well" documented not only in the US (Coibion and Gorodnichenko 2015; Blanchard 2016; Höynck 2020; Del Negro et al. 2020; Ascari and Haber 2021; Hazell et al. 2021), but also in Europe (Levy 2019; Onorante et al. 2019; Bonam et al. 2021) and even worldwide (Coibion et al. 2019).[1]

In the current empirical literature, there is a large amount of sampling uncertainty with different researchers using different data vintages to compute Phillips curves (Mavroeidis et al. 2014). This work introduces two newly assembled historical data series on unemployment rates and wages for a set of 18 countries and a clean identification strategy in the hope of taking one step further to an empirical consensus. The use of such a long-run panel is of utmost importance because it allows uncovering the time-varying nature of the tradeoff and whether the inflation environment is indeed a historical driver of the wage inflation-unemployment tradeoff. Moreover, it also allows exploring more variation in wage inflation, thereby reducing the results' sensitivity to the data vintage that arises when using, for example, only one country and recent data. To the best of my knowledge, this is the first paper to bring such a historical perspective to the debate on the wage inflation-unemployment tradeoff. Such an approach keeps up with the recent trend of using long-run and cross-country perspectives to inform central debates in monetary and financial policy as in Reinhart and Rogoff (2009) and Schularick and Taylor (2012).

This work also contributes to the literature about the effects of monetary policy using long run

[1] A good summary of the literature since the inception of the Phillips curve can be found in Gordon (2011), while more recent discussions can be found in Mavroeidis et al. (2014) and Coibion et al. (2018).

panel data (Alpanda et al. 2021; Jordà et al. 2019). By using the trilemma instrumental variable (IV) to identify the effect of monetary policy, I build not only on the seminal work of Di Giovanni et al. (2009) but also on recent studies by Jordà et al. (2019) and Schularick et al. (2021). Moreover, this paper applies the Phillips multiplier statistic which was first presented in the study of Barnichon and Mesters (2020) and applied by Eser et al. (2020), who estimated it respectively for the US and the UK, and the Eurozone. This paper's novelty lies in applying the state-of-art methodology to a historical setting with long run data series that allows testing the response of wage inflation and unemployment rates to a monetary policy surprise, and whether these responses are state-dependent.

Finally, this paper's empirical findings resonate with recent theoretical developments that link the wage inflation-unemployment tradeoff to the level of price inflation. According to the New Keynesian model, an increase (decrease) in trend inflation should cause an increase (decrease) in the frequency of price adjustment, leading to a decrease (increase) in the steepness of the wage Phillips curve (Benati 2007). This rationale that low price inflation weakens the wage inflation-unemployment tradeoff is consistent with two other strands of the literature, namely the state-dependent pricing (Alvarez et al. 2019; Costain et al. 2021) and the nominal price rigidities literatures (Tobin 1972; Benigno and Ricci 2011; Daly and Hobijn 2014).

Since Ball et al. (1988), the empirical literature has not paid enough attention to this low price inflation mechanism. Some notable exceptions are Benati (2007), who documented a positive correlation between the time-varying average gain of real activity and inflation, Vavra (2014), who rejected a New Keynesian Phillips curve with constant inflation output tradeoff in favor of a slope that increases with microeconomic volatility, Gertler and Hofmann (2018), who found a weak money-inflation link in regimes characterized by low inflation, and Ascari and Haber (2021) who provide evidence supporting non-linear effects in the response of the price level depending on the trend inflation regime, though using only aggregate US data. I complement these findings by showing a negative and strong historical correlation between a time-varying Phillips curve and price inflation, and also by estimating a weaker wage inflation-unemployment tradeoff in times of low price inflation due to a weaker response of wage inflation to monetary policy.

The remainder of this paper is structured as follows. Section 2 introduces the data and presents the descriptive statistics. Section 3 describes the empirical strategy. The results are presented in Section 4, and Section 5 concludes.

2 Data and Descriptive Statistics

2.1 Data

I construct a new historical dataset composed of wage inflation and unemployment rates series that go as far as the nineteenth century in order to uncover the historical tradeoff between wage inflation and unemployment. The newly assembled yearly data include a wage index measure and the unemployment rate for 18 advanced economies — Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The sample spans from 1870 to 2020 and draws on more than 60 different sources.[2] Before the Bretton Woods epoch, available data is mostly at an annual frequency for both variables, so using panel data to study the wage inflation-unemployment tradeoff is of paramount importance. With the exception of wage inflation and unemployment, the macroeconomic data series used in this paper, such as price inflation, come from the Macrohistory Database (Jordà et al. 2017).

When possible, the *unemployment rate* is defined as the percentage of unemployed in the total labor force. According to Rasmussen and Pontusson (2018), most countries had no unemployment insurance system until after the World Wars. Hence, citizens without a job had little incentive to enroll in a labor bureau since there was no compulsory unemployment insurance.

The earlier data, which comes mainly from Mitchell (2013), Tabin and Togni (2013), Maddison (1982), and Galenson and Zellner (1957), build upon the previous caveat and present unemployment rates within smaller subsets of the active population such as trade unions or within people insured against unemployment. The underlying assumption is that the unemployment growth rates within smaller subsets of the active population are the same (or at least, highly correlated) as the national unemployment growth rate.

The most recent data follows the preferred definition and is based on either the Current Population Survey or the EU Labour force survey from the International Labour Organization (ILOSTAT). As a complement, data from the National Statistics agencies ensure the robustness of the series.

When possible, the *wage* series are an index of the average earnings of all employees. However, the earlier data may build upon series of specific sectors according to their availability. I construct this nominal index using old publications of statistical offices, financial history books, and articles. The most recent data is based on the International Monetary Fund (IMF) wage index series and the Organization for Economic Cooperation and Development (OECD).

An important caveat should be

[2]Table A.1 in the online Appendix summarizes the data coverage by country. All data sources and further description of their construction are provided in the online Data Appendix.

2.2 Descriptive Statistics

Table 1 lists selected summary statistics of the dataset for the entire sample and five separate periods. Both wage and price inflation series are computed as growth rates of nominal indices. The average wage inflation rate for the entire sample is 5.05%, almost two percentage points above the average price inflation. On average, the unemployment rate throughout the sample is 5.65%.

Table 1: Descriptive statistics

	N	Mean	Std. Dev.	Min	Max
1870-1913					
Unemployment rate	223	4.08	2.75	0.20	18.40
Wage inflation	223	1.68	2.63	-6.71	10.26
Price inflation	223	0.39	3.21	-10.94	11.56
1920-1938					
Unemployment rate	268	7.17	4.99	0.60	24.90
Wage inflation	268	1.26	8.63	-27.72	43.97
Price inflation	268	-0.29	7.23	-18.45	30.43
1946-1971					
Unemployment rate	428	2.60	1.83	0.04	9.92
Wage inflation	428	7.77	5.10	-10.78	35.29
Price inflation	428	4.08	3.76	-6.87	20.38
1972-1999					
Unemployment rate	504	7.07	4.30	0.04	24.21
Wage inflation	504	8.30	6.27	-1.42	32.28
Price inflation	504	6.56	5.51	-0.71	37.88
2000-2020					
Unemployment rate	377	7.05	3.52	2.00	26.09
Wage inflation	377	2.32	1.84	-6.14	7.50
Price inflation	377	1.63	1.28	-4.48	5.57
Total					
Unemployment rate	1800	5.65	4.12	0.04	26.09
Wage inflation	1800	5.05	6.29	-27.72	43.97
Price inflation	1800	3.16	5.28	-18.45	37.88

Notes: All statistics are expressed in percent. The war periods (1914-1919 and 1939-1945) and the German hyperinflation episode (1920-1925) are not included. This table only uses *unweighted* country-year observations for which there is data for the unemployment rate, and price and wage inflation. Table A.2 presents descriptive statistics for the unrestricted sample.

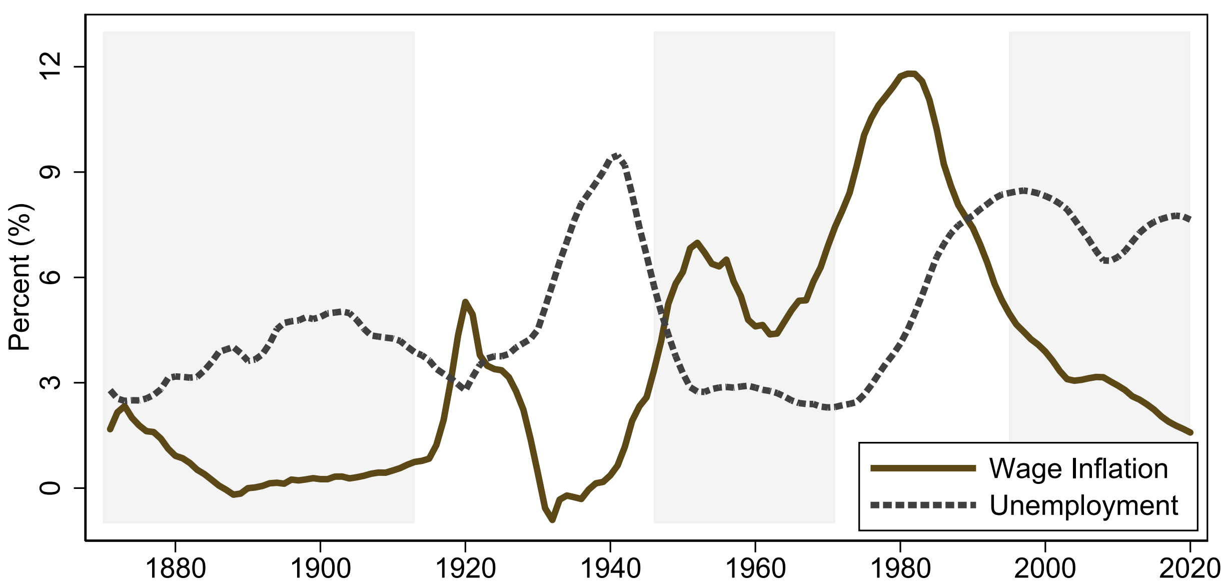
In the wake of the Great Recession, it was surprising to observe how stable and low the inflation rates were (Miles et al. 2017). In fact, to observe such a pattern, one has to go back more than 100 years when most of the studied countries were part of the Gold Standard agreement.

Moreover, although only 8 out of the 18 countries in the sample are explicit inflation targeters

(Svensson 2010), Table 1 indicates that using price inflation as the nominal anchor instead of the price of gold makes the volatility of price and wage inflation smaller albeit the higher means.[3] Hence, the inflation targeting regime successfully keeps inflation under control with the lowest volatility ever observed.

In addition, Figure 1 summarizes the data's cross-country trends by plotting a time-varying estimate of the mean wage inflation and the mean unemployment rate for the 18 countries using a 10-year rolling window. We observe stable wage inflation and unemployment series during the Gold Standard epoch, until 1913. That picture dramatically changes once we enter the war period with a large swing in the inflation series. The period from 1946 to 1971 corresponds to the Bretton Woods epoch and shows persistently low unemployment and high wage inflation rates. Then, after 1972, we can observe a peak for the inflation series, partly driven by the two oil price shocks in 1973 and 1979. This peak is followed by a general decrease in inflation and an increase in unemployment stemming from the Great Moderation period.

Figure 1: Mean wage inflation and unemployment rate



Notes: This figure plots a time-varying estimate of the mean wage inflation (solid line) and mean unemployment rate (dashed line) using a 10-year rolling window and the full matched sample.

Summing up, Figure 1 points to a strong negative co-movement between the two variables, which is also corroborated at the country level (see Table A.4 in the Appendix). Nevertheless, during the Gold Standard and the last twenty years, wage inflation and unemployment series were

[3]The higher means should come without surprise given that targeting the price of gold implicitly yields a zero inflation expectation, contrary to a 2% inflation target.

more stable, suggesting a weaker co-movement and thus, unveiling a potentially time-varying wage inflation-unemployment tradeoff.

2.3 Historical Wage Phillips Curves

To give more structure to the previous exploratory analysis, I turn my attention to the wage Phillips curve across historical periods. I depart from the wage Phillips curve derived from the micro-founded New Keynesian model presented in Galí (2011) and estimate the following equation:

$$\pi^w_{c,t} = \mu_c + \varphi u_{c,t} + \gamma \pi^p_{c,t-1} + \epsilon_{c,t} \tag{1}$$

where $\pi^w_{c,t}$ denotes the annual wage inflation in country c at time t; α is a constant; $u_{c,t}$ denotes the unemployment rate in country c at time t; $\pi^p_{c,t-1}$ is the lagged price inflation, the measure by which wages are indexed; and $\epsilon_{c,t}$ is an error term proxying for time-varying cost-push shocks to wages.[4] The twist of exploring the Phillips curve using a panel approach has been recently explored by Coibion et al. (2019), Levy (2019), De Schryder et al. (2020), and Hazell et al. (2021) at both national and regional levels. Following the empirical literature, I include time-invariant country fixed effects μ_c.

Here, I implicitly assume that, when there is no reoptimization, wages are indexed to ($\pi^p_{c,t-1}$), where γ represents the degree of indexation on past price inflation.[5] Given an increase in the price level in $t-1$, workers bargain for a higher wage in t due to an increase in the cost of living in $t-1$.[6]

Figure 2 shows the time-varying estimates of its slope (φ) based on the Panel-OLS regression of Equation (1) using a 20-year rolling window. The estimates support the *low inflation hypothesis* which proposes that the slope of the wage Phillips curve is significantly flatter following periods of low price inflation.

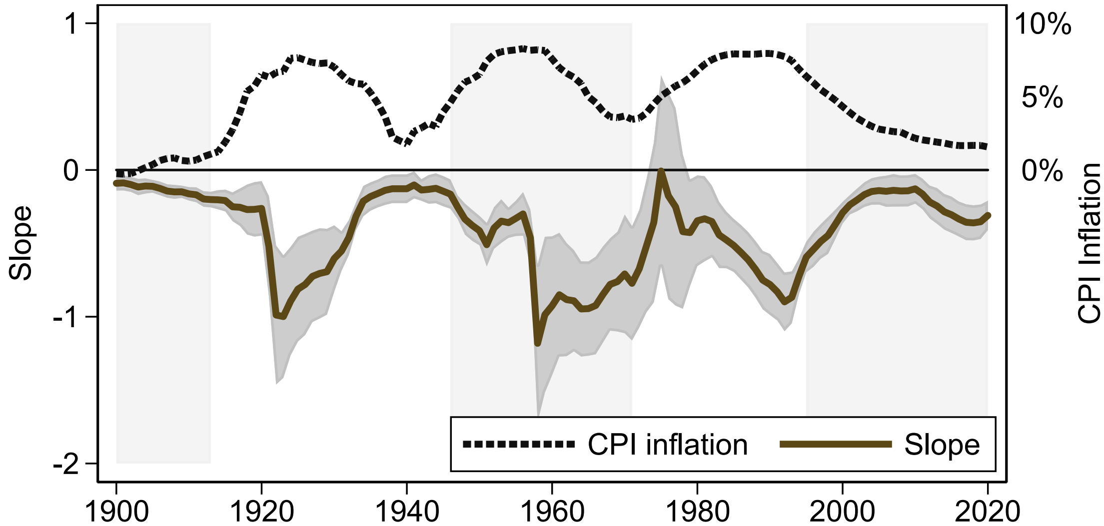
There are three key features from Figure 2 which deserve to be highlighted. First, it displays the consecutive steepening and flattening of the wage Phillips curve after the end of the Bretton Woods agreement. This pattern is already well documented, especially for the US (Ball and Mazumder 2011; Blanchard et al. 2015; Blanchard 2016; Galí and Gambetti 2020) and Europe

[4]The majority of the literature argues for the use of the unemployment gap instead of its level. However, that approach ignores the problem of measurement error arising from the computation of a natural unemployment rate. In my setting, due to the use of historical data, I believe that the latter poses a bigger threat because it is not possible to use detailed data to get the best estimates of the natural unemployment rate.

[5]Another possible interpretation is that firms look at the previous period price inflation as a good measure of inflation expectations, which then affects their decision in changing both their products' prices and workers' wages.

[6]Table A.3 in the online Appendix corroborates this idea by displaying a correlation between price inflation in $t-1$ and wage inflation in t of more than 0.5 for almost every country.

Figure 2: Panel-OLS 20-year Rolling Window



Notes: This figure plots a time-varying estimate of the slope of the wage Phillips curve (parameter φ, in Equation (1)), using OLS and annual data from 1870 to 2020 for all 18 countries. It is computed based on a rolling OLS regression using a 20-year window and displays a 90% confidence band. In Appendix, Figure A.1 shows the estimate for the persistence coefficient (γ) while Figure A.2 presents the same regression when adding year fixed effects.

(Bonam et al. 2021). However, the fact that I am using a panel of 18 advanced economies to perform this analysis might indicate that this flattening could be considered a global phenomenon.

Second, the wage Phillips curve was also flatter during the Gold Standard period and the beginning of the Bretton Woods epoch. This novel finding suggests that the recent weakening of the wage inflation-unemployment tradeoff is not a unique feature of the last 20 years.

Third, it seems that during periods of low price inflation, the slope of the wage Phillips curve becomes flatter. One potential explanation for this correlation is the *low inflation hypothesis* which will be tested in Section 4. During the majority of the three periods shaded in gray, inflation was strongly anchored either to the price of gold or to a composite price measure (CPI), and thus, countries experienced a persistent low price inflation environment (as we saw in Table 1). Consequently, firms adjusted prices and wages less often (Gagnon 2009; Nakamura et al. 2018; Alvarez et al. 2019) and promoted a disconnect between wage inflation and movements in the labor market.

A major element of modern Phillips curve estimations are *inflation expectations*. Hazell et al. (2021) show that not accounting for the decline in long-run inflation expectations during the Volcker disinflation may introduce an upward bias in estimates of the slope of the United States (price) Phillips curve during that period. Taking this into account might question the use of Galí (2011) framework that may be overly restrictive on the nonexistent role of inflation expectations.

Moreover, even though this work focuses only on the relationship between wage inflation and unemployment, it is still important to acknowledge that there is a strong correlation between price and wage inflation (Table A.4) and therefore it might be important to have this issue into account. While the absence of historical data on inflation expectations makes it impossible to add it as a control variable, I collect OECD data on inflation forecast starting in the 1990s for the European countries and starting in the 1960s for the remaining ones to 2020 and run the same analysis for this sub-sample.

Empirically, Ciccarelli and Mojon (2010) have estimated a common factor in countries' price inflation that accounts for nearly 70% of their variance. They include 22 OECD countries in their sample - the 18 countries in my sample plus Austria, Greece, Luxembourg, and New Zealand - from 1960 to 2008. With this in mind, it seems worthwhile to include time fixed effects as a way to control not only for the dynamics of global inflation but also to control for the common component (across countries) of inflation expectations.

Figure A.2 in appendix thus presents the estimates when including year fixed effects or inflation forecast from OECD. It is important to emphasize the difference in the slope estimates from 1990 to 2000 might be due to differences in the sample as most European countries only have expectations data starting in 1991. Not surprisingly, the confidence bands become wider. Notwithstanding, the three key features highlighted before are shown to be robust.

This Section thus provides sufficient and robust *motivation* to explore the time-varying trade-off between wage inflation and unemployment in more detail while using a more appropriate econometric method.

3 Empirical Strategy

The literature has extensively documented the empirical challenges in estimating both the price and wage Phillips curves (Galí 2011; Mavroeidis et al. 2014; McLeay and Tenreyro 2020) and, more generally, the wage inflation-unemployment tradeoff which is at the center of this work (Barnichon and Mesters 2020; Galí and Gambetti 2020). The main concern is the simultaneity bias arising from the correlation between the measures of economic slack and inflation with the error term. Departing from an AS-AD model framework, cost-push shocks might affect both the dependent and independent variables. These might be either shocks to input prices such as imported goods, oil and other important commodities, or input quantities such as a freeze in raw materials production or even wars which drain the labor force.

McLeay and Tenreyro (2020) made the case that the empirical disconnect between inflation and economic slack is expected to be emphasized when monetary policy is set optimally. Even absent of supply shocks, a purely inflation targeting central bank would neutralize any aggregate demand fluctuations to achieve constant inflation at its target. Hence, inducing a negative correlation between price inflation and economic slack and making it harder to uncover the true relationship between them. It is worth noting, however, that the wage inflation-unemployment tradeoff is less prone to this later criticism because many central banks do not explicitly target the unemployment rate. This observation is undeniably true for the majority of the sample in this study in which only two central banks (United States and Australia) started targeting unemployment in recent decades.

Acknowledging these issues, I use monetary policy shocks to identify the wage inflation-unemployment tradeoff in the same spirit as Jordà and Nechio (2020). To be precise, I apply the trilemma IV, strategy pioneered by Di Giovanni et al. (2009) and recently applied by Jordà et al. (2019) and Schularick et al. (2021). This allows taking advantage of the fact that economies with fixed exchange rates and under perfect capital mobility are unable to implement independent monetary policies.

When a country pegs its exchange rate, its interest rate from then on has to closely follow that of the base country; otherwise, there will be unsustainable capital outflows. Moreover, since changes in the base country's interest rate are mainly determined by the base country's economic conditions, their variation is exogenous to the economic conditions in the pegged countries. Notwithstanding, in order to isolate unpredictable movements in the base country's interest rates Δr_b, I also subtract the predicted changes in the base country's interest rate $\Delta \hat{r}_b$.[7]

The trilemma IV, $z_{c,t}$, for local policy rate changes, $\Delta r_{c,t}$, can only be computed when a country's exchange rate is fixed with respect to a base country b and is thus defined as follows:

$$z_{c,t} \equiv (\Delta r_{b(c,t),t} - \Delta \hat{r}_{b(c,t),t}) \times k_{c,t} \tag{2}$$

where c and t are the country and year indices, respectively; $b(c,t)$ denotes country c's base country in year t; $\Delta r_{b(c,t),t} - \Delta \hat{r}_{b(c,t),t}$ can be interpreted as a Taylor residual of the base country $b(c,t)$; and $k_{c,t}$ is the degree of capital openness from Quinn et al. (2011), this index ranges from 0 to 1, with 0 indicating a low degree and 1 a high degree of capital mobility. Both studies by Jordà et al. (2019) and Schularick et al. (2021) show that the trilemma IV is relevant due to its strong relation with changes in pegs' domestic short-term interest rates. In my sample, the instrument exhibits a statistically significant coefficient of 0.65 over the full sample (SE $= 0.08$) and for both the pre- and post-World War II periods, with the slope coefficients being approximately 0.64 (SE $= 0.15$) and 0.65 (SE$= 0.09$), respectively (see Table A.5 in the Appendix for more details).

Another main challenge that persists even after correcting for endogeneity is specification

[7] To predict $\Delta \hat{r}_b$, I follow Jordà et al. (2019) and use the first lags of the growth rates of GDP, consumption, investment, stock prices, and credit (all CPI deflated), as well as changes in nominal long-term interest rates, nominal short-term interest rates, the CPI inflation rate, and the current account-to-GDP ratio.

uncertainty. One can think of estimating a non-parametric version of the Phillips curve without the straitjacket of any ad-hoc functional relation between inflation and economic slack (Galí and Gambetti 2020). Inspired by the fiscal multiplier literature (Ramey and Zubairy 2018), Barnichon and Mesters (2020) proposed estimating a Phillips multiplier defined as the expected cumulative change in inflation caused by a demand shock that affects expected cumulative unemployment. This statistic directly captures the central bank's inflation-unemployment tradeoff across different horizons, which is consistent with the definition of Mankiw (2001).

In the following section, I start by tracing the effect of a one percentage point surprise increase in policy rates on average wage inflation and average unemployment rate. To be precise, I estimate impulse response functions (IRFs) by making use of a panel local projections instrumental variable (Panel LP-IV) approach (Jordà 2005; Stock and Watson 2018) as follows:

$$\bar{X}_{c,t:t+h} = \alpha^X_{c,h} + \beta^X_h z_{c,t} + \zeta^X_h W_{c,t} + e^X_{c,t+h} \tag{3}$$

where $\bar{X}_{c,t:t+h} \equiv \frac{1}{h}\sum_{j=0}^{h} X_{c,t+j}$ is either the average value of wage inflation or the unemployment rate over $[t, t+h]$, $\alpha^X_{c,h}$ denotes country fixed effects, $z_{c,t}$ is the trilemma IV as introduced in Equation (2), and $W_{c,t}$ is a vector of controls including the world GDP growth and two lags of wage inflation and unemployment.[8] To remove potential extreme values, throughout the analysis I remove the war periods and observations for which yearly wage inflation is above 50%.[9]

Building on these IRFs, I estimate the Phillips multiplier as in Barnichon and Mesters (2020). The Phillips multiplier ($\mathcal{P}_h$) can be estimated using a Panel LP-IV approach from the following cumulative regression:

$$\sum_{j=0}^{h} \pi^w_{c,t+j} = \alpha_{c,h} + \mathcal{P}_h \sum_{j=0}^{h} \hat{u}_{c,t+j} + \zeta_h \mathbf{W}_{c,t} + \epsilon_{c,t+h} \tag{4}$$

where $\alpha_{c,h}$ denotes country fixed effects; $\mathbf{W}_{c,t}$ is the same vector of control variables as in Equation (3); and $\sum_{j=0}^{h} \hat{u}_{c,t+j}$ is instrumented by the trilemma IV, $z_{c,t}$, the exogenous changes in the short-term interest rate in country c. These monetary shocks are orthogonal to supply shocks and to the natural unemployment rate under the common assumption that monetary policy is neutral under flexible prices (Galí 2015). Through this IV approach, the Phillips multiplier allows estimating the tradeoff without bias from confounding supply shocks and without the need to measure the natural unemployment rate.

Intuitively, the Phillips multiplier, $\mathcal{P}_h$, measures the impact of a policy that induces 1 percentage point increase in unemployment on cumulative wage inflation. A negative multiplier

[8]Please note for later reference that I include a global real GDP growth variable to parsimoniously remove global business cycle effects as including time-fixed effects would require over a hundred additional parameter estimates.

[9]Alternatively, I trimmed the first and last percentiles of wage inflation and results go through.

($\mathcal{P}_h < 0$) indicates that a transitory increase in unemployment yields a persistent wage inflation decrease. In other words, central banks can trigger a persistent change in wage inflation at a finite unemployment cost through a transitory increase in their policy interest rates, which is exactly the type of tradeoff monetary policymakers want to explore.

The impulse response functions from Equation (3) are estimated in such a way that we can obtain the Phillips multiplier directly from $\mathcal{P}_h \equiv \frac{\beta_h^{\pi^w}}{\beta_h^u}$. The advantage of doing the one-step estimation of the Phillips multiplier in Equation (4) is to directly obtain the correct confidence bands. Nevertheless, the two-step estimation is consistent once the samples are matched (Ramey and Zubairy 2018).

4 Results

Can central banks "transform" unemployment into inflation (and vice-versa) through their policy interest rates? And, if so, is this tradeoff time-varying and undermined by a low price inflation environment? This section presents the answers provided by the empirical results. I begin by reporting that the central bank's ability to control inflation depends on the unemployment cost of reducing inflation and that its ability is high when considering the full sample. In a second step, I uncover that this ability is impaired when the economy is in a low price inflation environment displaying a different multiplier for two different sub-samples.

4.1 Phillips multiplier

Figure 3 displays my estimate for the Phillips multiplier over a 10-year horizon (Figure 3a), its F-statistic (Figure 3b), and the underlying impulse responses for the average unemployment rate and average wage inflation (Figure 3c). The statistic is initially undetermined, decreasing over the horizon and becomes significantly negative after 5 years, diverging further on. A 1 percentage point (p.p.) policy-induced increase in cumulative unemployment leads to a 1.4 p.p. decrease in cumulative wage inflation 10 years after the shock.[10]

As Barnichon and Mesters (2020) noted, a large tradeoff in the longer-run implies that a transitory policy-induced change in unemployment has a persistent effect on wage inflation. Hence, Figure 3a suggests that, over the last 170 years, central banks had sufficient ability to steer inflation.

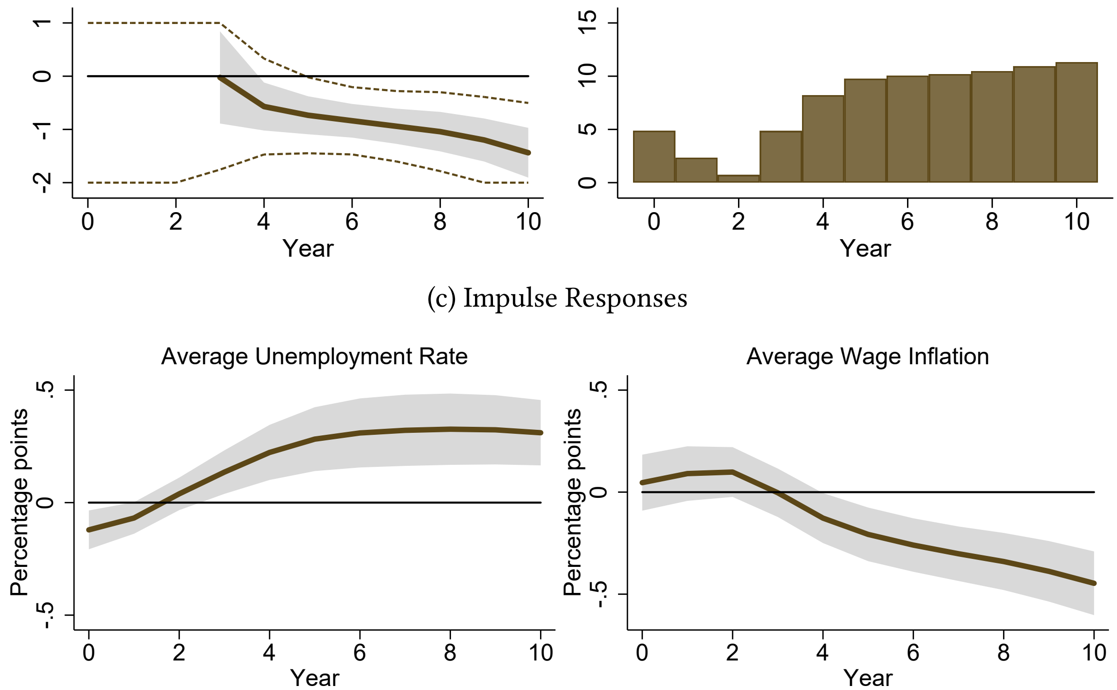
Figure 3b reports the Olea and Pflueger (2013) F-statistics from the first-stage regression of Equation (4) and documents that monetary policy shocks are correlated with cumulative unem-

[10]In the short-term, the multiplier cannot be interpreted because the value of one of the impulse responses is very close to zero. The uncertainty in the estimation is in line with what Barnichon and Mesters (2020) also report.

Figure 3: Phillips multiplier and IRFs

(a) Phillips multiplier (b) F-Statistic

(c) Impulse Responses



Notes: Phillips multiplier estimations using the trilemma IV as instrument, using a matched sample of approximately 1000 observations, and controlling for two lags of unemployment and wage inflation, country fixed effects, and world GDP growth as explained in Equation (4). For the multiplier (upper-left), the shaded area corresponds to the 90% confidence interval implied by the normal limiting distribution of the 2SLS estimator, while the dashed lines correspond to the two-sided 90% Anderson-Rubin confidence sets robust to weak instruments. The F-statistics (upper-right) are computed using the method presented in Olea and Pflueger (2013). The impulse responses (bottom panels) for *average* wage inflation and *average* unemployment are obtained from the OLS regressions (3) and display 90% confidence sets. Impulse responses for non-averaged cumulative unemployment and wage inflation can be found in Figure A.3.

ployment. Since the F-statistic estimates are not above the threshold of Olea and Pflueger (2013) but are still above 5 for most periods, I rely on weak instrument robust methods to compute the confidence bands of the Phillips multiplier. I compute 90% Anderson and Rubin (1949) confidence bands that are robust to weak instruments and display them in dashed lines in Figure 3a.[11]

Figure 3c decomposes the Phillips multiplier into the response of both the average wage inflation and average unemployment rate to a monetary policy surprise. While the average unemployment response starts mean-reverting after horizon $t = 5$, the average wage inflation cumulative response decreases persistently. This implies that after the shock, the Phillips multiplier keeps decreasing over time and there is an exploitable tradeoff between unemployment and wage in-

[11]While the asymptotic distribution of the AR statistic does not depend on the strength of the instrument, the confidence bands of the Phillips multiplier will be larger when the instrument is weaker.

flation.

4.2 The Phillips multiplier is different across sub-samples

Building on the previous Phillips multiplier analysis, I can test whether the wage inflation-unemployment tradeoff is different across different sub-samples. The baseline specification is thus augmented to include an interaction term. Therefore, in the reamining exercises I estimate a state-dependent Phillips multiplier as follows:

$$\begin{aligned}\sum_{j=0}^{h} \pi^{w}_{c,t+j} =& \mathcal{I}_{c,t}\left[\alpha^{(\mathcal{I})}_{c,h} + \mathcal{P}^{(\mathcal{I})}_{h}\sum_{j=0}^{h}\hat{u}_{c,t+j} + \zeta^{(\mathcal{I})}_{h}\mathbf{W}_{c,t}\right] \\ &+ (1-\mathcal{I}_{c,t})\left[\alpha^{(1-\mathcal{I})}_{c,h} + \mathcal{P}^{(1-\mathcal{I})}_{h}\sum_{j=0}^{h}\hat{u}_{c,t+j} + \zeta^{(1-\mathcal{I})}_{h}\mathbf{W}_{c,t}\right] + \epsilon_{c,t+h}\end{aligned} \tag{5}$$

where $\mathcal{I}_{c,t}$ is the indicator variable different for each sub-sample analysis. This exercise allows comparing the evolution of the Phillips multiplier in each sub-sample and directly test whether $\mathcal{P}^{(\mathcal{I})}_{h} = \mathcal{P}^{(1-\mathcal{I})}_{h}$.

4.2.1 The Phillips multiplier is smaller during the Gold Standard and the last 20 years

Motivated by Figure 2, I now test in a more robust empirical setting whether the wage inflation-unemployment tradeoff is different across sub-samples. To be precise, I am going to aggregate the years where inflation was more credibly anchored - the last 20 years (2000-2020) and the Gold Standard epoch (1870-1913) - and compare them against the post-war period (1946-1999) leaving the between-war period (1920-1938) out of this analysis.

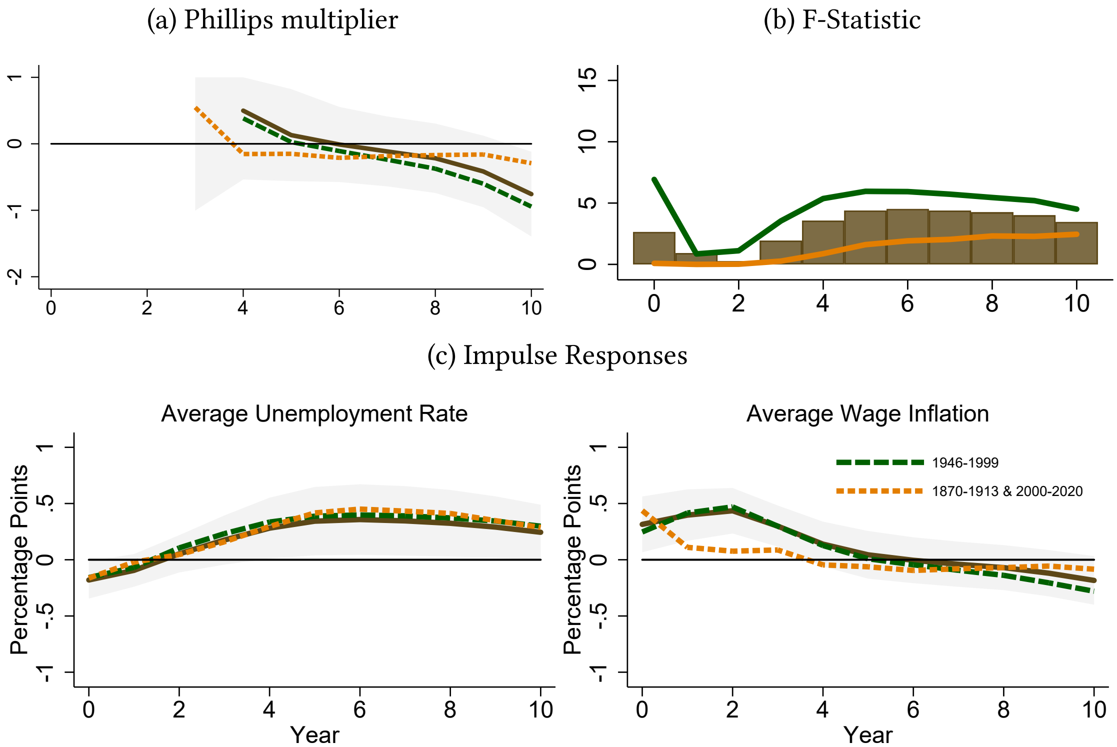
Therefore, I estimate equation 5 where $\mathcal{I}_{c,t}$ is an indicator of the post-war period defined as a dummy variable, which is equal to 1 for the years between 1946 and 1999 and equal to 0 for the years where inflation was more credibly anchored. This exercise allows comparing the evolution of the Phillips multiplier in these sub-samples and directly test whether $\mathcal{P}^{(\mathcal{I})}_{h} = \mathcal{P}^{(1-\mathcal{I})}_{h}$.

Figure 4 displays the estimates of both the baseline and state-dependent Phillips multipliers over a 10-year horizon (Figure 4a), their F-statistics (Figure 4b), and their underlying impulse responses (Figure 4c) in the historical sub-samples.

Figure 4a displays a bigger Phillips multiplier for the post-war period. Its difference becomes statistically significant from horizon $t = 7$ onward with the weak instrument robust Anderson-Rubin p-values being 0.031, 0.019, 0.025, and 0.089 for horizons 7, 8, 9, and 10 respectively.[12] This

[12] See Table A.6 in the Appendix for a more detailed description of this result.

Figure 4: State-Dependent Phillips multiplier and IRFs



Notes: Phillips multiplier estimated using the trilemma IV as instrument according to Equation (4). For the multiplier (upper-left), the shaded area corresponds to the 90% confidence interval implied by the normal limiting distribution of the 2SLS estimator. The F-statistics (upper-right) are computed as discussed in Olea and Pflueger (2013). The impulse responses (bottom panels) for *average* wage inflation and unemployment are obtained from the OLS regressions (3) and display 90% confidence sets. Across all figures, one can distinguish the state by its color and shape, short-dashed orange shape for the period with more credible anchored inflation (1870-1913 & 2000-2020) and long-dashed green shape for the post-war period (1946-1999).

result is in line with the idea put forward by Figure 2 in which we see that the correlation between unemployment and wage inflation is weaker in the last 20 years and during the Gold Standard.

Figure 4c indicates that the wage inflation response is the main driver of the weaker tradeoff in the credible inflation anchor periods. Although the average unemployment rate response is virtually identical in both the baseline and the state dependencies for longer horizons, the average wage inflation response is muted for longer horizons.

4.2.2 The Phillips multiplier is smaller in a low inflation environment

Research on the wage inflation-unemployment tradeoff, traditionally inferred from a Phillips curve, pointed to the hypothesis that an increase (decrease) in trend inflation should lead to an increase (decrease) in the frequency of price adjustment, thereby decreasing (increasing) the steepness of the wage Phillips curve (Benati 2007).

In this exercise, I test whether the wage inflation-unemployment tradeoff is shaped by a low price inflation environment. Therefore, I estimate equation 5 where $\mathcal{I}_{c,t}$ is an indicator of low price inflation defined as a dummy variable, which is equal to one for periods when countries experienced lagged price inflation below the threshold of 2% and above -2% ($\mathcal{I}_{i,t} = 1 \text{ if } -2\% < \pi^p_{i,t-1} < 2\%$) and equal to 0 when countries experienced high price inflation ($\mathcal{I}_{i,t} = 0 \text{ if } 2\% \leq \pi^p_{i,t-1} < 40\%$). This exercise allows comparing the evolution of the Phillips multiplier in times of low versus high price changes and directly test whether $\mathcal{P}_h^{(\mathcal{I})} = \mathcal{P}_h^{(1-\mathcal{I})}$.

The choice of the 2% threshold can be rationalized by the inflation target strategy of many of the central banks present in the analyzed sample. Over the last 20 years of the sample, most central banks were targeting inflation either implicitly or explicitly. Most of them disclaimed that their goal was to achieve inflation close to or even below 2%. With such division of the sample, I assign 64% of the sample to a high-inflation state and 31% to the low-inflation state while the remaining 5% of the sample is left out of this sub-sample analysis.

Figure 5 displays the estimates of both the baseline and state-dependent Phillips multipliers over a 10-year horizon (Figure 5a), their F-statistics (Figure 5b), and their underlying impulse responses (Figure 5c) in periods of high and low price inflation.

Figure 5a displays a smaller Phillips multiplier in times of low inflation and a higher multiplier in times of high inflation. Its difference becomes statistically significant from horizon $t = 8$ onward with the weak instrument robust Anderson-Rubin p-values being 0.069, 0.072, and 0.061 for horizons 8, 9, and 10 respectively.[13] This result is in line with recent work by Forbes et al. (2021) who show that the Phillips curve becomes non-linear when inflation is low.

Figure 5c indicates that the unemployment rate response is the main driver of the weaker tradeoff in low inflation periods. Although the average wage inflation response is virtually identical in both the baseline and the state dependencies for longer horizons, the average unemployment rate response is much more pronounced during low inflation periods. As a robustness check, I also used an unmatched sample and a longer horizon (see Figure A.4 and Table A.8 in the Appendix). Regardless of the sample trimming process or the horizon chosen, the results do not qualitatively change.

These two exercises together lend empirical substance to the concern that monetary policy effects are time-variant and state-dependent. In particular, during periods of low price inflation, the long-run tradeoff between wage inflation and unemployment is less exploitable. In other words, given the weaker tradeoff, central banks are less able to steer wage inflation when facing a low price inflation environment.

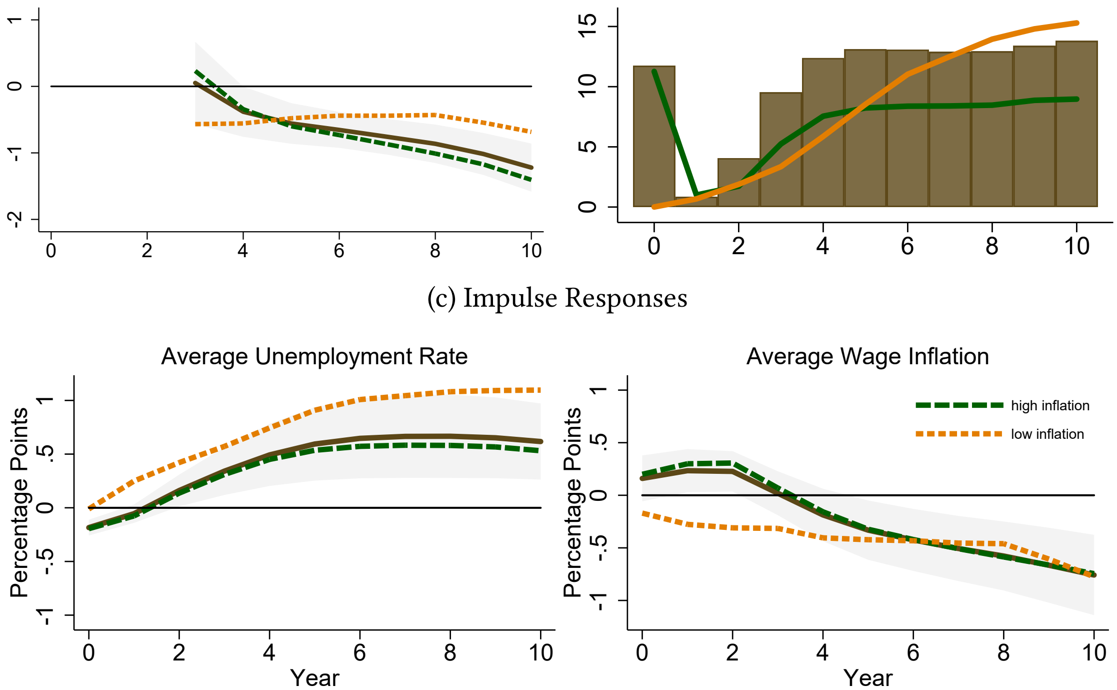
[13]See Table A.7 in the Appendix for a more detailed description of this result.

Figure 5: State-Dependent Phillips multiplier and IRFs

(a) Phillips multiplier

(b) F-Statistic

(c) Impulse Responses



Notes: Phillips multiplier estimated using the trilemma IV as instrument according to Equation (4). For the multiplier (upper-left), the shaded area corresponds to the 90% confidence interval implied by the normal limiting distribution of the 2SLS estimator. The F-statistics (upper-right) are computed as discussed in Olea and Pflueger (2013). The impulse responses (bottom panels) for *average* wage inflation and unemployment are obtained from the OLS regressions (3) and display 90% confidence sets. Across all figures, one can distinguish the state by its color and shape, short-dashed orange shape for low inflation and long-dashed green shape for high inflation.

5 Conclusion

The wage inflation-unemployment tradeoff is a key building block for monetary policy. However, its existence has been questioned with some commentators arguing that it has flattened out of favor. This paper introduces newly assembled data on wages and unemployment rates for a set of 18 advanced economies starting in 1870, in order to revisit the historical relationship between wage inflation and unemployment, the focus of Phillips' (1958) original work. The empirical analysis starts by uncovering a historical time-varying Phillips correlation. This paper documents a weaker correlation between wage inflation and unemployment during the Gold Standard and the last 20 years, periods characterized by credibly anchored inflation expectations and a low price inflation environment.

I capitalize on the assembled historical data to study a factor that is possibly driving this time-varying pattern. First, in order to account for the possible endogeneity and model misspecification issues arising from the Phillips curve framework, I make use of monetary policy shocks and the Phillips multiplier framework to identify the historical wage inflation-unemployment tradeoff. The results provide evidence in favor of the hypothesis that the observed time-variation pattern is due to the price inflation environment: the tradeoff is weaker in periods of low price inflation.

These results add a new perspective to the current debate about the existence of the wage inflation-unemployment tradeoff and its state dependency. In particular, this paper's empirical evidence points to an impaired ability in exploring the tradeoff in times of low inflation driven by a muted wage inflation response to a monetary policy surprise. Such a finding uncovers a hidden dichotomy: central banks cannot simultaneously target a low price inflation (2%) and expect conventional monetary policy tools to work to their full extent.

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Monetary Policy and the Wage Inflation-Unemployment Tradeoff

Online Appendix

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Appendix A Supporting tables and figures

Table A.1: Data Coverage

Country	Wages	Unemployment	Inflation Forecast	CB Foundation
Australia	1870-2020	1901-2020	1961-2020	1911
Belgium	1870-2020	1921-2020	1992-2020	1850
Canada	1870-2020	1916-2020	1993-2020	1934
Denmark	1870-2020	1874-2020	1968-2020	1818
Finland	1870-2020	1920-2020	1991-2020	1811
France	1870-2020	1895-2020	1991-2020	1800
Germany	1870-2020	1887-2020	1996-2020	1876
Ireland	1943-2020	1960-2020	1996-2020	1943
Italy	1871-2020	1919-2020	1991-2020	1893
Japan	1870-2020	1930-2020	1961-2020	1882
Netherlands	1870-2020	1870-2020	1991-2020	1814
Norway	1870-2020	1904-2020	1961-2020	1816
Portugal	1870-2020	1953-2020	1991-2020	1846
Spain	1870-2020	1933-2020	1993-2020	1874
Sweden	1870-2020	1911-2020	1963-2020	1668
Switzerland	1870-2020	1913-2020	1963-2020	1907
United Kingdom	1870-2020	1870-2019	1991-2020	1694
United States	1870-2020	1890-2020	1961-2020	1913

Notes: This Table shows the earliest and the latest data point for each country's series: the wages nominal index and the unemployment rate. There are gaps in the unemployment rate data which mostly correspond to the war periods, for more information on the gaps and the sources please consult the Data Appendix. Data from inflation forecast comes from the OECD. All central bank foundations dates came from the central banks' websites.

Table A.2: Descriptive statistics - full sample

	N	Mean	Std. Dev.	Min	Max
1870-1913					
Unemployment rate	225	4.08	2.73	0.20	18.40
Wage inflation	730	1.81	4.23	-24.64	23.80
Price inflation	731	0.46	4.76	-26.91	33.31
World Wars					
Unemployment rate	130	3.63	2.97	0.40	17.20
Wage inflation	213	14.85	32.90	-19.94	412.23
Price inflation	228	20.29	71.10	-37.68	975.64
1920-1938					
Unemployment rate	270	7.12	5.00	0.60	24.90
Wage inflation	314	3.13	13.16	-27.72	86.48
Price inflation	333	0.67	9.84	-19.42	73.13
1946-1971					
Unemployment rate	436	2.60	1.84	0.04	9.92
Wage inflation	465	10.11	19.44	-55.42	225.19
Price inflation	468	5.38	10.37	-17.60	125.33
1972-1999					
Unemployment rate	504	7.07	4.30	0.04	24.21
Wage inflation	504	8.30	6.27	-1.42	32.28
Price inflation	504	6.56	5.51	-0.71	37.88
2000-2020					
Unemployment rate	377	7.05	3.52	2.00	26.09
Wage inflation	378	2.32	1.84	-6.14	7.50
Price inflation	378	1.63	1.28	-4.48	5.57
Total					
Unemployment rate	1942	5.49	4.08	0.04	26.09
Wage inflation	2604	5.85	14.41	-55.42	412.23
Price inflation	2642	4.40	22.54	-37.68	975.64

Notes: All statistics are expressed in percent. The hyperinflation period in Germany (1920-1925) is not included. All remaining observations available in the dataset are used in this Table.

Table A.3: Descriptive statistics - weighted by population size

	N	Mean	Std. Dev.	Min	Max
1870-1913					
Unemployment rate	223	4.97	3.42	0.20	18.40
Wage inflation	223	1.56	2.14	-6.71	10.26
Price inflation	223	0.51	2.15	-10.94	11.56
1920-1938					
Unemployment rate	268	8.34	6.14	0.60	24.90
Wage inflation	268	1.46	8.40	-27.72	43.97
Price inflation	268	0.04	6.97	-18.45	30.43
1946-1971					
Unemployment rate	428	3.25	2.03	0.04	9.92
Wage inflation	428	7.36	4.92	-10.78	35.29
Price inflation	428	3.91	3.69	-6.87	20.38
1972-1999					
Unemployment rate	504	6.76	3.76	0.04	24.21
Wage inflation	504	7.02	5.87	-1.42	32.28
Price inflation	504	5.57	4.77	-0.71	37.88
2000-2020					
Unemployment rate	377	6.75	3.37	2.00	26.09
Wage inflation	377	2.15	1.88	-6.14	7.50
Price inflation	377	1.62	1.23	-4.48	5.57
Total					
Unemployment rate	1800	6.01	4.01	0.04	26.09
Wage inflation	1800	4.65	5.64	-27.72	43.97
Price inflation	1800	3.07	4.50	-18.45	37.88

Notes: All statistics are expressed in percent. The war periods (1914-1919 and 1939-1945) and the German hyperinflation episode (1920-1925) are not included. This table only uses *weighted* by population country-year observations for which there is data for the unemployment rate, and price and wage inflation. Table A.2 presents descriptive statistics for the unrestricted sample.

Table A.4: Wage Inflation Correlations Table

	π_t^p	π_{t-1}^p	u_t
Australia	0.699	0.693	-0.459
Belgium	0.406	0.595	-0.191
Canada	0.806	0.497	-0.424
Denmark	0.657	0.674	-0.093
Finland	0.372	0.475	-0.356
France	0.835	0.726	-0.514
Germany	0.691	0.625	-0.531
Ireland	0.832	0.654	-0.175
Italy	0.635	0.771	-0.109
Japan	0.287	0.383	-0.744
Netherlands	0.627	0.581	-0.321
Norway	0.814	0.729	-0.626
Portugal	0.586	0.621	-0.235
Spain	0.548	0.467	-0.275
Sweden	0.806	0.775	-0.498
Switzerland	0.627	0.714	-0.483
UK	0.762	0.574	-0.266
USA	0.857	0.573	-0.286

Notes: Correlation between wage inflation and price inflation, lagged price inflation, and unemployment by country in the main sample excluding outliers as defined in the text.

Table A.5: First-Stage of trilemma IV

Dependent	No controls			With controls		
variable: Δr_{it}	All years	Pre-WW2	Post-WW2	All years	Pre-WW2	Post-WW2
trilemma $z_{i,t}$	0.60^{***}	0.41^{***}	0.68^{***}	0.65^{***}	0.64^{***}	0.65^{***}
	(0.08)	(0.09)	(0.09)	(0.08)	(0.15)	(0.09)
t-statistic	[7.65]	[4.42]	[7.99]	[8.47]	[4.29]	[7.58]
N	1316	505	811	1011	215	796

Notes: This table presents the first-stage estimates of the trilemma IV on the country's interest rate. The standard errors are in parentheses and the T-statistics are in square brackets. The full sample covers 1870–2020, excluding the World Wars and the German hyperinflation episode. The pre-WW2 sample covers 1870–1938, excluding 1914–1919, while the post-WW2 sample covers 1948–2020. The estimates in the last three columns (with controls) include country fixed effects and two lags of wage inflation and unemployment rate. In addition, I include world GDP growth to capture global cycles.

Table A.6: Estimates of multipliers across sub-samples

Horizon	Linear Model	1946-1999	1870-1913 & 2000-2020	AR p-value
4	0.499	0.383	-0.154	0.310
	(0.629)	(0.581)	(0.191)	
5	0.131	0.026	-0.150	0.167
	(0.421)	(0.411)	(0.107)	
6	-0.010	-0.109	-0.211	0.091
	(0.343)	(0.336)	(0.076)	
7	-0.115	-0.239	-0.184	0.031
	(0.319)	(0.307)	(0.089)	
8	-0.217	-0.374	-0.169	0.019
	(0.317)	(0.308)	(0.104)	
9	-0.416	-0.601	-0.161	0.025
	(0.327)	(0.322)	(0.125)	
10	-0.757	-0.945	-0.292	0.089
	(0.388)	(0.407)	(0.116)	

Notes: This table presents the multiplier estimates corresponding to the ones in Figure 4a. The values in parentheses under the multipliers indicate the correspondent standard errors. The last column indicates the weak instrument robust Anderson-Rubin p-values for the difference in multipliers across states.

Table A.7: Estimates of multipliers across states of inflation

Horizon	Linear Model	High Inflation	Low Inflation	AR p-value
3	0.051	0.233	-0.568	0.111
	(0.376)	(0.518)	(0.453)	
4	-0.381	-0.343	-0.557	0.483
	(0.229)	(0.284)	(0.337)	
5	-0.558	-0.599	-0.479	0.728
	(0.186)	(0.228)	(0.275)	
6	-0.655	-0.732	-0.440	0.314
	(0.164)	(0.214)	(0.242)	
7	-0.758	-0.870	-0.441	0.140
	(0.163)	(0.224)	(0.230)	
8	-0.863	-1.010	-0.430	0.069
	(0.176)	(0.253)	(0.231)	
9	-1.016	-1.172	-0.545	0.072
	(0.192)	(0.287)	(0.222)	
10	-1.221	-1.405	-0.684	0.061
	(0.220)	(0.348)	(0.213)	

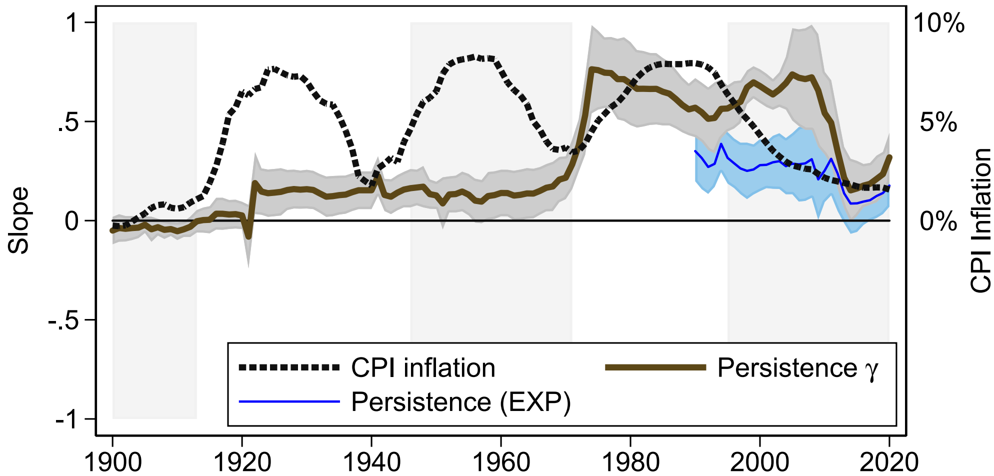
Notes: This table presents the multiplier estimates corresponding to the ones in Figure 5a. The values in parentheses under the multipliers indicate the correspondent standard errors. The last column indicates the weak instrument robust Anderson-Rubin p-values for the difference in multipliers across states.

Table A.8: Estimates of multipliers across states of inflation

Horizon	Linear Model	High Inflation	Low Inflation	AR p-value
3	-0.041	0.285	-0.677	0.137
	(0.354)	(0.648)	(0.329)	
4	-0.460	-0.391	-0.679	0.438
	(0.200)	(0.309)	(0.241)	
5	-0.650	-0.696	-0.668	0.933
	(0.162)	(0.241)	(0.237)	
6	-0.760	-0.830	-0.719	0.709
	(0.155)	(0.224)	(0.297)	
7	-0.810	-0.956	-0.595	0.180
	(0.148)	(0.232)	(0.210)	
8	-0.886	-1.058	-0.606	0.089
	(0.165)	(0.254)	(0.248)	
9	-1.004	-1.177	-0.571	0.051
	(0.176)	(0.277)	(0.180)	
10	-1.221	-1.405	-0.684	0.061
	(0.220)	(0.348)	(0.213)	
11	-1.403	-1.592	-0.543	0.037
	(0.270)	(0.410)	(0.344)	
12	-1.474	-1.671	-0.598	0.049
	(0.271)	(0.425)	(0.342)	
13	-1.677	-1.898	-0.794	0.092
	(0.307)	(0.514)	(0.350)	
14	-1.776	-1.966	-0.831	0.122
	(0.337)	(0.545)	(0.344)	
15	-1.918	-2.096	-0.724	0.119
	(0.401)	(0.621)	(0.364)	

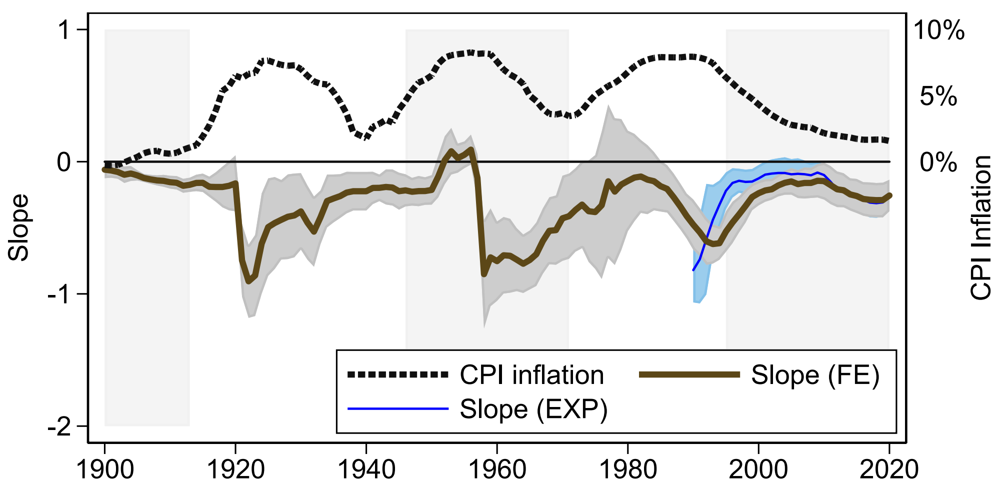
Notes: This table presents the multiplier estimates corresponding to the ones in Figure A.4a. The values in parentheses under the multipliers indicate the standard errors. The last column indicates the weak instrument robust Anderson-Rubin p-values for the difference in multipliers across states.

Figure A.1: Panel-OLS 20-year Rolling Window



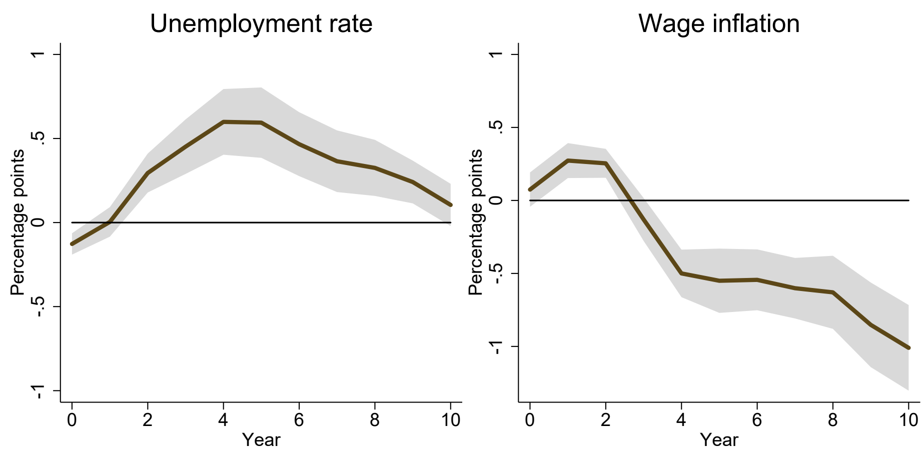
Notes: This figure plots a time-varying estimate of the persistence coefficient of the wage Phillips curve (parameter γ, in Equation (1)), using OLS and annual data from 1870 to 2020 for all 18 countries. In blue, I estimate the parameter γ also controling for inflation expectations by estimating: $\pi^w_{c,t} = \mu_c + \pi^e_{t+1} + \varphi u_{c,t} + \gamma \pi^p_{c,t-1} + \epsilon_{c,t}$. It is computed based on a rolling OLS regression using a 20-year window and displays a 90% confidence band.

Figure A.2: Panel-OLS 20-year Rolling Window with year fixed effects



Notes: This figure plots a time-varying estimate of the slope of the wage Phillips curve for two different specifications of Equation (1). In brown, I estimate the parameter φ by estimating: $\pi^w_{c,t} = \mu_c + \delta_t + \varphi u_{c,t} + \gamma \pi^p_{c,t-1} + \epsilon_{c,t}$. In blue, I estimate the parameter φ by estimating: $\pi^w_{c,t} = \mu_c + \pi^e_{t+1} + \varphi u_{c,t} + \gamma \pi^p_{c,t-1} + \epsilon_{c,t}$. In both specifications I am using Panel-OLS and annual data from 1870 to 2020 for all 18 countries. It is computed based on a rolling OLS regression using a 20-year window with year fixed effects (δ_t) and displays a 90% confidence band.

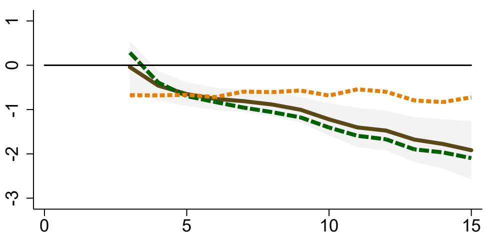
Figure A.3: Impulse Responses of Cumulative Changes in Unemployment and Wage Inflation



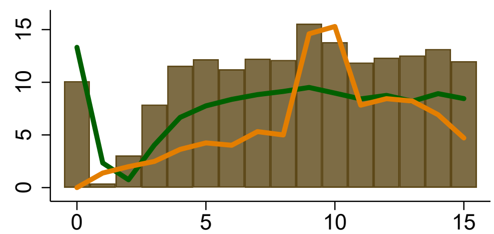
Notes: These impulse responses for cumulative unemployment and cumulative wage inflation are obtained from the OLS regressions (3) by changing the dependent variable from the average $\frac{1}{h}\sum_{j=0}^{h} y_{c,t+j}$ to the difference $y_{c,t+j} - y_{c,t+1}$. They display 90% confidence sets and show the temporary effect of the monetary policy shock to unemployment and the persistent effect to the wage inflation (in line with the persistent effect to price inflation in Jordà et al. (2019)).

Figure A.4: State-Dependent Phillips multiplier and IRFs

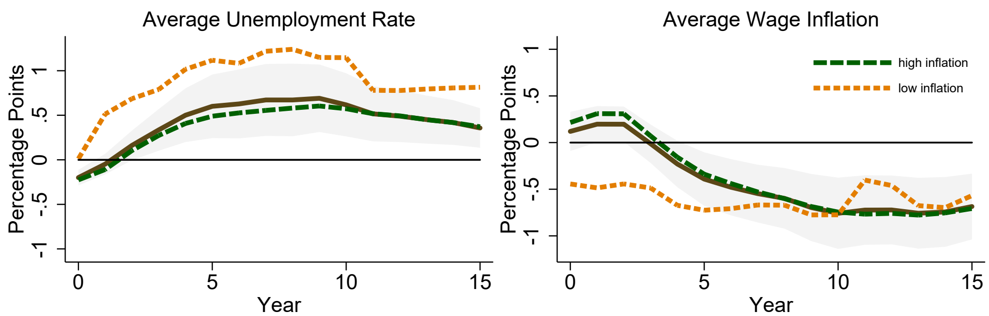
(a) Phillips multiplier



(b) F-Statistic



(c) Impulse Responses



Notes: This figure presents a robustness exercise with a higher horizon (15 years) and an unmatched sample, that is, using all available information and abstracting from eventual sample changes across each horizon as the number of observations decreases from 1000 to approximately 650. Here, I also control for two lags of unemployment and wage inflation, country fixed effects, and world GDP growth. The Olea and Pflueger (2013) effective F-statistic of the IRFs are around 30 and 50, for unemployment and wage inflation respectively, and always above the 10% TSLS threshold. Figures display 68% and 90% confidence bands for the baseline scenario. The state-dependent multipliers are significantly different for horizons between years 9 and 12 as one can confirm in Table A.8. Across all figures, one can distinguish the state by its color and shape, short-dashed orange shape for low inflation and long-dashed green shape for high inflation.

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