The Phillips Curve: a Relation between Real Exchange Rate Growth and Unemployment*

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Abstract

The negative relationship between inflation and unemployment (also known as the Phillips curve) has been repeatedly challenged in the last decades: missing inflation in 2013-2019, missing deflation in 2007-2010, missing inflation in the late 1990s, stagflation in the 1970s, contrasting with always strong regional Phillips curves. Using data from multiple sources, this paper helps to solve many empirical puzzles by distinguishing between fixed and flexible exchange rate regimes: in fixed exchange rate regimes, inflation is negatively correlated with unemployment but this relationship does not hold in flexible regimes. By contrast, there is a negative correlation between real exchange rate appreciation and unemployment, which remains consistent in both fixed and flexible regimes. These crucial observations have important implications for identifying the source of business cycle fluctuations, for normative analysis, and imply a significant departure from rational-expectation-based solutions to Phillips curve puzzles.

Keywords: Phillips curve, Unemployment, Inflation.
JEL classification: E2, E24, E3, E31, F3.

Introduction

The Phillips curve is named after A.W. Phillips who first documented a negative correlation between inflation and unemployment in the United Kingdom (Phillips 1958).[1] The neoclassical synthesis has interpreted this correlation as a menu of short-run options between inflation and unemployment, an aggregate supply curve. By increasing aggregate demand through monetary or fiscal policy, policymakers can boost employment for some time, at the cost of higher inflation. The Phillips curve trade-off between inflation and unemployment is taught in most undergraduate textbooks and is at the heart of much central banking policy today.[2]

Yet despite its impressive impact and widespread adoption, the empirical relevance of the Phillips curve has been challenged at numerous occasions, and the Phillips curve is subject to repeating controversies. Some of these controversies are central to the history of macroeconomic thought. For example in the 1970s the U.S. experienced both high inflation and high unemployment, a period that became known as "stagflation." This observation was inconsistent with the simple trade-offs in the Phillips curve, and led to new models to explain

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[1]The U.S. Phillips curve is usually credited to Samuelson and Solow (1960). In fact, Fisher (1926) documented the U.S. correlation between inflation and unemployment well before Samuelson and Solow, and even before A.W. Phillips.

[2]Textbooks include Mankiw (2015), Blanchard (2016a), Jones (2017), and the New-Keynesian Phillips curve is a reference point for modern Dynamic Stochastic General Equilibrium (DSGE) models with sticky prices (Smets and Wouters 2007).

it. More recently, inflation has not increased despite unprecedented fiscal stimulus and low unemployment, which has raised new questions about the Phillips curve (a similar "missing inflation" happened at the end of the 1990s). Symmetrically, the U.S. 2007-2009 depression was not accompanied by any deflation. At the same time, some scholars have noted that regional Phillips curve have remained strong (McLeay and Tenreyro 2019; Hooper, Mishkin, and Sufi 2019).

In this paper I provide a solution to this puzzle, explaining why we appear to observe a relationship between employment and inflation in some contexts but not others. I argue that most, if not all, Phillips curve related controversies can in fact be very simply understood using a fixed versus flexible exchange rate dichotomy, and distinguishing between traded and non-traded goods: in fixed exchange rate regimes, inflation is negatively correlated with unemployment but this relationship does not hold in flexible regimes. By contrast, there is a negative correlation between real exchange rate appreciation and unemployment, or equivalently between the relative price of non-traded goods versus traded goods and unemployment. This relationship, which I call the "real exchange rate Phillips curve", remains consistent in both fixed and flexible regimes, unlike the price Phillips curve. Casual observation is consistent with this hypothesis. For example consider again the case of the missing U.S. inflation since 2013, "the biggest surprise in the U.S. economy" according to Janet Yellen (2017). Despite a very large fiscal stimulus in an economy considered above potential, U.S. inflation has not risen above 2%, so that the Federal Reserve has wondered whether to raise interest rates or not. At the same time, the U.S. dollar has appreciated in nominal terms against many of the currencies of its trading partners, making imported goods cheaper: the price of traded goods in dollars has fallen relatively. In contrast, rents and house prices have indeed gone up in dollar terms. Overall CPI inflation has thus not risen by as much: the increase in rent prices of 2-3% has contributed to inflation, while falling traded goods prices have contributed to deflate the economy. This paper shows that this pattern is in fact general, and that this is what the Phillips curve is ultimately about. In fixed exchange regimes (such as the the Gold Standard), an increase in aggregate demand, for example due to fiscal or monetary policy, leads to a fall in unemployment, and a rise in non-traded goods' prices. Because nominal exchange rates are then fixed, the price of traded goods is essentially constant (exactly constant for a small open economy), so that overall CPI inflation rises. In a flexible regime, such as the one we have today in the United States, the same policy will lead to an appreciation in the nominal exchange rate, so that traded goods' prices will fall. The aggregate effect on CPI inflation of rising relative non-traded goods prices, and falling traded goods prices will be ambiguous. Because regions of the U.S. are essentially in a fixed exchange rate regime, this theory suggests that regional Phillips curves should be observed today, but not national ones.

Using panel data covering more than 35 advanced economies, I first show the relation between inflation and unemployment exists in fixed exchange rate regimes more broadly, which generalizes A.W. Phillips' findings in the U.K. under the Gold Standard, and Samuelson and Solow's in the U.S. under Bretton Woods. This relationship is very strong and robust, and holds regardless of whether one examines headline, core, harmonized inflation rates, and consumption or GDP deflators. However, the Phillips curve does not hold on average in flexible exchange rate regimes. I show that this fact is mostly driven by the price of tradables, which fail to have a Phillips curve correlation in flexible exchange rate regimes. In contrast, the price of non-tradables (such as the price of housing, rents and services) is everywhere correlated with unemployment, supporting the main hypothesis of the paper that Phillips curves really are about relative prices, and a correlation between the relative price of non-traded goods versus traded goods and unemployment.

Next, I consider event studies. In particular, the missing deflation in 1933, or the 1970s stagflation associated with a shift in the Phillips curve coincide with a change in exchange rate regimes: in 1933, Roosevelt abandons the Gold Standard, while in 1971, Nixon suspends the convertibility of the dollar into Gold. I also show that the response of the economy to "large shocks", and the associated failure of the price Phillips curve, such as the 2007-2009 missing deflation, and the 2013-2019 missing inflation, are also supportive of the model: in 2007-2009, despite a large global negative aggregate demand shock, there is no deflation, but a big relative fall in rents and house prices. In 2013-2019, despite massive fiscal and monetary stimulus, there is no inflation but an appreciation of the dollar, and a rise in house prices and rents. In terms of identification, these large shocks allow to make sure other coincident sources of variation are small.

Then, I use a narrative approach to investigate the response of inflation, real exchange rates and unemployment to identified aggregate demand shocks. I borrow Romer and Romer (2004) and Romer and Romer (2010)'s

monetary and fiscal policy shocks and investigate the response of different components of the CPI. These conditional correlations corroborate both cross-country and within country evidence: monetary and fiscal shocks have their largest effect on the relative price of non-traded goods. They imply a real exchange rate Phillips curve, not a price Phillips curve.

Then, I move on to regional Phillips curves. I show, in line with a growing literature (most recently, Hooper, Mishkin, and Sufi (2019)), that regional Phillips curve are very strong in the United States, as well as across European countries. However, unlike the existing literature, I relate these regional Phillips curve to the exchange rate regime: this paper shows that aggregate, flexible exchange rate relations between inflation and unemployment are completely different from regional ones, as they are mediated by the nominal exchange rate.

Finally, I discuss some implications of the real exchange rate Phillips curve. First, it implies that the economy can have high aggregate demand even when overall CPI inflation is low, whenever the relative price of housing goes up, such as at the end of the 1990s (the "missing inflation" under Alan Greenspan) and during the run up to the 2007 financial crisis. Diagnozing the cause of business cycle fluctuations is important: during the financial crisis, the "missing deflation" led some economists to argue that there was no shortage of aggregate demand, and that aggressive fiscal and monetary policy were not necessary. Second, the real exchange rate Phillips curve highlights that one negative consequence of aggregate demand stimulating policies sometimes is trade deficits, loss of competitiveness, and an oversized non-traded sector.[3] Finally, the real exchange rate Phillips curve has implications for macroeconomic theory. It implies that the stagflation experienced by the U.S. in the 1970s was no failure of Keynesian economics, nor a proof that Friedman (1968) had been right about the expectations-augmented Phillips curve[4], but simply a consequence of the depreciation of the dollar following the exit from the Bretton Woods system of fixed exchange rates.

The rest of the paper proceeds as follows. Section 1 provides cross-country evidence on the Phillips curve, distinguishing between fixed and flexible exchange rate regimes. Section 2 presents within-country event studies corroborating cross-country evidence. Section 3 shows some evidence relating to large events, where other sources of variations are swamped. Section 4 shows that real exchange rates Phillips curve also appear conditionally as a result of monetary and fiscal aggregate demand shocks. Section 5 discusses new and existing evidence concerning regional data, in majority in the United States, but also in Europe. In Section 6, I show that the real exchange rate Phillips curve has important implications for identifying the source of business cycle fluctuations and for normative analysis.

1 Phillips curve Correlations

In this section, I present Phillips curve correlations, in the spirit of early work by Fisher (1926), Phillips (1958) and Samuelson and Solow (1960), implicitely assuming that most if not all shocks are aggregate demand shocks.[5] I first look at price and wage Phillips curve in different types of exchange rate regimes. A robust finding is that price and wage Phillips curve are a strong feature of fixed exchange rate regimes, but that they are insignificant, sometimes positive, in any case always much noisier with flexible exchange rates. I then focus on the United States and the United Kingdom, given that early Phillips curves were documented in these two countries, and that many discussions around the Phillips curve revolve around the U.S. macroeconomic history. Finally, I show that the relative price of non-traded goods (mostly house prices and rents) are very strongly and robustly negatively correlated to unemployment across exchange rate regimes.

1.1 Price and Wage Phillips curve in Different Exchange Rate Regimes

In this section, I use the OECD's *Consumer Price Indices*, *Economic Outlook*, *Quarterly National Accounts*, *Main Economic Indicators* from 35 countries, and merge this cross-country database to data on exchange

[3] In a context of dynamic inefficiency or secular stagnation (Summers (2013), Geerolf (2013b), Geerolf (2019)), the problem lies in low aggregate demand in surplus countries, not in high aggregate demand in deficit countries.

[4] Friedman (1968) had been arguing in 1968 that "there is always a temporary trade-off between inflation and unemployment; there is no permanent trade-off", so in the 1970s, stagflation was interpreted as having proved Milton Friedman right.

[5] For readers whose prior belief is that business cycles are mostly driven by technology shocks, correlations conditional on identified aggregate demand shocks will be computed in section 4.

rate regimes constructed by Ilzetzki, Reinhart, and Rogoff (2019). According to their classification, exchange rate regimes are divided between "Fixed / Peg", "Crawling Peg", "Crawling Band", and "Floating". Table 49 in appendix F.1 gives a detail of exchange rate arrangements corresponding to this coarse classification.

Original Price Phillips curves. The first suggestive piece of evidence in favor of the main thesis in this paper is exposed in Table 1 and Table 2. These two tables present results from the original Phillips curve regression, with inflation being 1-Year inflation π_{it}, and U_{it} being the unemployment rate, with country-level fixed effects δ_i:

$$\pi_{it} = \alpha + \delta_i + \beta U_{it} + \epsilon_{it}.$$

where the regression coefficient β is the slope of the Phillips curve (PC Slope in the tables).

Table 2 shows the results from these Phillips curve regressions, run separately for each type of exchange rate regime. Because of fixed effects, the Phillips curve is here identified from within country variation. With fixed effects, the Phillips curve appears to be present for the "Fixed / Peg" type of regime, as well as the "Crawling Band", but not for floating exchange rates, and crawling pegs. The explained variance of inflation explained by unemployment (the adjusted R^2) is greater for fixed exchange rates.

Table 1: Original Price Phillips curve: Headline inflation and Unemployment, No Fixed Effects

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.23***	-9.1	13.2%	541
Crawling Peg	-0.23***	-3.0	2.4%	327
Crawling Band	-0.06	-0.8	-0.1%	423
Floating	0.28***	2.7	4.7%	129

Table 2: Original Price Phillips curve: GDP Deflator Growth and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.35***	-9.6	14.3%	541
Crawling Peg	-0.53***	-4.7	6.1%	327
Crawling Band	-0.84***	-4.9	5.1%	423
Floating	-0.31**	-2.1	2.5%	129

Table 3 shows Phillips curve regressions using alternative definitions of inflation: Consumption Deflator Growth, Core Inflation, GDP Deflator Growth, Harmonized Core Inflation, Harmonized Headline Inflation, and Headline Inflation. Again, this reveals that the Phillips curve is always strong in fixed exchange rate regimes, although with different coefficient magnitudes, and weak if not reversed in floating rate regimes. Crawling pegs and crawling bands sometimes do have Phillips curves on average, and sometimes don't.

Table 3: Alternative Inflation Definitions and Unemployment, by Exchange Rate Regime

Inflation Concept	Fixed	Cr. Peg	Cr. Band	Float
Consumption Deflator Growth	-0.19***	-0.21***	-0.07	0.3***
Core Inflation	-0.79**	-0.55***	-0.1	0.32***
GDP Deflator Growth	-0.23***	-0.23***	-0.06	0.28***
Harmonized Core Inflation	-0.1***	-0.29**	0.37**	0.07
Harmonized Headline Inflation	-0.09***	-0.12	0.15	0.26
Headline Inflation	-0.4**	-0.49***	-0.04	0.35***

Original Wage Phillips curves. The original Phillips curve plotted wage not price inflation against unemployment. In Table 4, I therefore look at the wage Phillips curve across exchange rate regimes. Once again, it can be seen that the correlation between nominal wage inflation and unemployment is very strong, and has a high R^2 in fixed exchange rate regimes, not in floating exchange rate regimes. The magnitude of the correlation is also weaker in floating exchange rate regimes than in fixed.

Table 4: Original Wage Phillips curve: Wage Rate Inflation and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-76.41***	-11.0	29.5%	284
Crawling Peg	-76.45***	-6.9	19.9%	184
Crawling Band	-81.25***	-4.6	16.7%	99
Floating	-32.27*	-1.9	2%	128

Accelerationist (Expectations Augmented) Price Phillips curves. Since the 1970s, following Phelps (1967) and Friedman (1968)'s seminal contributions, and the 1970s stagflation, it is usually assumed that there does exist a permanent tradeoff between inflation and unemployment as postulated by the simple Phillips curve, but that there only exists a temporary tradeoff. In other words, increasing unemployment does not imply that inflation falls, but simply that inflation decelerates: the reason is that agents' expectations quickly adapt to the new level of inflation. Therefore, I now test this accelerationist version of the Phillips curve:

$$\Delta\pi_{it} = \beta U_{it} + \epsilon_{it}$$

Table 5 presents the results from such a regression. The accelerationist Phillips curve does not appear very strong in any of the exchange rate regimes. As previously, it is more significant in fixed change rate regimes, than in floating ones. The rest of the paper focuses on the original Phillips curves. In the United States too, the original Phillips curve appears stronger after the financial crisis than the 1970s accelerationist version, as argued by Blanchard (2016b).

Table 5: Accelerationist Price Phillips curve: GDP Deflator Growth and Unemployment, No Fixed Effects

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.03	-1.5	0.2%	522
Crawling Peg	-0.09*	-1.8	0.7%	318
Crawling Band	-0.03	-0.6	-0.1%	415
Floating	-0.09	-1.5	0.9%	128

Accelerationist Wage Phillips curves. Since the 1970s, the correlation between price inflation, or the change in price inflation and unemployment is usually plotted. Table 6 shows that Phillips' original correlation does not hold up anywhere, even in an expectations-augmented form. This again, strengthens my choice to study the original Phillips curve, rather than its accelerationist version, in the remainder of the paper.

1.2 House Price and Real Exchange Rate Phillips curves

House Price Phillips curves. While inflation and unemployment are not correlated in floating exchange rate regimes, some components of the Consumer Price Index still are. One such important example concerns house prices, and other components of the CPI related to lodging. Table 7 shows indeed that in all four types of exchange rate regimes, house prices are strongly negatively correlated to unemployment rates. The appendix shows that this relationship is actually very strong and robust: it is even stronger when looking at 2-Year inflation rates, or at measures of house prices other than the BIS's.

Table 6: Accelerationist Wage Phillips curve: Change in Wage Rate Inflation and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-8.88	-1.2	0.1%	277
Crawling Peg	-3.1	-0.3	-0.5%	177
Crawling Band	-24.86	-1.5	1.1%	96
Floating	5.47	0.4	-0.7%	127

Table 7: House Prices (BIS) and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-103.74***	-8.8	22.9%	259
Crawling Peg	-131.32***	-6.0	15.1%	197
Crawling Band	-135.04***	-5.7	12.9%	214
Floating	-137.75***	-3.6	8.7%	128

Other CPI components. The OECD also provides some data on more disaggregated components of the Consumer Price Index. Table 8 presents the results from running the regression at the "sector" level:

$$\pi_{ist} = \alpha + \delta_i + \beta_s U_{it} + \epsilon_{it},$$

where π_{ist} is *sectoral* inflation in sector s. I obtain one Phillips curve slope β_s for every type of product s. It can be seen that the above insights generalize. Relatively local components of the price index are correlated to the unemployment rate across exchange rate regimes, just as house prices or rents are. On the other hand, less local components are not correlated to the unemployment rate in flexible exchange rate regimes. For example

Table 8: 2-Year Inflation and Unemployment, by Exchange Rate Regime

CPI Concept	Fixed	Cr. Peg	Cr. Band	Float
CPI: All items non-food non-energy	-0.59***	-0.92***	-1.03***	0.14
CPI: Energy	-0.11	-0.42	-0.79**	0
CPI: Goods	-0.35***	0.36	0	-0.9*
CPI: Housing	-0.73***	-1.2***	-0.72**	-0.88***
CPI: Housing excl. imp. rent	-1.07***	0.05	-1.5***	-0.99***
CPI: Services	-0.69***	-0.61*	0.58**	-1.03***
CPI: Services less housing	-0.63***	-0.11	-0.63*	-0.99***
CPI: Services less housing (Housing excl. imp. rent)	-0.52***	-0.99***	-4.01***	0.17

Table 43 in the appendix presents more results at a more disaggregated level. Again, the results from these regressions suggest a quite general pattern. The correlation between real exchange rates and consumption booms is also well-known in the literature, in the form of the Backus and Smith (1993) correlation, which in the real business cycles literature is usually interpreted as evidence for a lack of risk-sharing.

1.3 United States

The usual account of the history of the Phillips curve says that although A.W. Phillips had documented the Phillips curve for the United Kingdom, Samuelson and Solow (1960) were the first to document it in the United States (even though as I argue in the conclusion based on Sleeman (2011), A.W. Phillips was probably

not happy with the Phillips curve). In fact, this account is not correct, at least because Fisher (1926) is an earlier study of the relationship between unemployment and inflation. Fisher (1926) even interpreted as a causal relationship: "The fact that deflation causes unemployment has been well recognised for many years in isolated instances, such as the great deflation of 1921 in America or the corresponding post-war deflation in Great Britain, Czechoslovakia, or Norway. It has likewise been recognised that inflation carries with it a great stimulation to trade and an increase in employment (or decrease in unemployment)." This correlation between prices and unemployment was, in fact, very well known at the time as argued by Robinson (1974): "In those days (unlike now) the leading symptom of a recession was a fall in prices."

Table 9: U.S. Price Phillips curves

Period	Exchange Rate Regime	U.S. PC Slope	t-stat	Adj. R2
1891-1933	Gold Standard	-0.67***	-4.5	31.6%
1933-1945	1933 Devaluation, War	-0.26*	-2.1	23.4%
1945-1971	Bretton Woods	-1.26**	-2.1	12.2%
1971-2016	Flexible Exchange Rates	0.28	1.1	0.4%

Figure 1 shows the U.S. Price Phillips curve from 1891 to 1945, with data from Global Financial Data. At the time, the U.S. was on the Gold Standard, with a fixed value of the dollar in terms of Gold, apart from the devaluation of the dollar in 1933 by Roosevelt. In fact, not only did Fisher (1926) "discover" the Phillips curve much earlier than Phillips, and showed this correlation. He even related inflation or deflation to the purchasing power of the dollar explicitely: "In short, facts and theory both indicate that in the *dance of the dollar* we have the key, or at any rate a very important key, to the major fluctuations in employment. If this conclusion be sound, we have in our power, as a means of substantially preventing unemployment, the stabilisation of the purchasing power of the dollar, pound, franc, lira, mark, crown, and any other monetary units." In doing so, Irving Fisher was actually stating a correlation between real exchange rate and unemployment. However, whether the relationship is causal as he stated or just simulateneous, we shall discuss later.

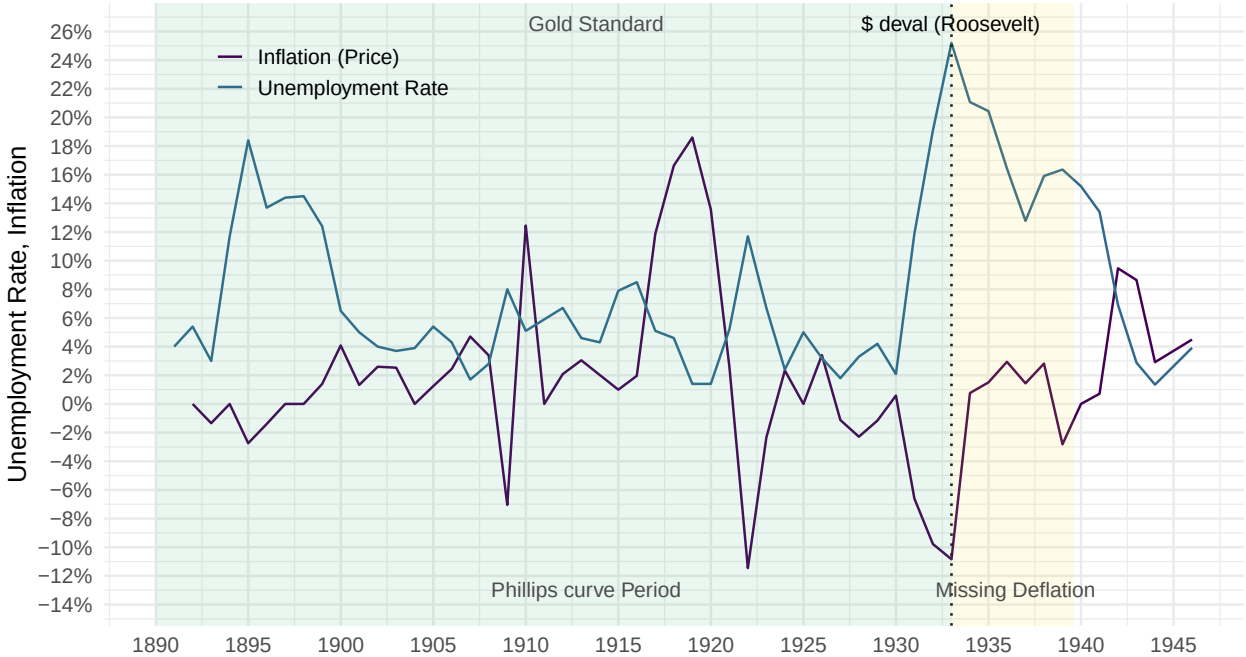

Figure 1: U.S. Price Phillips curve (1891-1945)

Figure 2 shows the U.S. Price and Wage Phillips curve starting in 1945 to today, with data from The Federal Reserve Bank of Saint louis.

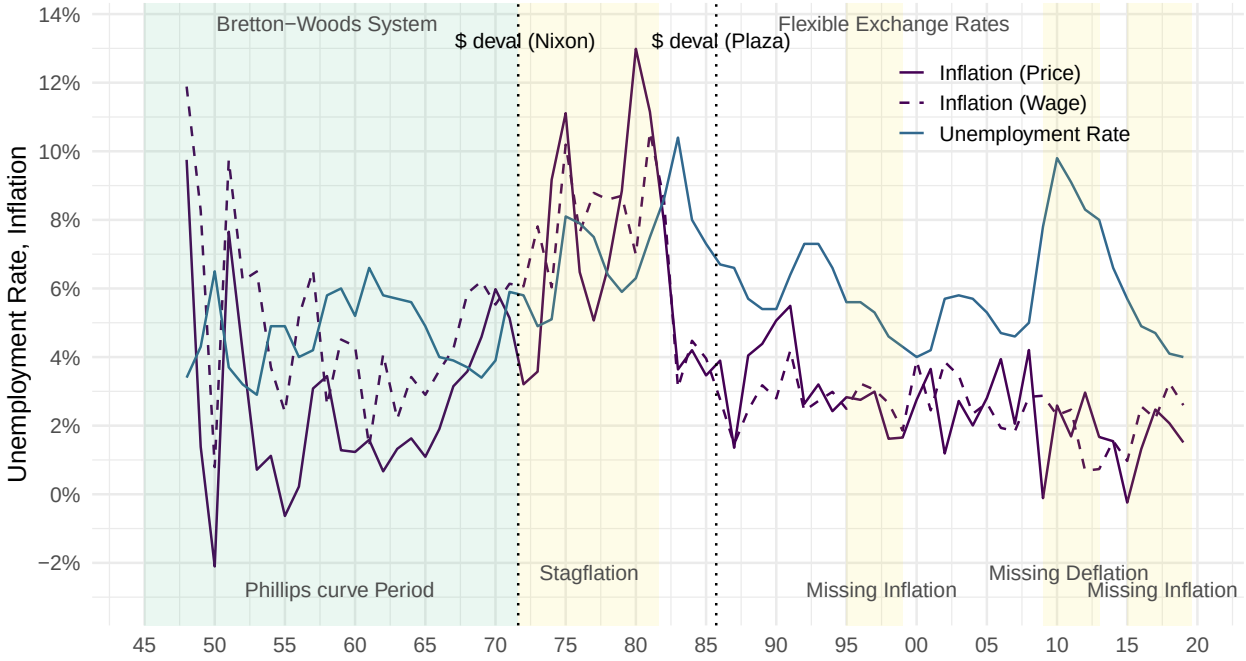

Figure 2: U.S. Price and Wage Phillips curve (1945-)

Indeed, at that time, the U.S. Phillips curve was a very strong one. Table 10 shows that the wage Phillips curve also was significant before 1971, but not after.

Table 10: U.S. Wage Phillips curves

Period	Exchange Rate Regime	U.S. PC Slope	t-stat	Adj. R2
1948-1971	Bretton Woods	-1.6***	-4.4	44%
1971-2018	Flexible Exchange Rates	0.32	1.3	1.7%

CPI Components. Much more data is available for the United States, which allows to test the hypothesis more precisely. I now use the Bureau of Labor Statistics' All Urban Consumers series (BLS-CU) in order to investigate which components of the growth in the Consumer Price Index are negatively related to unemployment, and which are not. I test the original version of the phillips curve, that is, for each sector s, I test whether price inflation in this sector is related to the unemployment rate in the time series:

$$\pi_{st} = \beta_s U_t + \epsilon_t$$

The Phillips curve coefficients β_s from these regressions are reported in Table 11. For the sake of brievety, I report only the sectors for which the regression has a high explained variance is high (that is, where the adjusted R^2 is higher than 20%). These results are presented as follows. The top panel shows the sectors where there is a negative relationship between price inflation and unemployment. They are ranked by decreasing order of adjusted R^2. The bottom panel shows the sectors where the relationship is positive, contradicting the Phillips curve.

Apart from a few noteworthy exceptions, we can notice a pattern. Prices for which the local cost component is important such as rents, local services (personal care, services), tend to have a strong Phillips curve. The fact that "rent of shelter" has a strong negative relation to unemployment is very meaningful, as this item

Table 11: U.S. Price Phillips curves on CPI Components (Adjusted R^2 higher than 20%)

Item (U.S. City Average, All Urban consumers, SA)	PC Slope	t-stat	Adj. R2
Other recreation services	-0.5***	-15.1	48.1%
Rent of shelter	-0.42***	-17.5	47.3%
Information technology commodities	-0.66***	-7.5	35.1%
Club memberships	-0.57***	-11.3	34.1%
Moving, storage, freight expense	-0.92***	-9.7	27.6%
Televisions	-2.08***	-9.8	26.1%
Cigarettes	-0.39***	-5.3	21.4%
Admission to movies, theaters, and concerts	-0.42***	-8.0	21.3%
Lodging away from home	-0.8***	-8.2	21.1%
Personal care	-0.18***	-7.8	20.4%
Toys, games, hobbies and playground equipment	0.95***	11.7	52%
Transportation commodities less motor fuel	0.6***	10.2	50.4%
Parking fees and tolls	0.91***	9.1	48.2%
Water and sewerage maintenance	0.64***	16.4	40.9%
Water and sewer and trash collection services	0.41***	12.2	37.4%
Education and communication services	0.42***	7.0	32.2%
New cars and trucks	0.43***	10.6	31.2%
New motorcycles	1.22***	6.8	29%
Recreation commodities	0.24***	6.4	28.4%
Women's underwear, nightwear, sportswear and accessories	0.78***	9.4	26.5%
College tuition and fees	0.81***	13.2	26.2%
Medical care commodities	0.86***	14.7	25.8%
Lunchmeats	0.73***	5.8	24.7%
Inpatient hospital services	0.46***	8.6	22%
New trucks	0.66***	10.7	21.6%
Other recreational goods	0.46***	8.2	21.2%
Other uncooked poultry including turkey	0.77***	8.1	20.7%
Tuition, other school fees, and childcare	0.67***	11.3	20.6%
Hospital and related services	0.77***	11.1	20.1%
Educational books and supplies	0.68***	12.5	20.1%

represents more than 35% of the overall CPI index. On the other hand, manuyfacturing goods such as new cars, new motorcycles, which also represent a large fraction of total spending, tend to go opposite to the Phillips curve.

1.4 United Kingdom

The correlation between unemployment and inflation is usually attributed to A.W. Phillips, who is usually be thought to have been the first to document this relationship in Phillips (1958) for the United Kingdom. Phillips (1958) documents a negative relationship between wage inflation and unemployment, the wage Phillips curve. Figure 3 shows Phillips' original relationship between wage inflation and the unemployment rate. On this graph, the correlation between unemployment and wage inflation can be seen even without running a regression: the R^2 is high, the effects were significant.

Tables 12 and 13 extend A.W. Phillips' work in the United Kingdom over different historical periods. Both tables 12 and 13 show that the wage and price Phillips curve works in fixed exchange rate periods, but not under flexible exchange rates. This period, unlike for the United States, starts in November 1967, when the U.K. devalues the pound by about 14% to $2.40, down from $2.80. Over the period starting in 1967 and ending in 2016, the Phillips curve is no longer a feature of the data.

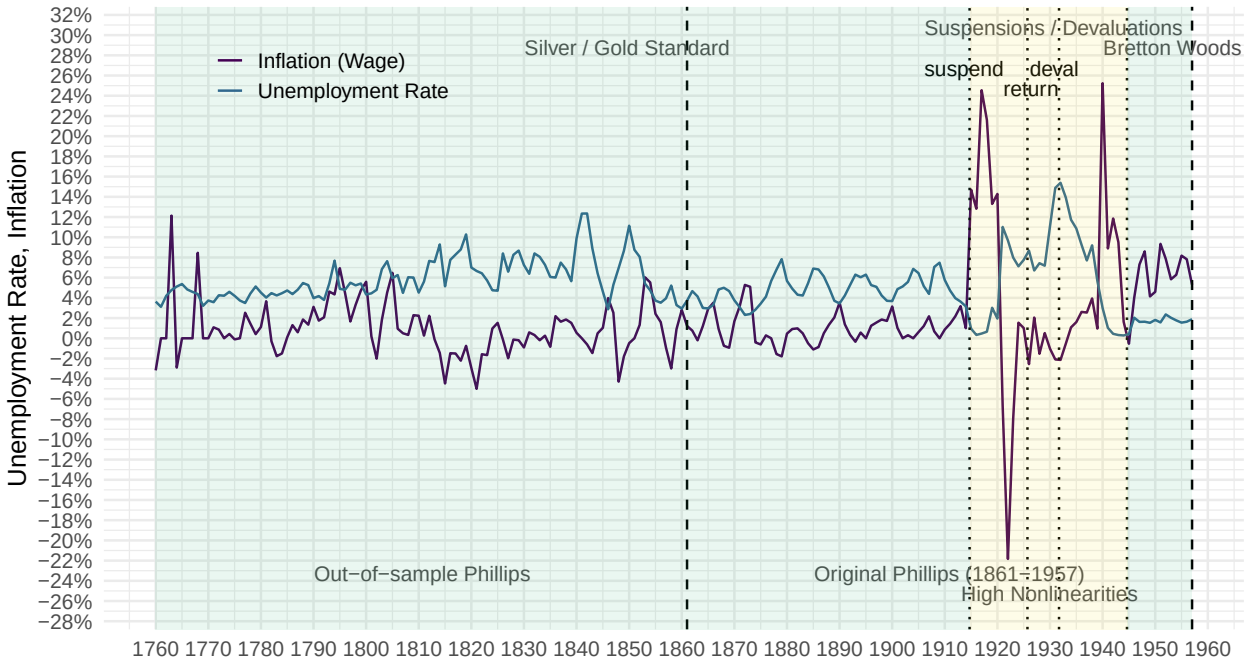

Figure 3: U.K. Wage Phillips curve (1760-1945): Unemployment and Wage Inflation.

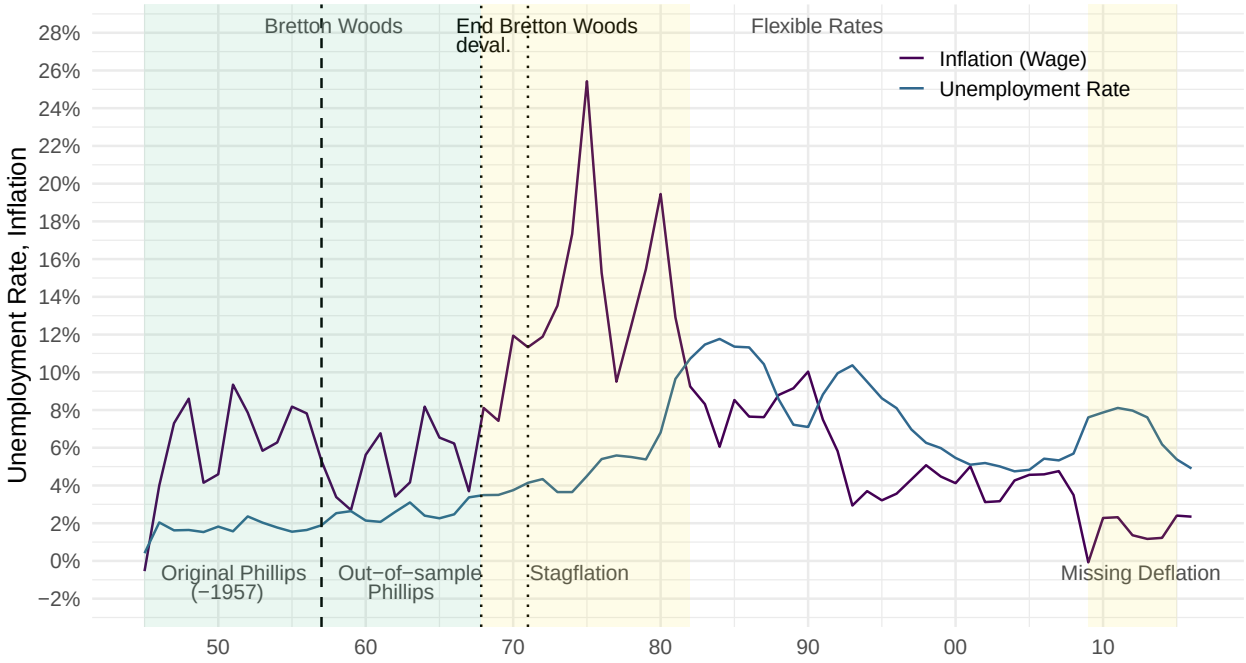

Figure 4: U.K. Wage Phillips curve (1945-): Unemployment and Wage Inflation.

Table 12: U.K. Wage Phillips curves

Period	Exchange Rate Regime	U.K. PC Slope	t-stat	Adj. R2
1780-1860	Silver / Gold Standard	-0.33**	-2.6	5.2%
1861-1913	Gold Standard	-0.79***	-7.1	48.4%
1914-1925	Suspension	-3.07***	-6.1	76.8%
1926-1944	Gold Standard	-0.71**	-2.8	26%
1945-1967	Bretton Woods	-2.14***	-3.0	27.6%
1967-2016	1967 Deval., Flexible Exchange Rate	-0.47	-1.5	2.7%

Table 13: U.K. Price Phillips curves

Period	Exchange Rate Regime	U.K. PC Slope	t-stat	Adj. R2
1780-1860	Silver / Gold Standard	-0.73**	-2.0	2.9%
1861-1913	Gold Standard	-0.63**	-2.6	10.1%
1914-1925	Suspension	-3.02***	-8.6	86.9%
1926-1944	Gold Standard	-0.68***	-3.9	43%
1945-1967	Bretton Woods	-1.95*	-1.9	11.7%
1967-2016	1967 Deval., Flexible Exchange Rate	-0.35	-1.2	0.9%

2 Event Studies: U.S. 1933 and 1971

One could argue that countries under fixed versus flexible exchange rates are different in other respects than just the exchange rate regime. In that case, the previous differences in the strength of Phillips curves under different exchange rate systems can be due to unobserved country characteristic driving both the exchange rate regime and the existence of a Phillips curve.

In this section, I use two examples of what Nakamura and Steinsson (2018) call "discontinuity based identification". These two episodes are very salient in U.S. macroeconomic history. First, I look at what happened to the Phillips curve, when the United States devalued the dollar in 1933. Second, I consider the change in the slope of the Phillips curve around the time where the U.S. left of the Gold Standard in 1971.

2.1 Post 1933 U.S.: Missing Deflation

In their seminal paper on the U.S. Phillips curve, Samuelson and Solow (1960) were writing about the Roosevelt era "missing deflation": "In the first place, the years from 1933 to 1941 appear to be sui generis: money wages rose or failed to fall in the face of massive unemployment." After 1933, and until the United States entered World War II, deflation gave way to inflation despite high unemployment, including during the 1937-1938 recession. What is a "puzzle" according to the traditional Phillips curve view can be explained very well according to the version of the Phillips curve I previously laid out.

According to this interpretation, the failure of wages to fall during 1933-1941 was due to Roosevelt's decision in 1933 to devalue the dollar. The reason for the failure of the Phillips curve in the 1970s, and its failures thereafter (missing inflation in the late 1990s and 2010s, missing deflation in 2007-2009), was not a change in inflation expectations, but coming from the fact that the U.S. were under flexible exchange rates starting from the end of the Bretton-Woods system in 1971. Therefore, the stagflation of the 1970s was no vindication of "rational expectations", as the story is usually told in textbooks, but more simply a manifestation that the structural relationship really is between real exchange rate appreciation and unemployment. The reason why regional Phillips curves are always very strong, even when national Phillips curves fail, is that U.S. regions are in a monetary union. To the best of my knowledge, the link between the stagflation period and the fall of the Bretton Woods System, the end of deflation in 1933 and Roosevelt's devaluation of the dollar, or the difference between regional and aggregate Phillips curves based on their differences in exchange rate regimes

have not been noted before.

The Phillips curve starts breaking in post-1933 Great Depression United States, which sees the coexistence of price, wage inflation, as well as a substantial unemployment rate. This is usually considered a challenge for the Phillips (1958) curve, as unemployment remained very high throughout the period. For instance, in a leading macroeconomics textbook, Blanchard (2016a) writes that "Starting in 1934, however, deflation gave way to inflation, leading to a large decrease in the real interest rate, and the economy began to recover. Why, despite a very high unemployment rate, the U.S. economy was able to avoid further and further deflation remains a hotly debated issue in economics."

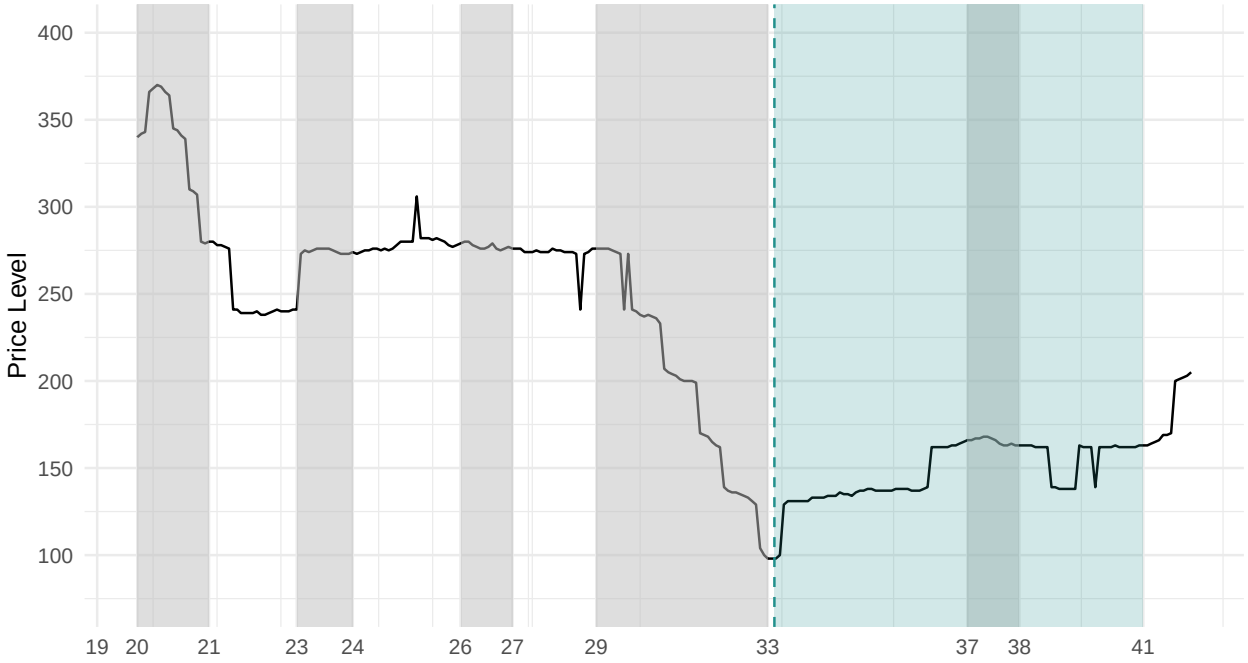

Figure 5: Missing Deflation (1933-1941)

This text exemplifies that according to New-Keynesian economics, changes in the relationship between inflation and unemployment must necessarily arise from changes in inflation expectations. Therefore, this is what changing the monetary system must have led to. On the contrary, in this paper I interpret the coexistence of inflation and unemployment as a proof that the Phillips curve is really about real exchange rates. The devaluation of the dollar brought about the fall in real exchange rates, which was necessitated by the crisis.

2.2 1970s Stagflation: the Triumph of Rational Expectations?

In the 1970s, only a decade after the neoclassical synthesis was proposed, a period of high inflation and high unemployment shattered the Phillips curve. The 1970s stagflation was considered a major challenge to mainstream Keynesian macroeconomic thinking at the time, which was based on the Phillips curve. Blanchard and Summers (2017) write: "A combination of intellectual developments and real world events led to a dramatic reconceptualization of macroeconomics between the late 1960s and the early 1980s. Phelps (1967) and Friedman (1968) pointed out that, on theoretical grounds, one would not expect to see a stable tradeoff between inflation and unemployment as postulated by the simple Phillips curve, as agents' expectations would change if policymakers tried to exploit the Phillips curve too much. At the same time by the late 1970s, and in apparent contrast to the Keynesian view, stagflation emerged as a major problem throughout advanced economies as inflation and unemployment both increased in unison." This disappointment led to a fierce attack of neoclassical economics against Keynesian economics (Lucas (1973), Lucas and Sargent (1979)), which continues until today.

Accelerationist Phillips curve models came to replace the original Phillips curve, following Phelps (1967) and Friedman (1968): in his 1968 presidential address, Milton Friedman argues that "There is always a temporary trade-off between inflation and unemployment; there is no permanent trade-off." Phelps (1967) and Friedman (1968) argued that the trade-off could not be persistently exploited, as people's expectations would change. The early correlation between inflation and unemployment was replaced with the *expectations-augmented* Phillips curve, a correlation between inflation growth and unemployment. Yet even this version of the Phillips curve quickly had problems too, so much that Larry Summers was asking in 1991 whether "Keynesian economics [should] dispense with the Phillips curve" (Summers (1991)). There was no rise in inflation during the late 1990s despite a strong economy, and Atkeson and Ohanian (2001) showed that Phillips curves were not on average useful to forecast inflation. The 2007-2009 crisis and subsequent recovery did not occur according to the Phillips curve either: there was no desinflation in 2007-2009 despite an unprecedented recession since the Great Depression, and an unemployment rate rising from 4.5% of the labor force in April 2007 to 10% in October 2009. Referring to this period, Hall (2011) talked about the "near-exogeneity of the rate of inflation". Symmetrically, there has been no sign of rising inflation during the recovery, at least until 2019, despite unprecedented tightness in the labor market. Janet Yellen (2017) has called it "the biggest surprise in the U.S. economy." Looking back on the performance of macroeconomics since the financial crisis, Paul Krugman (2018) has argued recently that there exists "a big failure in our understanding of price dynamics." At the same time, regional Phillips curves are always very strong: there is much evidence that a high correlation exists between local unemployment and local inflation across U.S. regions, even in periods when the Phillips curve fails at the aggregate level (Beraja, Hurst, and Ospina (2016), Hooper, Mishkin, and Sufi (2019)).

At the same time, the expectations-augmented Phillips curve seemed to still be a reasonably good fit to the data: instead of a correlation between unemployment and inflation, there was now a correlation between unemployment and the growth in inflation. This episode is usually interpreted as one of a rare case of "theory ahead of facts" on the part of Phelps (1967) and Friedman (1968), who had anticipated based on rational expectation theorizing that the Phillips curve trade-off could not be exploited for too long (see Blanchard (2016a) for a textbook treatment). The usual narrative is that Phelps (1967) and Friedman (1968) were proven right by the 1970s stagflation, which led the Phillips curve to be replaced by the accelerationist Phillips curve: a negative relationship between the change in inflation and unemployment. This alleged "success" also led to the triumph of rational expectations economics.

This paper proposes another interpretation of the breaking of the Phillips curve in the 1970s: Nixon left the Gold standard, which ended the Bretton Woods system of fixed exchange rates. Therefore, the U.S. economy moved from having a fixed exchange rate with a strong price Phillips curve (which was also a real exchange rate Phillips curve), to a flexible exchange rate where the correlation would now be between nominal exchange rate and unemployment, instead of between price inflation and unemployment. In that interpretation, the breaking of the Phillips curve should not have been interpreted as a triumph of rational expectations economics, or as a problem for Keynesian economics, but simply as a consequence of a different exchange rate regime.

What about the accelerationist Phillips curve? Although the accelerationist version of the Phillips curve (between the changes in inflation and unemployment) replaced the Phillips curve, it in fact always was noisy, and received numerous justified critiques (Atkeson and Ohanian (2001)). Recently, the accelerationist version of the Phillips curve has not done very well either, so much that Blanchard (2016b) has proposed to go back to the old version of the Phillips curve.

3 Large Shocks: U.S. Missing Deflation and Missing Inflation

As stated by Nakamura and Steinsson (2018), "Much empirical work takes the approach of seeking to control for confounding factors as well as possible. A different approach is to focus on large policy actions for which we can plausibly argue that confounding factors are drowned out." In this section, I argue that both the 2007-2009 financial crisis, as well as the 2016-2019 stimulus when the unemployment rate was already low are two such episodes. Both events have been characterized by absentee Phillips curve, but very large responses of rents and house prices. I argue that both these events are also supportive that a structural relationship exists

between real exchange rates and unemployment, but not between overall cpi inflation and unemployment.

3.1 2007-2009 Missing Deflation

If the Phillips curve view of the world is correct, then the 2007-2009 financial crisis, which was the most severe since the Great Depression, should have led to substantially more deflation. This missing deflation is a very puzzle problem for the Phillips curve. Among many examples, Hall (2011) writes: "A line of thought rather deeply embedded in macroeconomics holds that product prices fall in slack markets. (...) Recent experience requires a fundamental reconsideration of the view that producers find it desirable to expand output by cutting prices. Their behavior across all industries suggests, to the contrary, that price-cutting is not the answer to any problem they perceive in a time of extreme slack." Apart from a few exceptions, most commentators consider the Phillips curve to have been a failure.[6] Because of missing desinflation during the Great Recession, Hall (2011) has talked about the "near-exogeneity of the rate of inflation". Even Paul Krugman (2018) has argued that "So my claim that basic macroeconomics worked very well after the crisis needs to be qualified by what looks like a big failure in our understanding of price dynamics — but this failure didn't do too much damage in giving rise to bad advice, and hasn't led to big new ideas because nobody seems to have good ideas to offer."

The behavior of inflation during the financial crisis of 2007-2009, as well as during the ongoing recovery, also very hard to understand through the lens of the Phillips curve.

3.2 2016-2019 Missing Inflation

Symmetrically, inflation has not picked up since the recovery started, which Janet Yellen has called "the biggest surprise in the U.S. economy" (Yellen (2017)).

4 Identified Moments

Of course, one cannot identify structural relationships with correlations only, as in general supply and demand shocks shift both supply and demand curves, moving along demand and supply curves respectively. Therefore, looking at simple correlations such as the relationship between inflation and unemployment, and trying to uncover an aggregate supply curve, the implicit assumption is that most shocks are aggregate demand shocks, so that the resulting correlation allows to trace an aggregate supply curve. An alternative to event studies is to stack many episodes where aggregate demand is known to have increased, and compute the (conditional) covariance between unemployment and inflation during these episodes. Again, the response to both fiscal and monetary policy shocks strongly suggests that the structural aggregate supply curve is a relation between real exchange rates and unemployment, instead of inflation and unemployment. I show that in the U.S., unemployment rises strongly following a contractionary fiscal or monetary shock, while the Consumer Price Index responds ambiguously. However, the relative price of housing falls substantially following both such shocks.

4.1 U.S. Monetary Shocks (Romer and Romer (2004))

I start with monetary shocks identified in Romer and Romer (2004). In the New-Keynesian literature, monetary shocks are indeed usually identified as pure aggregate demand shocks. I estimate the simplest possible specification:

$$\Delta Y_t = a + \sum_{i=0}^{M} b_i \Delta T_{t-i} + e_t$$

Here, I set the number of lags to $M = 20$. The results from the cumulated partial responses b_i are shown on Figures 6, 7, and 8, together with the 68% and 90% confidence intervals obtained by bootstrap. We note that following a monetary shock, unemployment rises as shown on Figure 6. At the same time, the price level shows a "price puzzle": the price level first appears to rise, and only after two years to start to decline, as

[6] Blanchard (2018) however is more nuanced on how one should interpret the missing deflation.

shown on Figure 7. Finally, Figure 8 shows that house prices unambiguously decline starting in quarter 1. Once again, the Phillips curve pattern is much more apparent on house prices than it is on general price inflation.

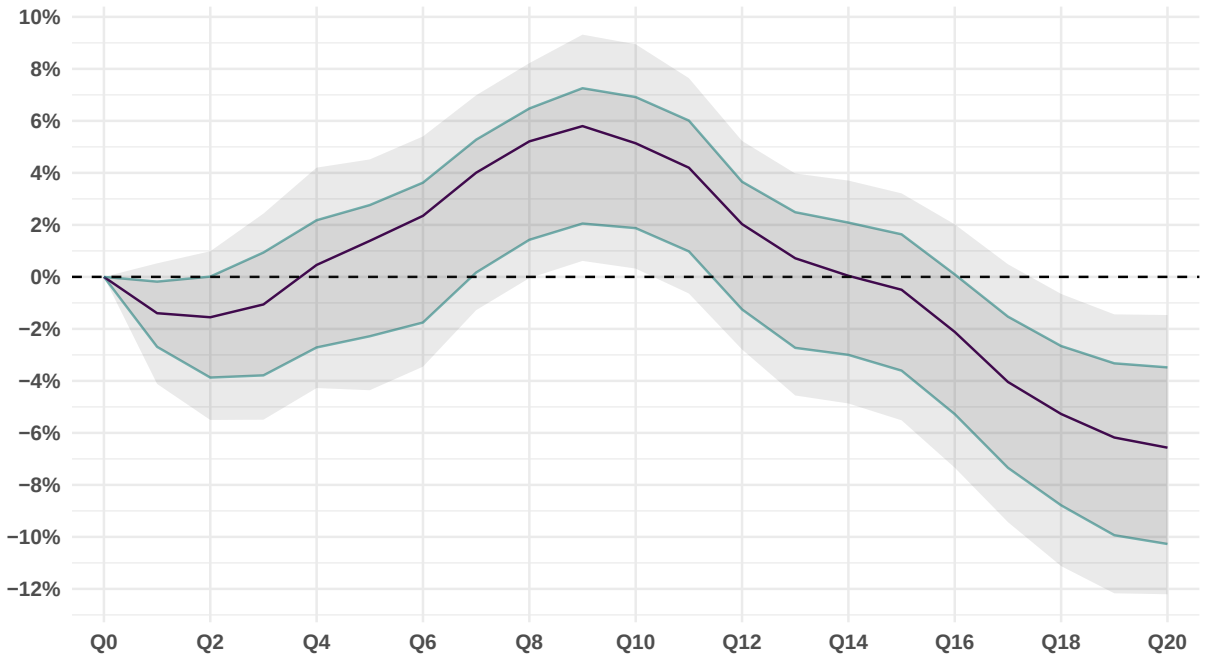

Figure 6: Response of Unemployment to a 1% Increase in the Federal Funds Rate

4.2 U.S. Fiscal Shocks (Romer and Romer (2010))

I next use the narrative shocks identified in the United States by Romer and Romer (2010). Using their methodology, I compute the impulse response functions to a 1% of GDP increase in taxes. Figure 9 shows that conditional on such shocks, unemployment increases. Figure 10 shows that inflation does not move significantly, although a Phillips curve type analysis would suggest it should. Finally, Figure 11 shows that similarly to monetary policy shocks, house prices respond much more than the overall Consumer Price Index. Again, this evidence is supportive with the main thesis of the paper: even conditionally on identified aggregate demand shocks, inflation does not respond in the way that the Phillips curve would say it should, while on the contrary house prices, the real exchange rate, or the relative price of non-tradable goods in terms of tradables, do.

Compared to monetary shocks, fiscal shocks are also sometimes interpreted as arising from supply responses, and not just from a change in disposable income which boosts consumption. However, it is also well-known that it is hard to make sense of the large effects of tax shocks on output, since the implied elasticities would be an order of magnitude higher than the much better identified microeconomic elasticities. Therefore, aggregate demand effects must be large.

5 Regional Phillips curves

The correlation between unemployment and local price indexes is already well-known in the literature. Recently, Hooper, Mishkin, and Sufi (2019) have studied these correlations more systematically. That the change in relative prices comes entirely from non-traded goods such as house prices and rents, which overwelmingly explain relative inflation rates across cities and states, both in nominal wages and prices, is also well known and documented in the urban and economic geography literature (Moretti (2013)).

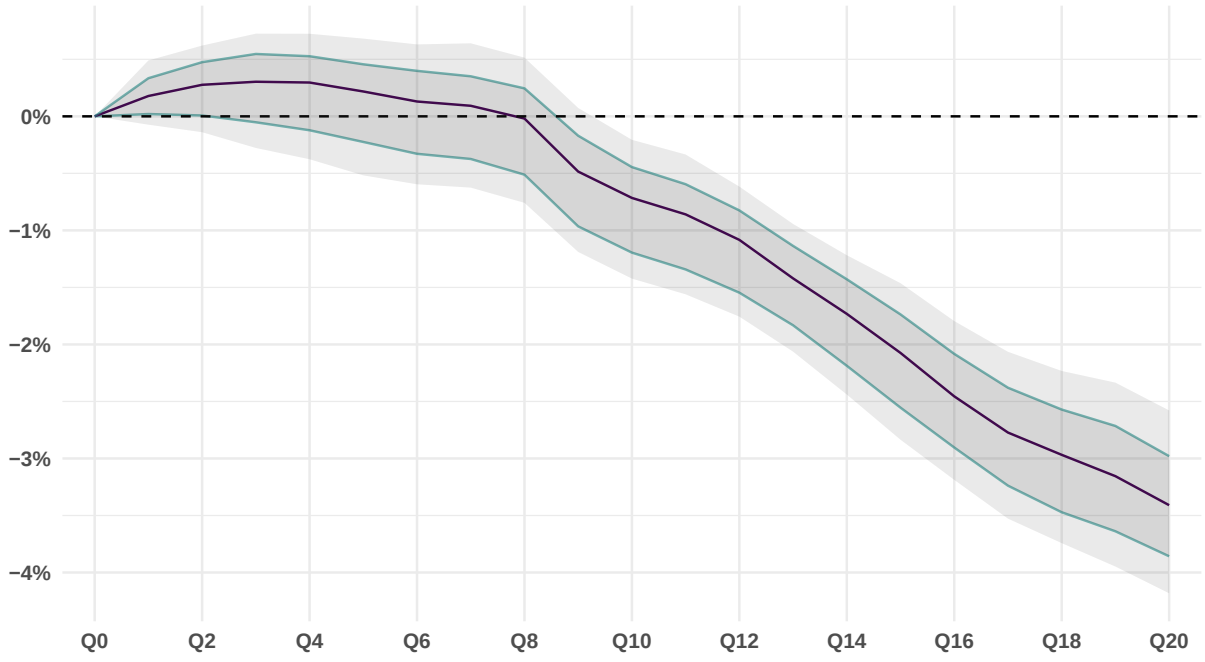

Figure 7: Response of CPI Inflation to a 1% Increase in the Federal Funds Rate

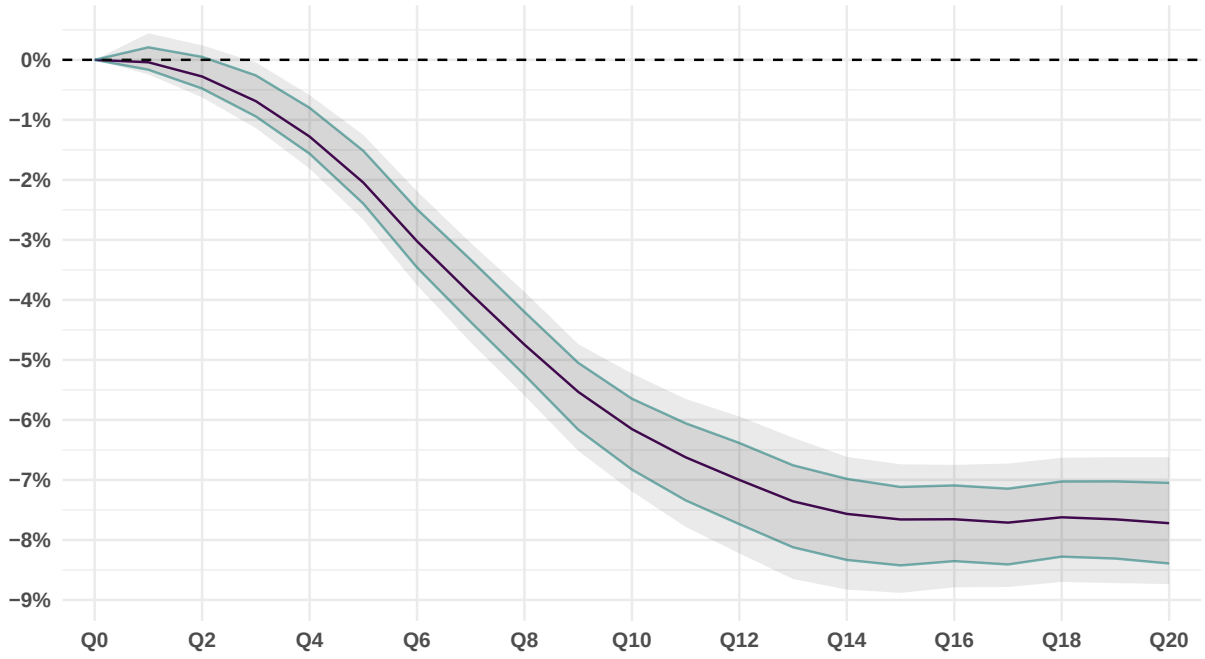

Figure 8: Response of House Prices to a 1% Increase in the Federal Funds Rate

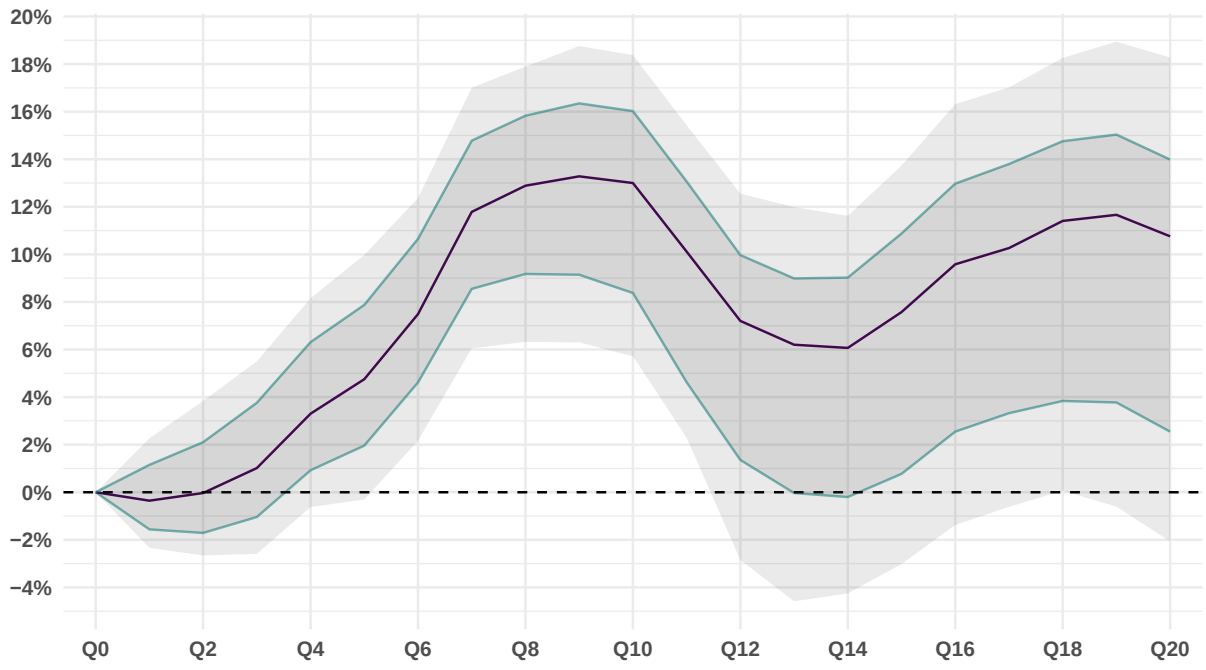

Figure 9: Response of Unemployment to a 1% of GDP Tax Increase

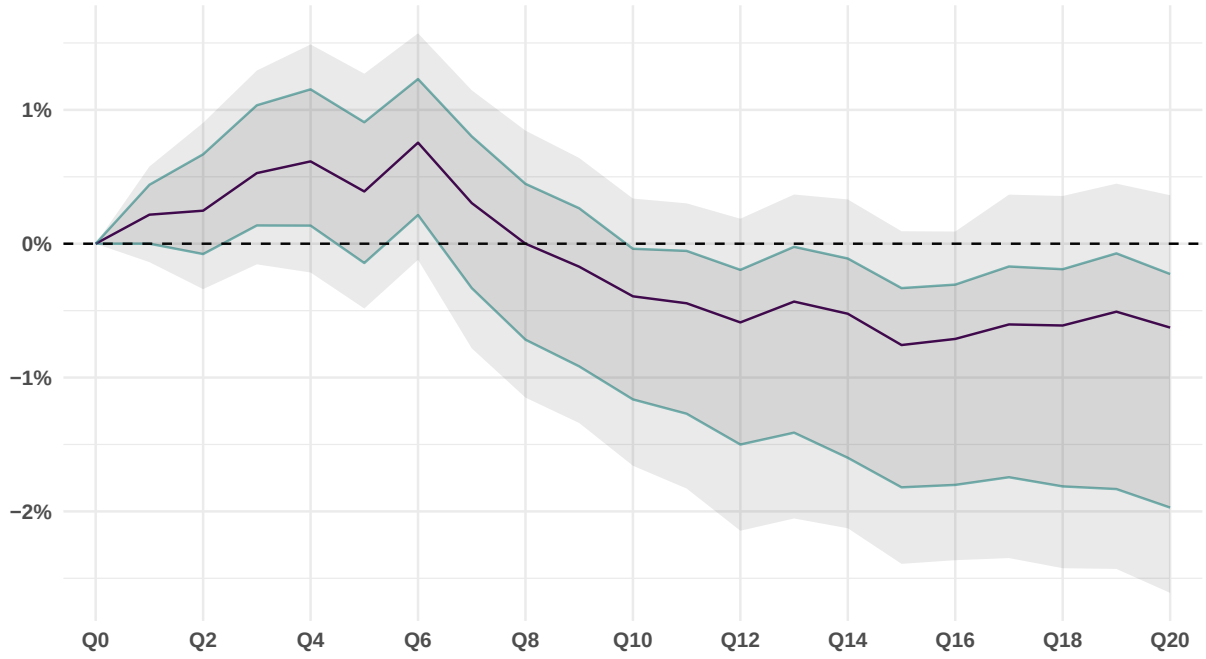

Figure 10: Response of CPI Inflation to a 1% of GDP Tax Increase

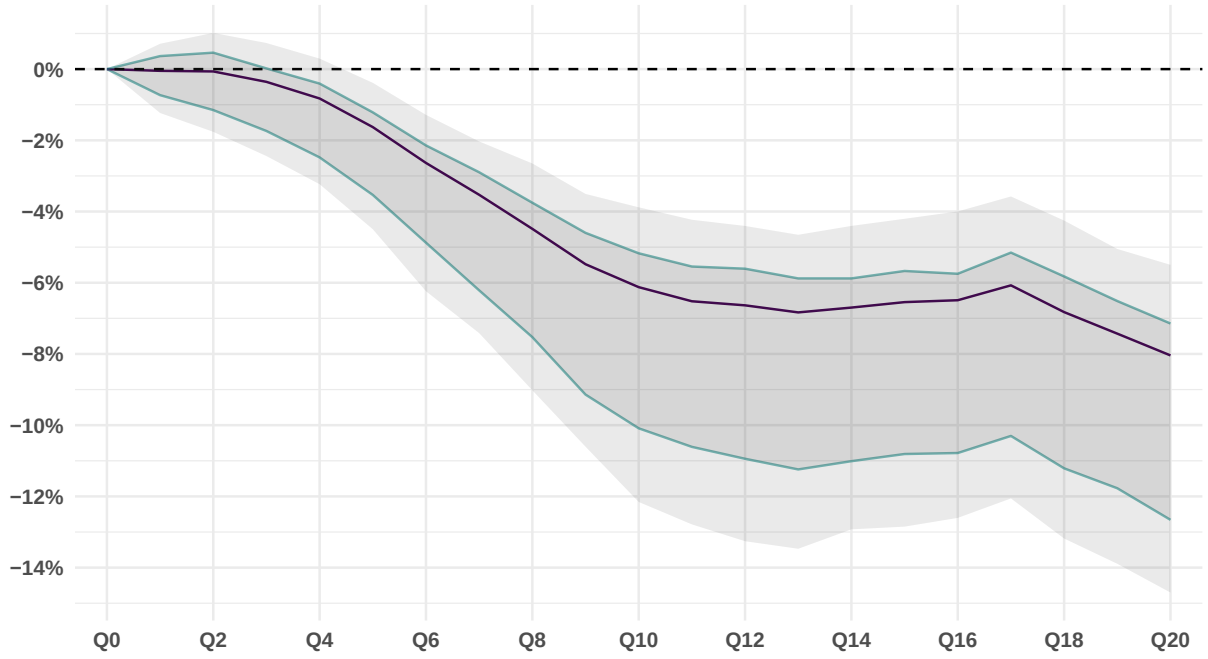

Figure 11: Response of House Prices to a 1% of GDP Tax Increase

However, to the best of my knowledge, all these studies use cross-sectional data in order to say something about Phillips curves at the aggregate level. None of these studies have noted that a correlation between regions in a monetary union was equally compatible where the structural relationship is between unemployment and exchange rates. I study the different geographies in turn.

5.1 U.S. States

The fact that nominal wage growth and unemployment are correlated at the state level is well-known at least since Blanchard and Katz (1992). They perform a VAR analysis, and compute the impulse response function to an "employment shock"). In response to an employment shock, they get a fall in nominal wages, as well as a fall in employment, which corresponds to a Phillips curve.

More recently, Zidar (2019) has investigated the state level impact of Romer and Romer (2010)'s fiscal shocks, depending on whether tax increases are concentrated on the Bottom 90% of earners (comprising approximately 50% of the income), or the Top 10%. Again, these impulses are potentially more informative, as they are conditioned on an identified fiscal shock; although just as for Romer and Romer (2010)'s shocks, however, there can be a debate on whether these shocks are to aggregate demand or aggregate supply.[7]

The results are nonetheless instructive, as he finds that prices tend to fall, as shown on Figure 13B, while composition-adjusted real wages stay constant, as shown on Figure 14C. Again, this implies a nominal wage Phillips curve, as well as a price Phillips curve. Once again, fiscal austerity drives inflation down, mostly through the price of housing.

[7] And indeed, Zidar (2019) states: "I find that real wages increase after tax changes for lower-income groups. While the estimates are imprecise, they suggest that labor supply responses are an important mechanism for the results." It should be noted however that all the impulse responses studied in this paper are very similar, while they typically correspond to aggregate demand shocks.

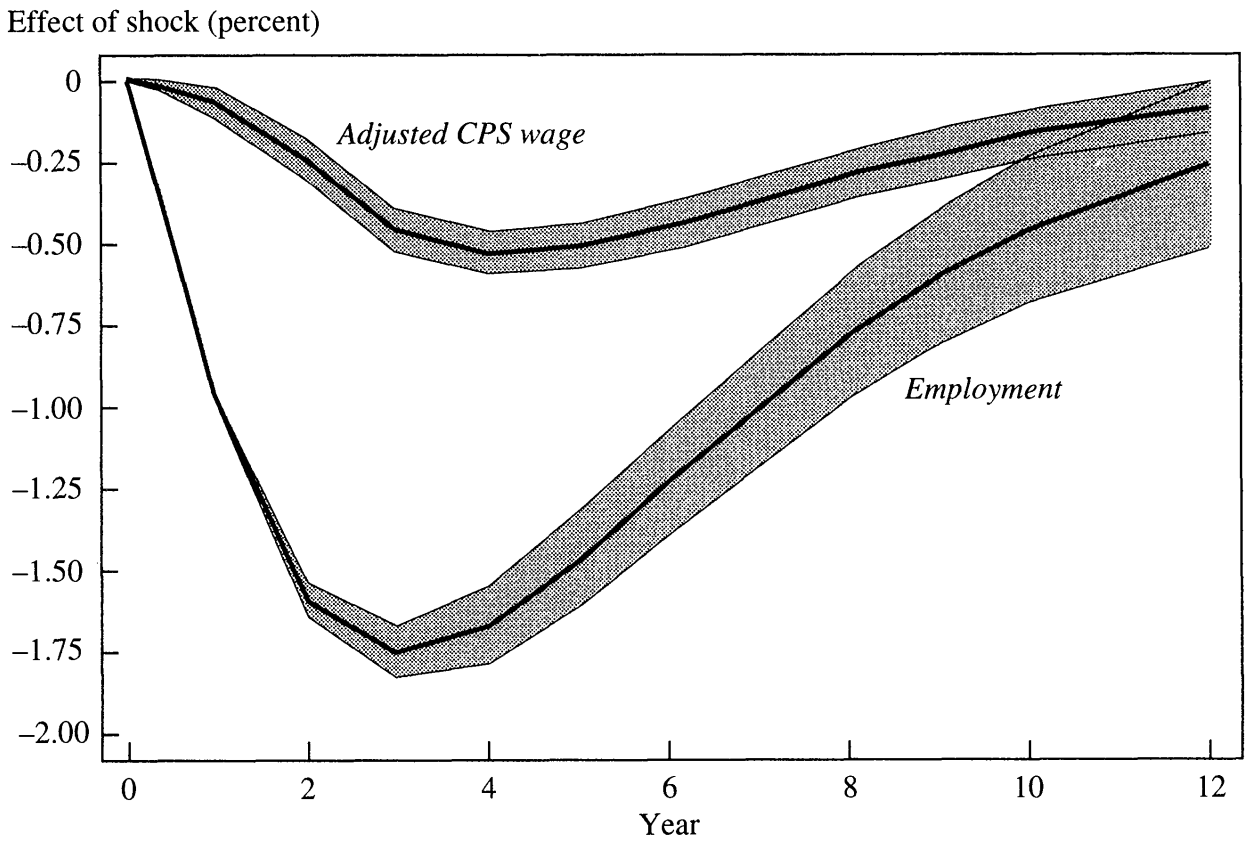

Figure 12: Reponse of Employment and Adjusted Wages to an Employment Shock (Blanchard and Katz (1992))

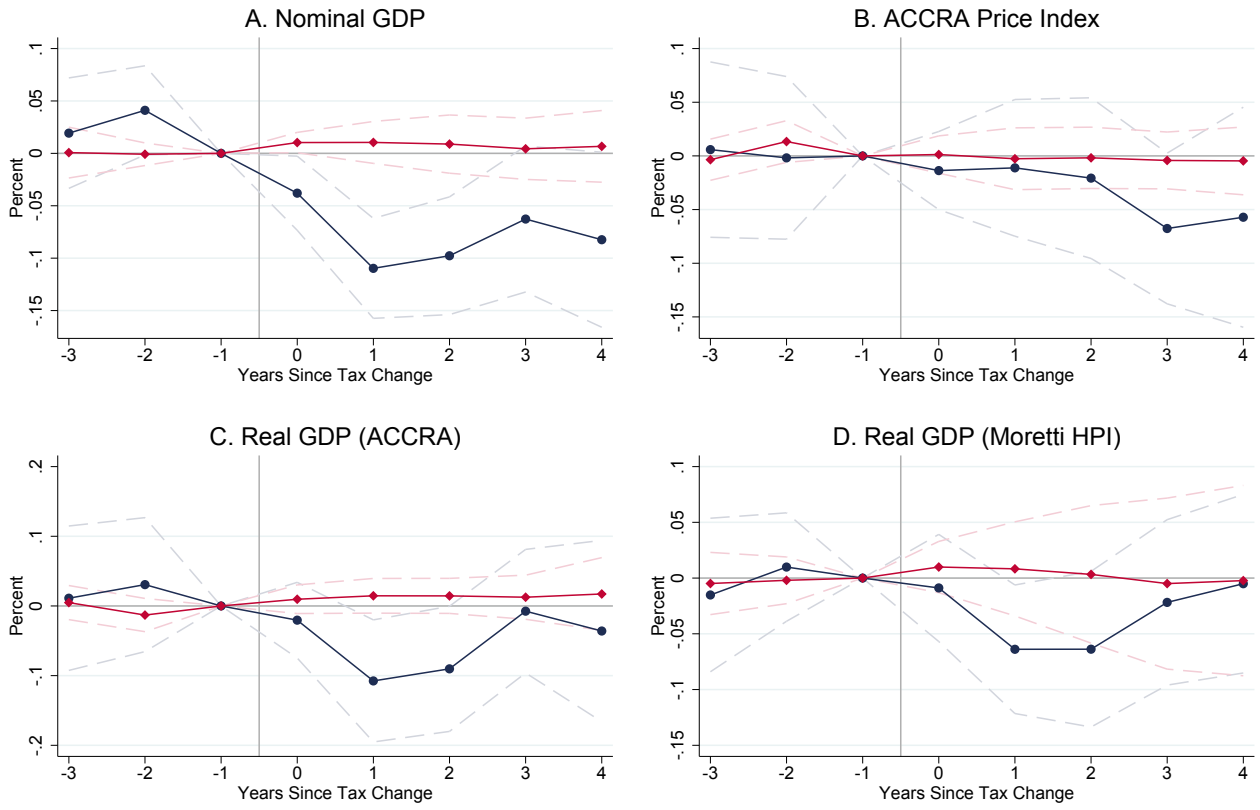

Figure 13: Nominal GDP, Real GDP, Price Indexes Responses to a 1% of GDP Shock (Red: Top 10%; Blue: Bottom 90%). Source: Zidar (2019).

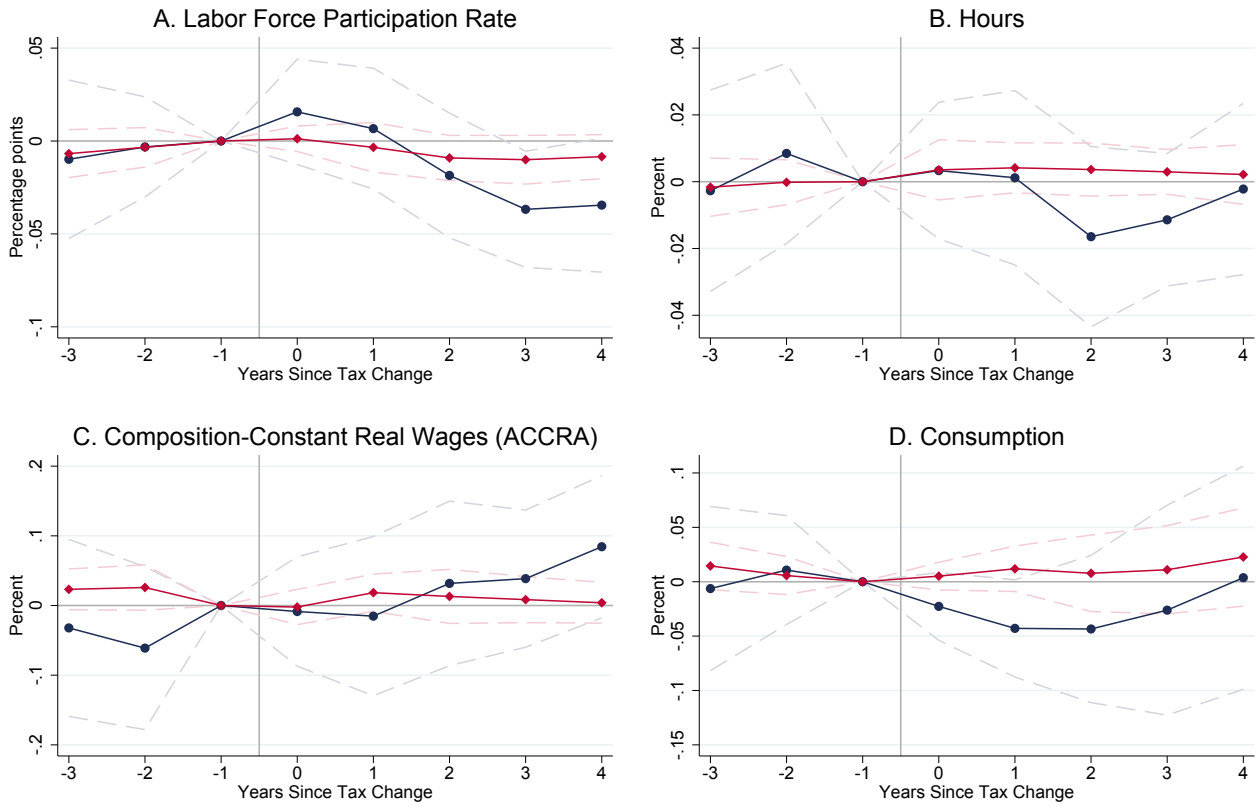

Figure 14: Participation, Hours, Real Wages, Consumption Responses to a 1% of GDP Shock (Red: Top 10%; Blue: Bottom 90%). Source: Zidar (2019).

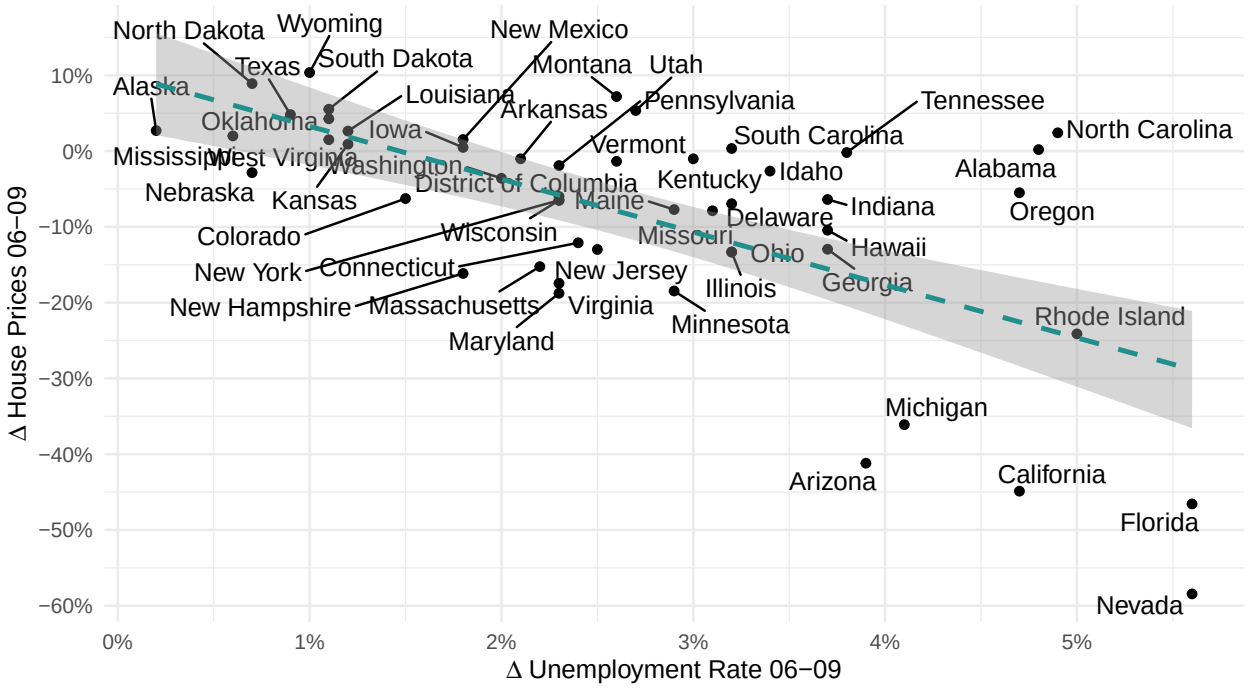

Figure 15: U.S. States Phillips curve (06-09)

Table 14: House Prices and Unemployment (Cross-sectional Regressions, State Level)

Period	PC Slope	t-stat	Adj. R2
1990-1995	-7.1***	-3.9	22%
1999-2005	-6.06**	-2.4	9%
2006-2009	-6.98***	-5.8	40%

5.2 U.S. MSAs

Since house prices probably vary most significantly at the city level, I now run similar cross-sectional regressions for U.S. Metropolitan Statistical Areas (MSAs). Again, regardless of the housing cycle one looks at, there exists a strong correlation between unemployment and house price growth, as shown on Table 15.

Table 15: House Prices and Unemployment (Cross-sectional Regressions, MSA Level)

Period	PC Slope	t-stat	Adj. R2
1990-1995	-2.34***	-7.2	22%
1999-2005	-4.14***	-8.3	9%
2006-2009	-5.48***	-13.7	40%

This correlation is plotted on Figure 16 for the 2006-2009 recession. For example, Merced, California had a higher increase in the unemployment rate and lower house prices price inflation than Midland, Texas.

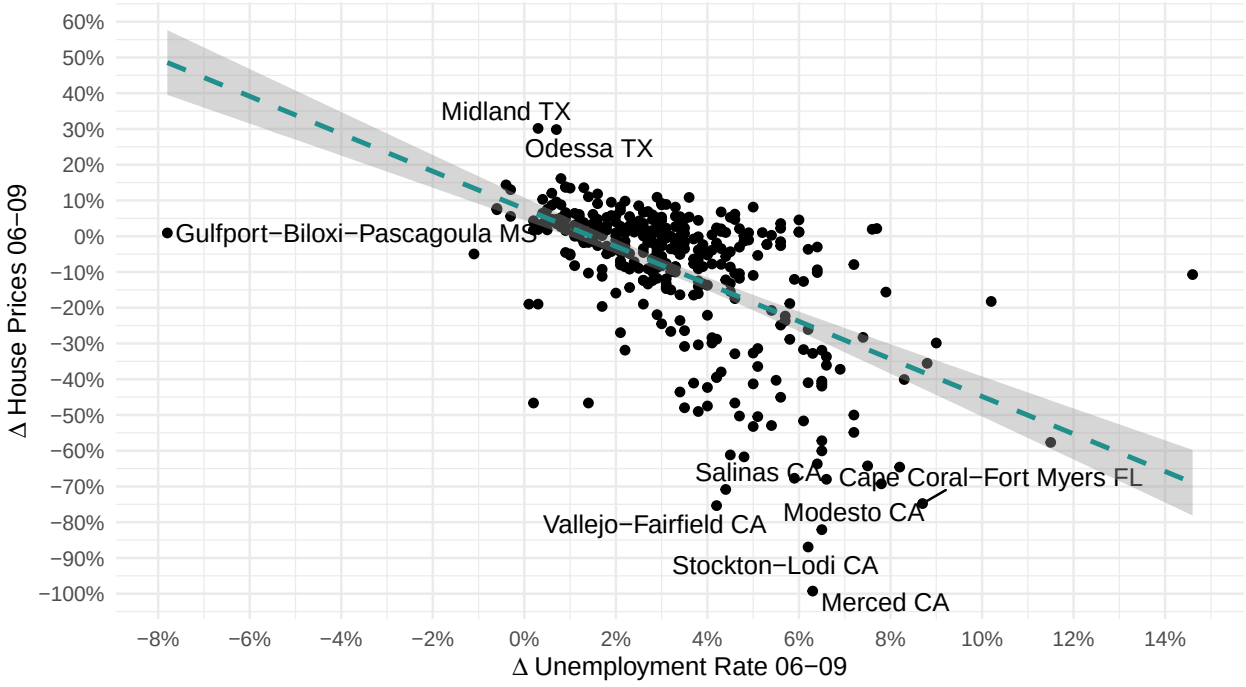

Figure 16: U.S. MSAs Phillips curve (06-09)

5.3 Euro Area Countries

Another example in support of this hypothesis is that of Euro area countries during the early 2000s, where periphery countries had higher consumption, trade deficits, massive capital inflows, higher price inflation,

together with a booming economy. (Martin and Philippon (2017)) This pattern was reversed in the bust, as shown on Figure 17. There was deflation in Greece, associated with high uneployment, following the collapse in aggregate demand prompted by fiscal austerity. Therefore, there was a strong correlation both in the boom and in the bust, between inflation and economic activity. At the same time, according to the external evidence provided above, this should on be interpreted as a structural relationship between competitiveness and economic activity, instead of a traditional Phillips curve.

One often accepted narrative is that fiscal policy was overall too lax in periphery countries such as Greece and Portugal, and that Spain and Ireland did not do enough to contain private leverage. While it is true that expansionary fiscal policy undertaken without coordination runs into potential external balance problems, it is also true that there exists an excess of aggregate savings at the world level. As a consequence, the problem was as much that periphery countries were doing too lax policies that core countries such as Germany were not doing the same.

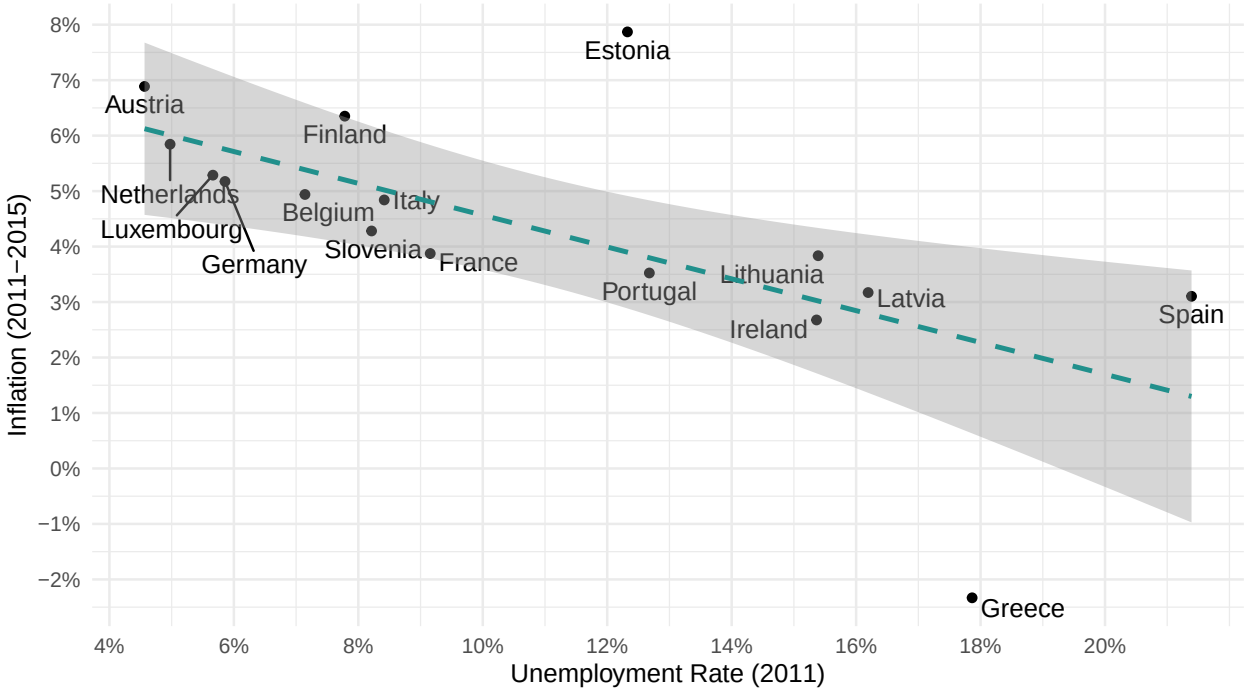

Figure 17: Euro Area Correlation between Inflation and Unemployment (2011-2015)

6 Implications of the Real Exchange Rate Phillips curve

In the previous sections, I have provided evidence in favor of the view that the Phillips curve is not a correlation between price or wage inflation and unemployment, but that it is instead a robust correlation between real exchange rate appreciation and unemployment, or equivalently a correlation between the relative price of non-traded goods (mostly housing and rents) over traded goods and unemployment. What are the consequences of this finding for positive and normative analysis? I first show that this finding is important for identifying the source of business cycle fluctuations, and telling apart between aggregate demand and aggregate supply shocks. This is important for central banks and other actors interested in questions of macroeconomic stabilization. Second, I argue that the costs of "too high" aggregate demand are perhaps more found in an "overvalued" real exchange rate, than in the (small) welfare costs of inflation. However, I emphasize that under secular stagnation, the adjustment should fall on countries with trade surpluses rather than on those which have trade deficits. Third, I show that the trade-off between real exchange rates and unemployment is actually already well-known to policymakers and monitored by them. However, many economists are often skeptical of these so-called competitiveness concerns, so that the real exchange rate

Phillips curve might help bridge the gap between academics and practioners. Fourth and finally, I show that the real exchange rate Phillips curve leads to a different assessment of Keynesian economics. I only sketch the surface here, in depth analysis of these issues is left for future research.

6.1 Identifying the source of business cycle fluctuations

According to the real exchange rate Phillips curve, real exchange rates are a better measure of aggregate demand conditions than inflation. This has important consequences for identifying the source of business cycle fluctuations. For example, high aggregate demand can come together with overall low CPI inflation, if the nominal exchange rate appreciates at the same time. A sign of this phenomenon is that house prices are then relatively high, even though inflation is lower because imported goods are cheaper. Conversely, deficient aggregate demand will not necessarily lead to deflation or falling inflation, if the nominal exchange rate depreciates by enough.

High aggregate demand was accompanied by low inflation at the end of the 1990s, when Alan Greenspan's term as a Federal Reserve chairman was accompanied with "missing inflation" despite a booming economy. The increase in housing prices started at that time, and continued throughout the housing boom of the 2000s. Alan Greenspan was actually even blamed for having made interest rates low for too long, which fuelled the housing bubble. Similarly, inflation has not risen in the United States recently, despite an unprecedented fiscal stimulus in an already low unemployment economy. More generally, with a real exchange rate Phillips curve, an appreciating dollar implies that aggregate demand shocks need not be inflationary, and that the Federal Reserve should monitor at the relative price of non-traded goods versus traded goods, if the objective is aggregate demand stabilization, and avoiding "overheating." I however discuss in the next section that "overheating" is only relative, and that under secular stagnation, the burden of the adjustment should fall on surplus countries, not on a deficit countries, because of deficient global aggregate demand.

Symmetrically, low aggregate demand was accompanied by relatively high inflation in the famous 1970s episode of the "stagflation." This was no failure of Keynesian economics, or the proof of a supply shock, as the story is usually told in undergraduate textbooks, but rather coming from the fact that the dollar had depreciated substantially following Nixon's decision to end the Bretton-Woods system of fixed exchange rates. Similarly, one could infer from the "missing deflation" between 2007 and 2009 that the U.S. simultaneously experienced an aggregate demand and an aggregate supply shock, which has been argued by some scholars (Beraja, Hurst, and Ospina (2016)). According to the real exchange rate Phillips curve, this can perfectly be explained by the fact that all countries experienced a similarly sized negative aggregate demand shock, so that the real exchange rate did not need to adjust by much. And even if the U.S. has been disproportionately hit by the financial crisis, the dollar could have depreciated, which would have replaced deflation in the real exchange rate adjustment. Again, this failure of prices to fall are usually considered a puzzle for Keynesian economics: Paul Krugman (2018) has recently argued that even though macroeconomic analysis fared well during the crisis, there exists "a big failure in our understanding of price dynamics."

Similarly, Zidar (2019) interprets tax multipliers as arising from aggregate supply effects, whereas the rise in wage inflation, house price inflation, and constancy of the real wage is in fact typical of the response to aggregate demand shocks: therefore, his results of large tax multipliers following tax cuts to the bottom 90% of workers can be interpreted as arising from disposable income effects.

More generally, the real exchange rate Phillips curve should allow to better account for the relative importance of aggregate supply and demand shocks to macroeconomic fluctuations. Given the very strong real exchange rate Phillips curve as given by the significance of the previous regressions, or their explanatory power (high R^2), accounting for business cycles through the lens of the real exchange rate Phillips curve will likely give a very important contribution to fluctuations in aggregate demand. However, a full identification the source of business cycle fluctuations based on the real exchange rate Phillips curve is left to future research.

6.2 The costs of overheating

In the new-Keynesian model, the costs of overstimulating the economy are found in the welfare cost of inflation, coming from the dispersion in prices. However, Nakamura et al. (2018) have shown based on

empirical evidence on price dispersion during the Great Inflation of the late 1970s and early 1980s that "the standard New Keynesian analysis of the welfare costs of inflation is wrong", since the welfare costs of inflation are way too small.

If the Phillips curve does not represent a trade-off between inflation and unemployment, but rather one between real exchange rates and unemployment, then the costs of "overstimulating" are potentially very different. The associated costs of high aggregate demand are represented by an oversized real estate, construction, and non-traded sector, which can be detrimental to growth (Rodrik (2008)). In the next section, I discuss that this potential cost is in fact very much discussed by policymakers already, and potentially very salient.

The notion of an "overheating" economy in the context of a real exchange rate Phillips curve should be further discussed, however. With demand-side secular stagnation (Geerolf (2013b), Geerolf (2019)), the problem lies more in low aggregate demand in surplus countries than in too high aggregate demand in deficit countries: there is a global excess of saving over investment, and surplus countries simply "export their way out" of this problem, by finding stores of value abroad. In fact, these issues of surplus countries' adjustment was central to John Maynard Keynes' thinking around the creation of the International Monetary Fund: this was the so-called Keynes plan at Bretton Woods.[8]

6.3 A well-known policy trade-off: aggregate demand and competitiveness

The trade-off between unemployment and real exchange rate appreciation, corresponding to the real exchange rate Phillips curve, is in fact well-known both in the academic as well as the policy world, where issues of external imbalances are often discussed and monitored, albeit usually independantly from inflationary pressures. These worries are often behind the reluctance to stimulate aggregate demand, even when inflation is low. The contribution of this paper is to show that the external balance constraint, and worries about inflation, in fact represent the two sides of the same trade-off: the real exchange rate Phillips curve. This worry is known both in the case of emerging markets, as well as in advanced economies.

The case of emerging markets. Although it is not usually associated to the Phillips curve, a vast body of research has studied the potential effects of aggregate demand stimulating policies on the real exchange rate and competitiveness. In fact, it is well known in business cycle research of emerging economies, that they follow strong patterns of boom-bust episodes. In the boom, there is a rise in the real exchange rate, a move of the economy towards the non-traded sector, a deterioration in competitiveness, together with a rise in consumption (Kalantzis (2015)). For example, Rebelo and Vegh (1995) describe how disinflation came from the stabilization programs in the Southern Cone of Latin America (Argentina, Chile, and Uruguay) in the late 1970s, and the real effects of these experiences: "countries that use the exchange rate as the nominal anchor in inflation stabilization programs experience a boom in economic activity (consumption, investment, and GDP expand), a large real exchange-rate appreciation, a rise in the real wage rate, and a deterioration in the external accounts. Later in the programs, these effects are often reversed, with the economy contracting sharply and the real exchange rate depreciating." Again, this is just a reflection of the real exchange rate Phillips curve. In fact, this is often a very important argument against Keynesian, stimulative policies, which is given in the policy world. A textbook treatment of these effects is given in Vegh (2013), and in Schmitt-Grohé and Uribe (2016). For example, Figure 61 is taken from Vegh (2013), and it shows that boom busts episodes are characterized by a high relative price of non tradables during the boom, associated with a large current account deficit. I next show that this trade-off is in fact not only present in emerging markets, but that it is a well-known issue in advanced economies as well.

The trade-off in advanced economies. In fact, the suggested trade-off between unemployment and real exchange rates is not just relevant for emerging markets, it has in fact long been discussed by policymakers around the world. The starkest example is provided by a policy publication called *Economic Report of the President*. For example, the 1963 Economic Report of the President report has a chapter called "Prices, Wages, and the balance of payments" (Kennedy (1963)). In this chapter, one can read the following: "Stability of prices is particularly important for the balance of payments. It should be emphasized, however, that what is significant for America's competitive position in international grade is not the absolute change in the level of U.S. prices, but rather the change relative to prices abroad." Current discussions around U.S. trade deficits,

[8] See Steil (2013) for historical background around the *Battle of Bretton Woods*.

prompted by very accommodative fiscal policies, can also been understood in terms of the trade-off between real exchange rates and unemployment. The Trump tax cuts have led to a nominal appreciation of the dollar, instead of price inflation in the United States. This might explain why inflation has not risen so far despite unprecedented tightness in the labor market, which Janet Yallen has called "the biggest surprise in the U.S. economy." (Yellen (2017))

Another example is provided by the United Kingdom, where aggregate demand stimulating policies are usually called "income policies". In reviewing Forder (2014)'s critical take on the Phillips curve, Goodhart (2018) argues that "under Bretton Woods, the relevant trade-off in the U.K. was between growth and the Balance of Payments." This appears to be a very general pattern, at least in fixed exchange rate regimes. Again, this trade-off is not unknown from policymakers, and even academics. For example, J.M. Keynes advocated in favor of a general tariff on imports "without discriminating protective taxes" in *Proposals for a Revenue Tariff*, published in March 1931, precisely to avoid the negative effects of stimulus policies on the balance of trade.[9]

Another example is that of countries in the euro area, or even before the euro of countries inside the Exchange Rate Mechanism, as they were preparing for a common currency. For example, after experiencing with Keynesian policies at the beginning of François Mitterand's first presidential term from 1981 to 1983, France embarked on austerity measures in 1983. Jacques Delors, then Minister of Finance, justified the fiscal consolidation measures by referring to the growing French trade deficit (March 25 1983): "We cannot continue to consume more than we produce, to buy more than we sell abroad. For three, four years, France is in this situation. This must change, and fast... We designed these measures as much as possible by reducing public deficits, and the least possible by directly reducing household incomes... This effort is only temporary. It must be massive enough to allow the rapid decline in imports in an open economy without protectionism." Throughout the 1980s and 1990s, France was then said to be experiencing with "competitive desinflation", as the "franc" was trying to follow the "mark": inflation and competitiveness were then seen as going hand in hand. Inflation was a problem not per se (because of price dispersion, for example) but rather because it meant loss of competitiveness. In discussing Blanchard and Giavazzi (2002)'s optimistic assessment of trade deficits in Europe, Pierre-Olivier Gourinchas was asking: "Should we worry?", comparing the situation of Portugal and Greece to that of Latin American countries which had adopted exchange rate stabilization programs.[10] Once again, the relevant trade-off seemed to be between fiscal profiligacy, and trade deficits, rather than inflation.

Finally, the Japanese episode can be interpreted through the same theoretical framework. Again, the level of the real exchange rate played an important role. In 1985, the Plaza Accord forced Japan to move from an export-driven model of growth, to a demand-driven model. This is reflected on Figure 60. An increase in trade deficits, together with a large increase in house prices and the price of land, ensued. Unemployment rates reached a low point. In the early 1990s, this consumption-led boom came to a halt, unemployment increased, and the real exchange rate depreciated very sharply.

[9] "I do not believe that a wise and prudent Budget can be framed today without recourse to a revenue tariff. (...) In so far as it leads to the substitution of home-produced goods for goods previously imported, it will increase employment in this country. At the same time, by relieving the pressure on the balance of trade it will provide a much-needed margin to pay for the additional imports which a policy of expansion will require and to finance loans by London to necessitous debtor countries. In these ways, the buying power which we take away from the rest of the world by restricting certain imports we shall restore to it with the other hand. Some fanatical Free Traders might allege that the adverse effect of import duties on our exports would neutralise all this; but it would not be true." Of course, because he was in favor of the international division of labor based on comparative advantage, he advocated a tariff on the broadest possible range of goods: "The tariff which I have in mind would include no discriminating protective taxes, but would cover as wide a field as possible at a flat rate or perhaps two flat rates, each applicable to wide categories of goods". For this same reason, his views were also quite sympathetic to mercantilism in Chapter 23 of the General Theory (Keynes (1936)).

[10] "The experience of these two countries—up to this point—is very reminiscent of that of many Latin American countries that have adopted exchange rate–based stabilization programs. Stabilization of the exchange rate, renewed access to international capital markets, and some euphoria at the prospect of steady future growth combined to generate a strong consumption boom—that is, a decline in saving—which may or may not have been accompanied by an investment boom. Growth was initially solid and everything looked benign. Over time, however, clouds gathered on the horizon: the currency appreciated in real terms, competitiveness plummeted, and foreign investors became worried as growth performance failed to meet expectations. The endgame is well known: with a fixed exchange rate, restoring competitiveness required an adjustment in relative prices. Often this was too little and too late. Eventually capital pulled out, forcing a devaluation." (Blanchard and Giavazzi (2002))

Conclusion

This paper suggests that the Phillips curve in fact reflects a relationship between relative prices and unemployment, not a monetary phenomenon. Sleeman (2011) in a retrospective on the Phillips curve argues that "A.W. Phillips was not satisfied with the paper and had not intended to publish it in 1958." He further notes: "I believe that Phillips was well aware that his case for the stability of his famous curve was not compelling. His comments on his 1958 paper were often dismissive: he referred to the paper as "a very crude attempt" (Leeson, 2000, p. 218), a "quick and dirty job" (Schwier, 2000, p. 24), something "just done in a weekend" (letter from Gregory quoted by Leeson, 1994a, p. 613), and as a "rushed job" (Blyth, 1978, p. xvi). The then-editor of Economica, Basil Yamey (Leeson, 2000, p. 337), wrote that he would show Phillips the Phillips-curve papers submitted to Economica, but that Phillips "always declined my invitation to write comments on the more substantial pieces or indeed to write a follow-up article to include his further reflflections. He seems to have lost interest in the subject soon after the paper was published. His fertile mind had moved on to other matters." Holt, a fellow engineer turned economist, who spent a sabbatical at LSE observes (2000, pp. 309–310): "I think that he was a little embarrassed by the attention that the paper received../.. perhaps because both the empirical econometric work and the theory were conspicuously sloppy."". Even so,"the concept became familiar to students and teachers of economics a year later when Samuelson (1961, p. 383) incorporated the Phillips curve in its trade-off form into the fifth edition of Economics, the textbook that dominated the teaching of introductory economics on both sides of the Atlantic in the early 1960s."

Dissatisfaction on the Phillips curve has been expressed by prominent Keynesians before. In 1991, Larry Summers did not mince his words: "Frequent ad hoc adjustments to account for embarrassing realities were a hallmark of Ptolemaic astronomy. It is sad but true that the half-life of various Keynesian views about the aggregate supply curve has been little more than a decade. In The General Theory (1947) Keynes proposed that the aggregate supply curve drawn in unemployment-price space was L-shaped. This view was falsified by the coincidence of inflation and less than full employment in the late 1940s and 1950s. By the early 1960s, a derivative was slipped and Keynes's view had given way to the Phillips curve vision of a stable downward-sloping relationship between unemployment and the rate of inflation. This view remained popular for not much more than a decade. The stagflation of the 1970s led to the slipping of another derivative and the widespread acceptance of the view that there existed a natural rate of unemployment, which was the only rate at which inflation could remain stable. On this 'expectations augmented' Phillips curve view, there is a trade-off not between current inflation and current unemployment but between permanent inflation and current unemployment." According to him, "even its friends must acknowledge that the textbook Keynesian view of aggregate supply possesses many of the attributes that Thomas Kuhn has ascribed to dying scientific paradigms." (Summers (1991)) In 2017, he reiterated: "Recent events are as severe a challenge to current orthodoxy as the Depression was to the orthodoxy of John Maynard Keynes' times or the inflation of the 1970s was to the orthodoxy of its time." (Summers (2017))

In this paper, I have argued that the Phillips correlation between inflation and unemployment perhaps never was about inflation, but that it was instead about real exchange rates. And in fact, Nakamura et al. (2018) have shown based on empirical evidence on price dispersion during the Great Inflation of the late 1970s and early 1980s that "the standard New Keynesian analysis of the welfare costs of inflation is wrong", since the welfare costs of inflation are way too small. The results in this paper suggest that the impact of stimulative policies on competitiveness and trade deficits is potentially large. I have shown that although the failure of the Phillips curve contradicts the New-Keynesian theory of Aggregate Supply, it is consistent with a demand-based secular stagnation view based on excess saving and limited investment needs. The empirical evidence for such a "savings glut" has been illustrated in Geerolf (2013a) and Geerolf (2013b). A theoretical model with demand-driven secular stagnation has been developed in Geerolf (2019). In fact, there was very little mention of sticky prices or wages in Keynes' work, as argued very early on by Axel Leijonhufvud (1967) and others.

Is this view is correct, then the Phillips curve still might represent some meaningful trade-off, perhaps not between inflation and unemployment, but between competitiveness (real exchange rates) and unemployment instead. Indeed, one important concern with Keynesian policies that they have a negative effect on the balance of trade, a concern which is much discussed in policymaking. In fact, concerted action of aggregate-demand

stimulating policies is often undertaken on these grounds. Similarly, one can view the current trade tensions between the United States and surplus countries (Germany and Japan) also in light of this issue. The most preferable course of action to deal with these problems is international coordination of fiscal policies. However, when such coordination is not possible, there is a trade-off for a given country taken in isolation. How to best manage that trade-off between competitiveness and unemployment, through exchange rate policy, trade policy, or management of capital flows (which the IMF has recently argued in favor of), is an important question for future research.

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A Price Levels and Real Exchange Rates

In this section, I remind the reader of basic concepts in international economics concerning the relationship between price levels, the nominal and real exchange rates. The real exchange rate ϵ is given as a function of the nominal exchange rate E, the home price level P and the foreign price level P^* by:

$$\epsilon = \frac{E \cdot P}{P^*}$$

Throughout, I assume that the foreign price is fixed, either because I consider a small open economy, or because I implicitely neglect the effects of the home economy on the foreign economy. Therefore, shocks to the home economy are considered, taking other economies as given:

$$P^* = \bar{P}^*.$$

I now relate price levels and real exchange rates, and the first difference of their logarithms, inflation and real exchange rate appreciation, under different monetary policy arrangements. I consider fixed exchange rates, then flexible exchange rates with perfect price level or inflation taregeting, and finally a mixed regime, whereby in general both the nominal exchange rate and the price level adjust following a shock to the real exchange rate.

A.1 Fixed Exchange Rates

Under fixed exchange rates ($E = \bar{E}$), a higher price level implies a higher level of the real exchange rate:

$$E = \bar{E} \quad \Rightarrow \quad \epsilon = \left(\frac{\bar{E}}{\bar{P}^*}\right) \cdot P.$$

From the above expression, real exchange rate appreciation is simply equal to inflation in fixed exchange rates:

$$\Delta \log \epsilon = \Delta \log P.$$

As a consequence, a correlation between inflation and unemployment is also a correlation between real exchange rate appreciation and unemployment. Anticipating on the results, this paper shows that in fact, Phillips curves have only robustly been documented under fixed exchange rate regimes.

A.2 Flexible Exchange Rates with Price-level / Inflation targeting

Under flexible exchange rates, and assuming price level targeting $P = \bar{P}$, the level of the real exchange rate depends linearly on the level of the nominal exchange rate:

$$P = \bar{P} \quad \Rightarrow \quad \epsilon = \left(\frac{\bar{P}}{\bar{P}^*}\right) \cdot E.$$

With flexible exchange rate, under inflation targeting, real exchange rate appreciation is equal to nominal exchange rate growth:

$$\Delta \log \epsilon = \Delta \log E.$$

This is a fortiori the case for price level targeting, as the inflation rate is then also constant and equal to zero.

A.3 Flexible Exchange Rates

If neither the price level nor the nominal exchange rate are stabilized, then the level of the real exchange rate depends on both:

$$\epsilon = \left(\frac{1}{\bar{P}^*}\right) \cdot E \cdot P.$$

As a consequence, an rise in the real exchange rate can occur through both through an appreciation of the nominal exchange rate, or a rise in the level of prices.

Conditional on real exchange rate appreciation, the split between inflation and nominal exchange rate growth is undetermined:

$$\underbrace{\Delta \log \epsilon}_{\text{Real ER Growth}} = \underbrace{\Delta \log E}_{\text{Nominal ER Growth}} + \underbrace{\Delta \log P}_{\text{inflation}}.$$

A.4 Summary

Given the definitions above, a relationship between inflation and unemployment in a fixed exchange rate regime, as that considered in Phillips (1958) and Samuelson and Solow (1960), may as well be a relation between real exchange rates and unemployment.

B Phillips curve Correlations

B.1 Cross-Country Evidence

B.1.1 Original Price Phillips curves

B.1.1.1 Harmonised headline inflation

Table 16: Original Phillips curve: Harmonised headline inflation and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.22***	-7.7	14.7%	334
Crawling Peg	-0.06	-0.4	-2.5%	33
Crawling Band	-0.39**	-2.2	11.6%	27
Floating	0.7**	3.2	47.7%	9

Table 17: Original Phillips curve: Harmonised headline inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-20.05***	-5.9	10.4%	291
Crawling Peg	-10.42	-0.6	-2.3%	25
Crawling Band	36.57*	1.8	11%	17
Floating	77.36**	3.2	48.7%	9

B.1.1.2 Core inflation

Table 18: Original Phillips curve: Core inflation and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.53**	-2.3	9.2%	39
Crawling Peg	-0.58**	-2.0	2.4%	119
Crawling Band	-1.05***	-4.6	5.8%	321
Floating	-0.13	-0.9	-0.2%	110

Table 19: Original Phillips curve: Core inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-66.64***	-4.0	28.2%	38
Crawling Peg	-40.73	-1.4	0.7%	119
Crawling Band	-61.11***	-3.2	3.5%	254
Floating	-11.54	-0.8	-0.3%	110

B.1.1.3 Harmonised core inflation

Table 20: Original Phillips curve: Harmonised core inflation and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.23***	-9.2	19.9%	334
Crawling Peg	-0.17	-1.0	-0.2%	32
Crawling Band	-0.16	-0.8	-2%	21
Floating	0.38**	3.2	47.9%	9

Table 21: Original Phillips curve: Harmonised core inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-18.71***	-6.4	11.9%	291
Crawling Peg	-19.19	-1.2	1.7%	24
Crawling Band	-62.15	-1.3	5.9%	11
Floating	38.32**	2.5	33.9%	9

B.1.1.4 Consumption deflator growth

Table 22: Original Phillips curve: Consumption deflator growth and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.29***	-8.3	11%	543
Crawling Peg	-0.47***	-4.1	4.4%	333
Crawling Band	-0.86***	-4.8	5%	422
Floating	-0.16	-1.1	0.1%	129

Table 23: Original Phillips curve: Consumption deflator growth and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-29.42***	-6.3	7.7%	460
Crawling Peg	-60.37***	-4.2	6.3%	240
Crawling Band	-75.52***	-4.3	5.9%	283
Floating	-12.64	-0.8	-0.2%	129

B.1.1.5 GDP Deflator growth

Table 24: GDP Deflator growth and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.35***	-9.6	14.3%	541
Crawling Peg	-0.53***	-4.7	6.1%	327
Crawling Band	-0.84***	-4.9	5.1%	423
Floating	-0.31**	-2.1	2.5%	129

Table 25: GDP Deflator growth and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-46.07***	-5.0	4.9%	460
Crawling Peg	-83.8***	-5.1	9.4%	240
Crawling Band	-107.23***	-4.7	7%	283
Floating	-15.57	-0.9	-0.1%	129

B.1.1.6 Headline inflation

Table 26: Original Phillips curve: Headline inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-36.53**	-2.6	7.2%	73
Crawling Peg	-47.58*	-1.7	1.3%	152
Crawling Band	-66.61***	-3.6	4.7%	249
Floating	-21.27	-1.3	0.5%	114

B.1.2 Accelerationist Phillips curves

B.1.2.1 Harmonised headline inflation

Table 27: Accelerationist Phillips curve: Harmonised headline inflation and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.09***	-3.2	2.8%	326
Crawling Peg	-0.09	-0.6	-2.6%	26
Crawling Band	-0.73***	-5.0	47.5%	25
Floating	0.07	0.2	-11.7%	8

Table 28: Accelerationist Phillips curve: Harmonised headline inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-12.74***	-3.6	4.1%	284
Crawling Peg	3	0.1	-5.2%	19
Crawling Band	-32.75**	-2.6	24.9%	16
Floating	8.85	0.4	-10.6%	8

B.1.2.2 Core inflation

Table 29: Accelerationist Phillips curve: Core inflation and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.28	-1.2	1.1%	36
Crawling Peg	-0.24*	-1.9	2.3%	114
Crawling Band	-0.06	-0.4	-0.3%	311
Floating	-0.13**	-2.3	3.6%	109

Table 30: Accelerationist Phillips curve: Core inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-4.04	-0.2	-2.8%	35
Crawling Peg	-15.76	-0.9	-0.2%	114
Crawling Band	-12.23	-0.9	-0.1%	247
Floating	-10.69	-1.5	1.1%	109

B.1.2.3 Harmonised core inflation

Table 31: Accelerationist Phillips curve: Harmonised core inflation and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.07***	-3.5	3.3%	326
Crawling Peg	-0.06	-0.4	-3.2%	25
Crawling Band	-0.67***	-7.4	72.7%	19
Floating	0.09	0.6	-7.8%	8

Table 32: Accelerationist Phillips curve: Harmonised core inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-10.15***	-4.1	5.3%	284
Crawling Peg	0.36	0.0	-5.5%	18
Crawling Band	-104.18**	-3.1	44.1%	10
Floating	7.63	0.4	-10.3%	8

B.1.2.4 Consumption deflator growth

Table 33: Accelerationist Phillips curve: Consumption deflator growth and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.07**	-2.5	1%	525
Crawling Peg	-0.24***	-2.7	2%	323
Crawling Band	-0.19	-1.6	0.4%	413
Floating	-0.21***	-2.7	4.6%	128

Table 34: Accelerationist Phillips curve: Consumption deflator growth and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-10.06*	-1.8	0.5%	444
Crawling Peg	-18.93*	-1.9	1.2%	234
Crawling Band	-6.85	-0.4	-0.3%	280
Floating	-20.55**	-2.4	3.5%	128

B.1.2.5 GDP Deflator, growth

Table 35: GDP Deflator growth and Unemployment (Annual)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-0.04	-1.2	0.1%	522
Crawling Peg	-0.14*	-1.8	0.7%	318
Crawling Band	-0.13	-1.1	0.1%	415
Floating	-0.16*	-1.9	1.9%	128

Table 36: GDP Deflator growth and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-9.52	-0.8	-0.1%	444
Crawling Peg	-3.1	-0.2	-0.4%	234
Crawling Band	-0.82	0.0	-0.4%	280
Floating	-4.43	-0.3	-0.7%	128

B.1.2.6 Headline inflation

Table 37: Accelerationist Phillips curve: Headline inflation and Unemployment (Quarterly)

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-28.22**	-2.1	4.9%	67
Crawling Peg	-20.91	-1.2	0.3%	147
Crawling Band	-6.36	-0.5	-0.3%	246
Floating	-31.77***	-2.7	5.3%	114

B.1.3 House Prices Phillips curves

B.1.3.1 House Prices (BIS)

Table 38: House Prices (BIS) and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-247.77***	-11.8	35.5%	250
Crawling Peg	-289.16***	-8.0	24.4%	192
Crawling Band	-302.56***	-7.8	22%	210
Floating	-325.51***	-5.2	16.7%	127

B.1.3.2 House Prices (Dallas Fed)

Table 39: Dallas Fed Nominal House Price Growth and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-120.81***	-9.2	24.6%	258
Crawling Peg	-128.18***	-5.2	14.1%	156
Crawling Band	-119.02***	-5.8	13.6%	209
Floating	-130.87***	-3.8	9.7%	125

Table 40: Dallas Fed Real House Price Growth and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-95.38***	-7.3	16.9%	258
Crawling Peg	-58.71**	-2.2	2.4%	156
Crawling Band	-41.46*	-1.9	1.2%	209
Floating	-128.42***	-4.2	11.7%	125

B.1.3.3 House Prices (OECD)

Table 41: OECD House Price Growth and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-113.14***	-8.9	19.4%	326
Crawling Peg	-145.04***	-7.0	17.4%	226
Crawling Band	-141.57***	-6.9	15.3%	259
Floating	-134.54***	-4.0	10.2%	128

Table 42: OECD Real House Price Growth and Unemployment

Exchange Rate Regime	PC Slope	t-stat	Adj. R2	N
Fixed / Peg	-77.13***	-6.0	9.7%	326
Crawling Peg	-65.87***	-3.0	3.4%	226
Crawling Band	-66.48***	-2.9	2.8%	259
Floating	-123.53***	-4.1	11%	128

B.1.4 CPI Components

Table 43: 2-Year Inflation and Unemployment, by Exchange Rate Regime

CPI Concept	Fixed	Cr. Peg	Cr. Band	Float
CPI: 01 - Food & non-Alcoholic beverages	-0.62***	-1.72***	-2.19***	-0.21
CPI: 01-12 - All items	-0.5***	-1.12***	-1.13***	-0.11
CPI: 02 - Alcoholic beverages, tobacco & narcotics	0.07	-0.51	0.44	0.44
CPI: 03 - Clothing & footwear	-0.47***	0.39	0.12	-2.15***
CPI: 04 - Housing, water, electricity, gas & other fuels	-0.48***	-0.26	-0.74***	-1.56***
CPI: 04.1 - CPI Actual rentals for housing	-1.55***	-0.27	-0.26	-0.95***
CPI: 04.2 - CPI Imputed rentals for housing	0.24	-1.25***	-1.22***	-2.04***
CPI: 04.3 - CPI Maintenance & repairs of dwellings	-0.88***	-0.23	-0.28	-0.47
CPI: 04.4 - CPI Water supply & Misc. services	-0.37***	1.57**	0.54**	-0.27
CPI: 04.5 - CPI Electricity, gas & other fuels	0.13	0.89	-0.48	-1.18*
CPI: 05 - Furnishings, household equipment	-0.57***	-0.06	0.01	-1.83***
CPI: 06 - Health	-0.3***	0.09	0.22	-0.04
CPI: 07 - Transport	-0.24**	0.74*	0.24	1.84***
CPI: 07.2.2 - CPI Fuels & lubricants	-0.21	0.22	0.2	1.37
CPI: 08 - Communication	0.14	-0.07	0.92**	0.16
CPI: 09 - Recreation & culture	-0.43***	0.01	0.03	-2.32***
CPI: 10 - Education	-0.16	0.29	0.38	-0.7
CPI: 11 - Restaurants & hotels	-0.63***	-0.5	-0.82***	-1.66***
CPI: 12 - Miscellaneous goods & services	-0.39***	0.16	-0.21	-0.53
CPI: All items non-food non-energy	-0.59***	-0.92***	-1.03***	0.14
CPI: Energy	-0.11	-0.42	-0.79**	0
CPI: Goods	-0.35***	0.36	0	-0.9*
CPI: Housing	-0.73***	-1.2***	-0.72**	-0.88***
CPI: Housing excl. imp. rent	-1.07***	0.05	-1.5***	-0.99***
CPI: Services	-0.69***	-0.61*	0.58**	-1.03***
CPI: Services less housing	-0.63***	-0.11	-0.63*	-0.99***
CPI: Services less housing (Housing excl. imp. rent)	-0.52***	-0.99***	-4.01***	0.17
HICP: 01 - Food & non-Alcoholic beverages	-0.45***	0.33	-1.46**	0.95*
HICP: 02 - Alcoholic beverages, tobacco & narcotics	0.07	0.67**	-1.27**	2.03***
HICP: 03 - Clothing & footwear	-0.4***	0.36	-0.36	0.5
HICP: 04 - Housing, water, electricity, gas & other fuels	-0.27***	2.59***	-1.44**	-0.6
HICP: 04.1 - HICP Actual rentals for housing	-1.42***	2.53***	-1.78**	0.06
HICP: 04.3. - HICP Maintenance & repairs of dwellings	-0.82***	0.81***	-1.77***	3.06***
HICP: 04.4 - HICP Water supply & Misc. services	-0.44**	2.47***	-1.19*	2.12**
HICP: 04.5 - HICP Electricity, gas & other fuels	0.1	3.25***	-1.34*	4.33
HICP: 05 - Furnishings, household equipment	-0.46***	0.51**	-1.01	0.5
HICP: 06 - Health	-0.21**	0.34	-1.73**	0.18
HICP: 07 - Transport	-0.22**	2.06***	-1.2*	1.08
HICP: 07.2.2 - CPI Fuels & lubricants	-0.19	3.4***	-1.33	10.58***
HICP: 08 - Communication	0.35***	2.07***	-0.57	0.91*
HICP: 09 - Recreation & culture	-0.39***	0.62**	-0.9	0.17
HICP: 10 - Education	-0.15	0.71	-1.58**	-0.14
HICP: 11 - Restaurants & hotels	-0.59***	0.67**	-1.9***	-0.17
HICP: 12 - Miscellaneous goods & services	-0.38***	0.8***	-1.55***	0.14
HICP: All items	-0.32***	0.55**	-1.01*	0.27
HICP: Energy	-0.09	3.45***	-1.37**	7.06***
HICP: Ind. excl. energy, food, alcohol & tobacco	-0.37***	0.57*	-1.05*	0.66**
HICP: Services	-0.47***	1.24***	-1.57**	0.81***

Table 44: 3-Year Inflation and Unemployment, by Exchange Rate Regime

CPI Concept	Fixed	Cr. Peg	Cr. Band	Float
CPI: 01 - Food & non-Alcoholic beverages	-0.77***	-3.02***	-3.07***	0.04
CPI: 01-12 - All items	-0.63***	-1.95**	-1.46***	0.15
CPI: 02 - Alcoholic beverages, tobacco & narcotics	0.3**	-0.83*	0.86**	0.6
CPI: 03 - Clothing & footwear	-0.67***	0.89	0.31	-3.69***
CPI: 04 - Housing, water, electricity, gas & other fuels	-0.4**	-0.03	-0.68**	-1.82***
CPI: 04.1 - CPI Actual rentals for housing	-1.99***	-0.22	0.21	-1.34**
CPI: 04.2 - CPI Imputed rentals for housing	0.85	-1.37**	-1.12**	-3.51***
CPI: 04.3 - CPI Maintenance & repairs of dwellings	-1.15***	0.11	-0.13	-0.48
CPI: 04.4 - CPI Water supply & Misc. services	-0.3	2.3**	1.07***	-0.45
CPI: 04.5 - CPI Electricity, gas & other fuels	0.62***	1.77**	-0.34	-2.12**
CPI: 05 - Furnishings, household equipment	-0.73***	0.11	0.31	-2.83***
CPI: 06 - Health	-0.39***	0.25	0.55*	-0.42
CPI: 07 - Transport	-0.27*	1.09*	0.67*	2.01***
CPI: 07.2.2 - CPI Fuels & lubricants	-0.04	0.29	0.37	1.55
CPI: 08 - Communication	0.26	0.41	1.53**	-0.03
CPI: 09 - Recreation & culture	-0.59***	0.13	0.35	-3.64***
CPI: 10 - Education	-0.16	0.14	0.86**	-1
CPI: 11 - Restaurants & hotels	-0.77***	-0.73	-0.75**	-2.54***
CPI: 12 - Miscellaneous goods & services	-0.46***	0.13	-0.03	-0.66
CPI: All items non-food non-energy	-0.74***	-1.1***	-1.28***	0.44
CPI: Energy	0.15	-0.21	-0.94**	0.71
CPI: Goods	-0.31*	0.85	0.23	-1.97***
CPI: Housing	-0.98***	-1.48***	-0.65	-1.1***
CPI: Housing excl. imp. rent	-1.38***	0.25	-1.97**	-1.26**
CPI: Services	-0.8***	-0.51	1.39***	-1.24**
CPI: Services less housing	-0.75***	0.07	-0.89*	-1.17***
CPI: Services less housing (Housing excl. imp. rent)	-0.55***	-0.96*	-5.91***	0.13
HICP: 01 - Food & non-Alcoholic beverages	-0.47***	0.66**	-1.31*	1.66**
HICP: 02 - Alcoholic beverages, tobacco & narcotics	0.34***	0.98***	-1.05	3.03***
HICP: 03 - Clothing & footwear	-0.55***	0.83**	0.43	0.29
HICP: 04 - Housing, water, electricity, gas & other fuels	-0.09	3.96***	-1.12	-0.72
HICP: 04.1 - HICP Actual rentals for housing	-1.82***	3.52***	-1.18	-0.16
HICP: 04.3. - HICP Maintenance & repairs of dwellings	-1.02***	1.34***	-1.5	5.13***
HICP: 04.4 - HICP Water supply & Misc. services	-0.41*	3.22***	-0.47	2.03*
HICP: 04.5 - HICP Electricity, gas & other fuels	0.58**	4.91***	-1.09	5.53*
HICP: 05 - Furnishings, household equipment	-0.55***	1.06***	-0.62	0.84**
HICP: 06 - Health	-0.24**	0.57	-1.77	0.34*
HICP: 07 - Transport	-0.16	2.71***	-0.91	1.46
HICP: 07.2.2 - CPI Fuels & lubricants	0.01	4.1***	-1.08	14.96***
HICP: 08 - Communication	0.63***	3.53***	-0.24	1.34*
HICP: 09 - Recreation & culture	-0.49***	0.99***	-0.53	0.17
HICP: 10 - Education	-0.04	0.46	-1.44	-0.3
HICP: 11 - Restaurants & hotels	-0.69***	1***	-1.85**	-0.06
HICP: 12 - Miscellaneous goods & services	-0.4***	1.21***	-1.37	0.25
HICP: All items	-0.32***	1.1***	-0.74	0.39
HICP: Energy	0.28	4.81***	-1.13	9.75***
HICP: Ind. excl. energy, food, alcohol & tobacco	-0.43***	1.25***	-0.65	0.78**
HICP: Services	-0.51***	1.92***	-1.3	1.04***

Table 45: 1-Year Inflation and Unemployment, by Exchange Rate Regime

CPI Concept	Fixed	Cr. Peg	Cr. Band	Float
CPI: 01 - Food & non-Alcoholic beverages	-0.35***	-0.69***	-1.16**	-0.24
CPI: 01-12 - All items	-0.28***	-0.46***	-0.73***	-0.2
CPI: 02 - Alcoholic beverages, tobacco & narcotics	-0.06	-0.15	0.03	0.14
CPI: 03 - Clothing & footwear	-0.23***	0.12	0.09	-0.94***
CPI: 04 - Housing, water, electricity, gas & other fuels	-0.34***	-0.33	-0.51***	-0.93***
CPI: 04.1 - CPI Actual rentals for housing	-0.77***	-0.24*	-0.41***	-0.49***
CPI: 04.2 - CPI Imputed rentals for housing	-0.01	-0.85***	-0.77***	-0.94***
CPI: 04.3 - CPI Maintenance & repairs of dwellings	-0.46***	-0.28	-0.34***	-0.32**
CPI: 04.4 - CPI Water supply & Misc. services	-0.24***	0.62	0.03	-0.16
CPI: 04.5 - CPI Electricity, gas & other fuels	-0.06	0.14	-0.4**	-0.53
CPI: 05 - Furnishings, household equipment	-0.32***	-0.13	-0.04	-0.88***
CPI: 06 - Health	-0.18***	-0.08	0.08	0
CPI: 07 - Transport	-0.15**	0.25	0.03	1.03***
CPI: 07.2.2 - CPI Fuels & lubricants	-0.17	-0.07	-0.02	0.63
CPI: 08 - Communication	0.03	-0.19	0.46**	0.16
CPI: 09 - Recreation & culture	-0.22***	-0.05	-0.04	-1.12***
CPI: 10 - Education	-0.12*	0.11	0.08	-0.4*
CPI: 11 - Restaurants & hotels	-0.37***	-0.32*	-0.53***	-0.81***
CPI: 12 - Miscellaneous goods & services	-0.24***	0.07	-0.22*	-0.39**
CPI: All items non-food non-energy	-0.34***	-0.57***	-0.59***	-0.05
CPI: Energy	-0.14	-0.43**	-0.56***	-0.42
CPI: Goods	-0.23***	0.04	-0.08	-0.26
CPI: Housing	-0.39***	-0.72***	-0.53***	-0.49***
CPI: Housing excl. imp. rent	-0.56***	-0.09	-0.83***	-0.53***
CPI: Services	-0.42***	-0.47***	0.06	-0.61***
CPI: Services less housing	-0.34***	-0.19	-0.46**	-0.6***
CPI: Services less housing (Housing excl. imp. rent)	-0.33***	-0.67***	-2.16***	0.07
HICP: 01 - Food & non-Alcoholic beverages	-0.27***	0.06	-0.91***	0.36
HICP: 02 - Alcoholic beverages, tobacco & narcotics	-0.07	0.33*	-0.82**	0.92***
HICP: 03 - Clothing & footwear	-0.2***	0.04	-0.27	0.37
HICP: 04 - Housing, water, electricity, gas & other fuels	-0.23***	1.04***	-0.94***	-0.38
HICP: 04.1 - HICP Actual rentals for housing	-0.69***	1.14***	-1.16***	0.17
HICP: 04.3. - HICP Maintenance & repairs of dwellings	-0.44***	0.28**	-0.98***	1.22**
HICP: 04.4 - HICP Water supply & Misc. services	-0.34**	1.14***	-0.87**	1.34**
HICP: 04.5 - HICP Electricity, gas & other fuels	-0.1	1.38***	-0.91**	2.4*
HICP: 05 - Furnishings, household equipment	-0.27***	0.1	-0.6**	0.19
HICP: 06 - Health	-0.15***	0.01	-0.87**	0.06
HICP: 07 - Transport	-0.15**	0.9***	-0.67**	0.47
HICP: 07.2.2 - CPI Fuels & lubricants	-0.15	1.54***	-0.68	4.51*
HICP: 08 - Communication	0.12*	0.81**	-0.13	0.36
HICP: 09 - Recreation & culture	-0.22***	0.25	-0.53*	0.07
HICP: 10 - Education	-0.15**	0.47	-0.87**	0.06
HICP: 11 - Restaurants & hotels	-0.34***	0.26*	-1.1***	-0.16*
HICP: 12 - Miscellaneous goods & services	-0.25***	0.31**	-0.87***	0.02
HICP: All items	-0.21***	0.15	-0.64**	0.1
HICP: Energy	-0.17	1.53***	-0.87**	3.28**
HICP: Ind. excl. energy, food, alcohol & tobacco	-0.23***	0.05	-0.63**	0.37**
HICP: Services	-0.29***	0.45**	-0.88***	0.45***

B.2 United Kingdom

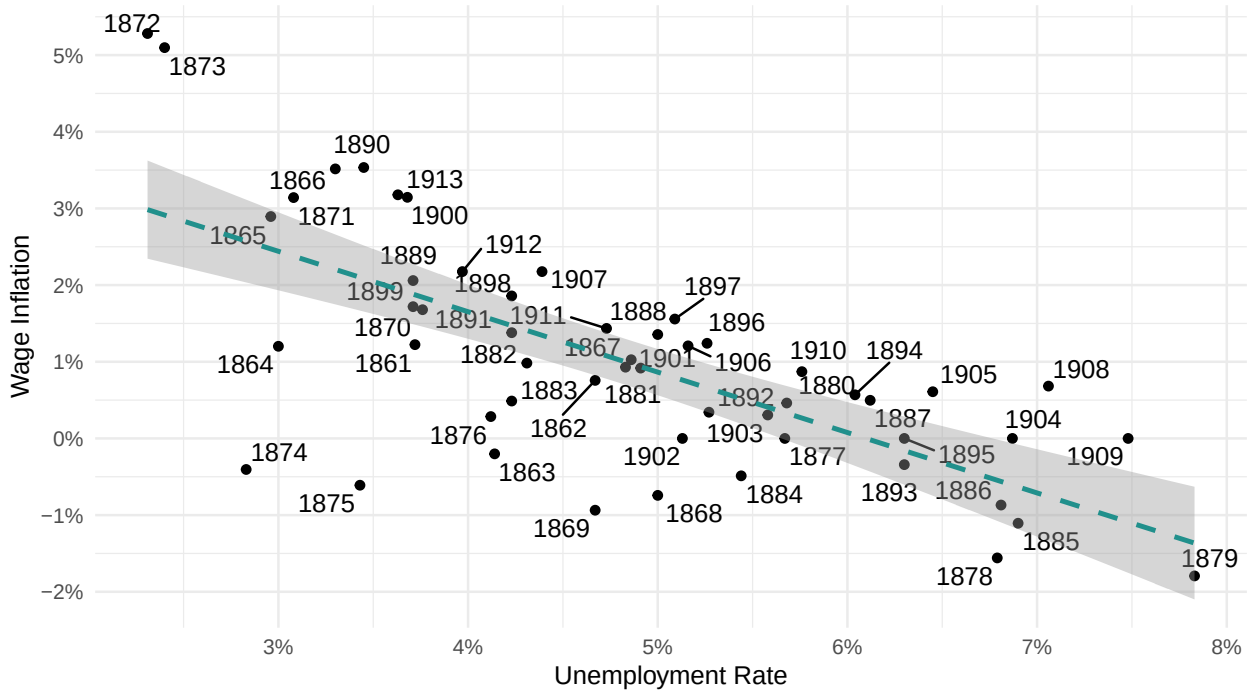


Figure 18: U.K. Phillips curve (1860-1915): Unemployment and Wage Inflation.

Figure 19: U.K. Dollar / Pound Exchange Rate (1914-1927)

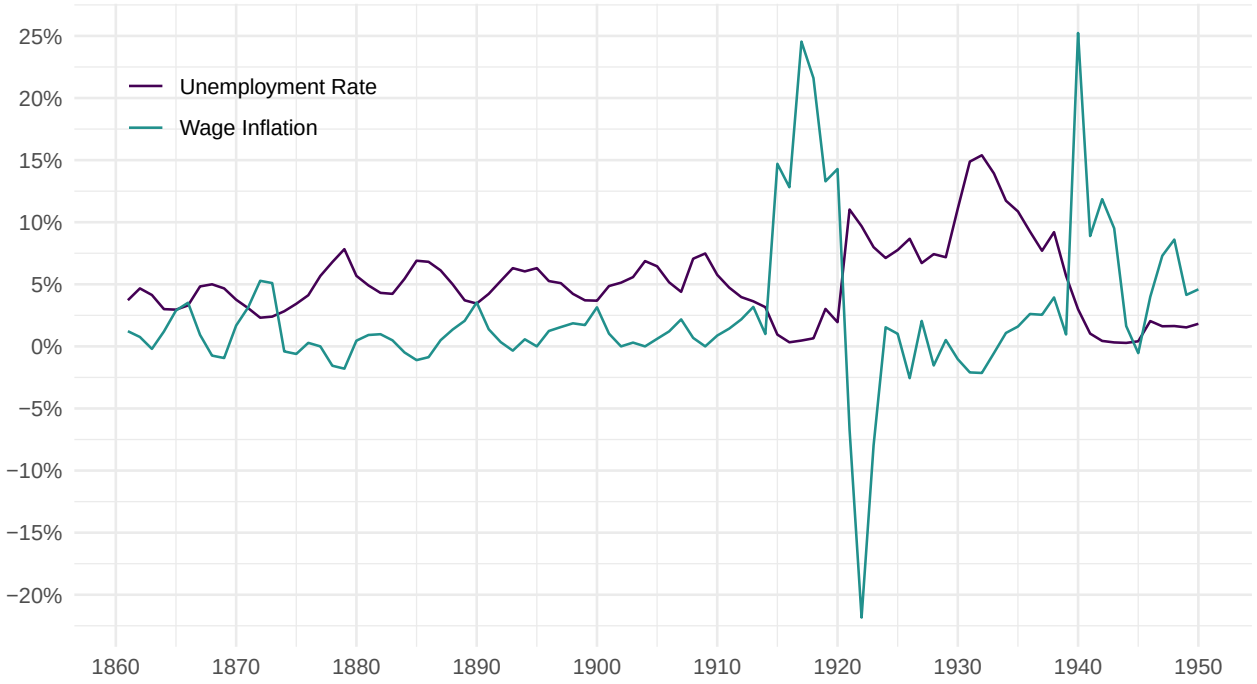


Figure 20: U.K. Phillips curve (1860-1950): Unemployment and Wage Inflation.

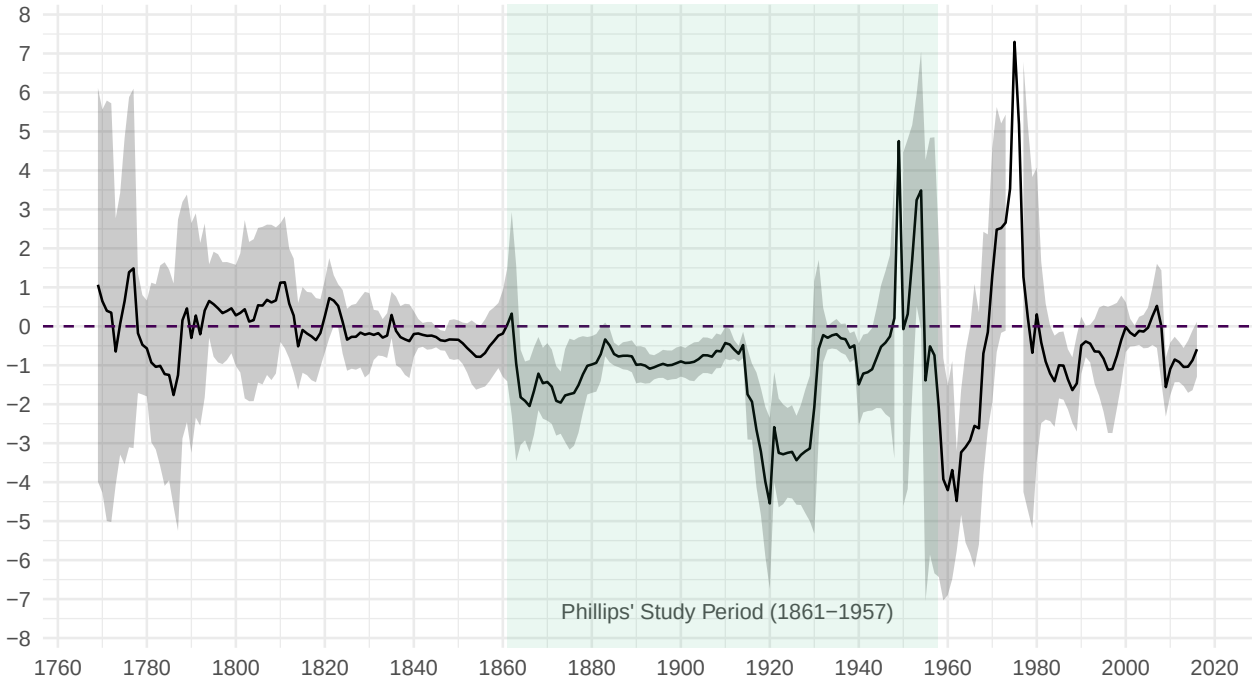


Figure 21: Slope of the U.K. Phillips Curve, 10-Year Rolling Regressions

B.3 United States

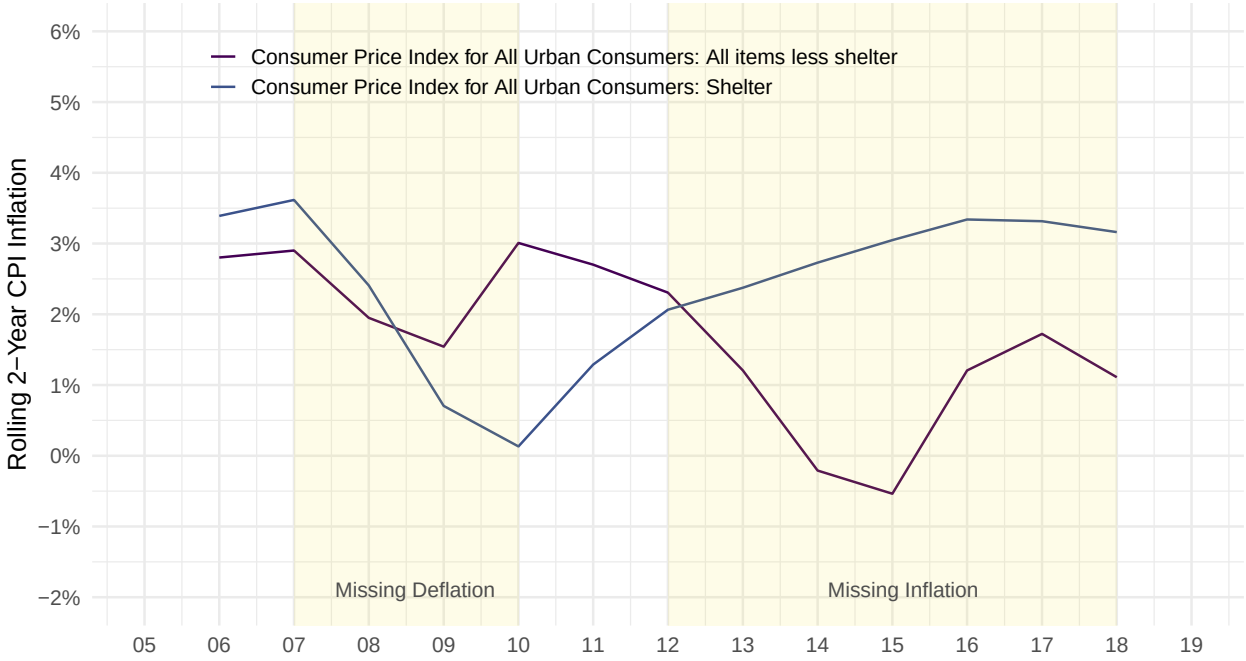


Figure 22: U.S. Missing Inflation, Deflation

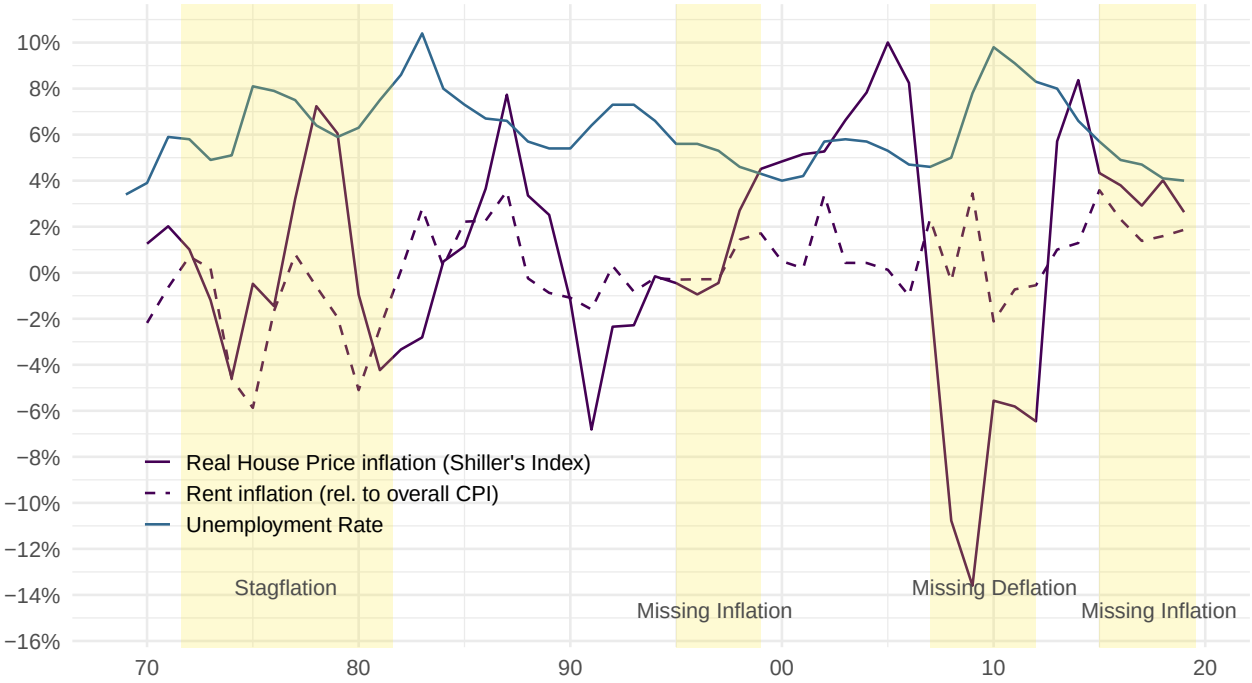


Figure 23: U.S. Unemployment and Relative Rent Price

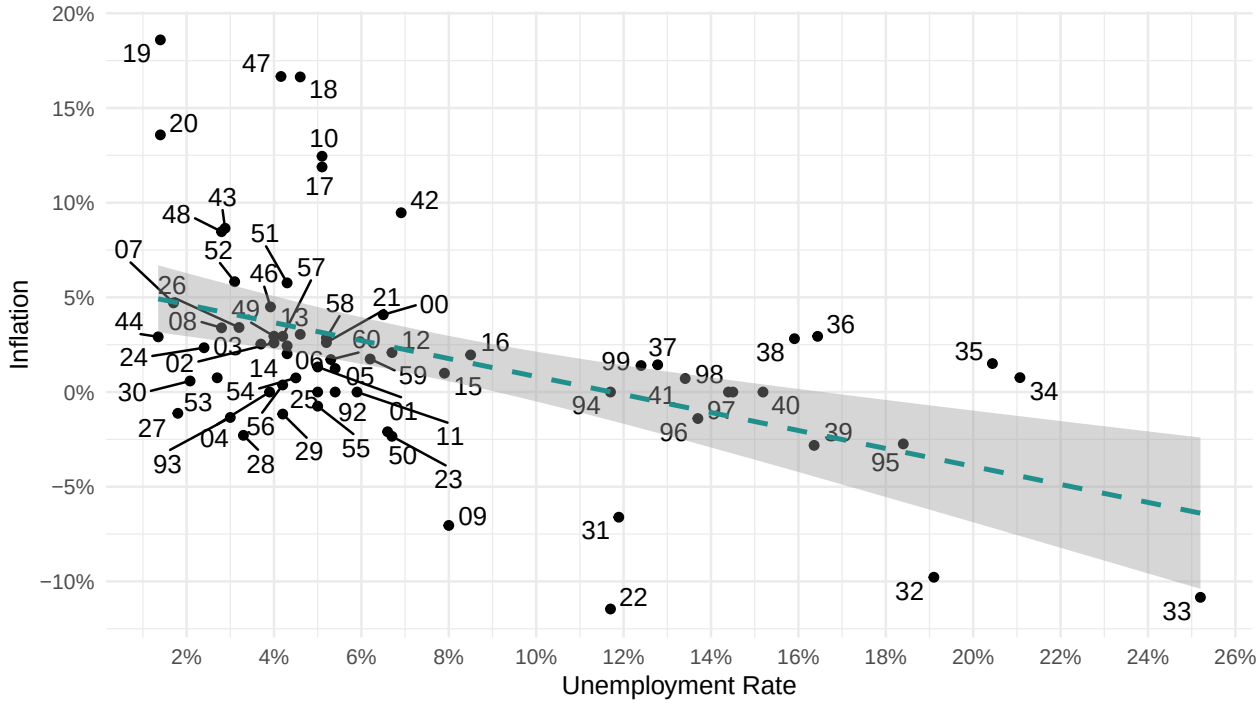


Figure 24: U.S. Phillips curve (1890-1960): Unemployment and Price Inflation.

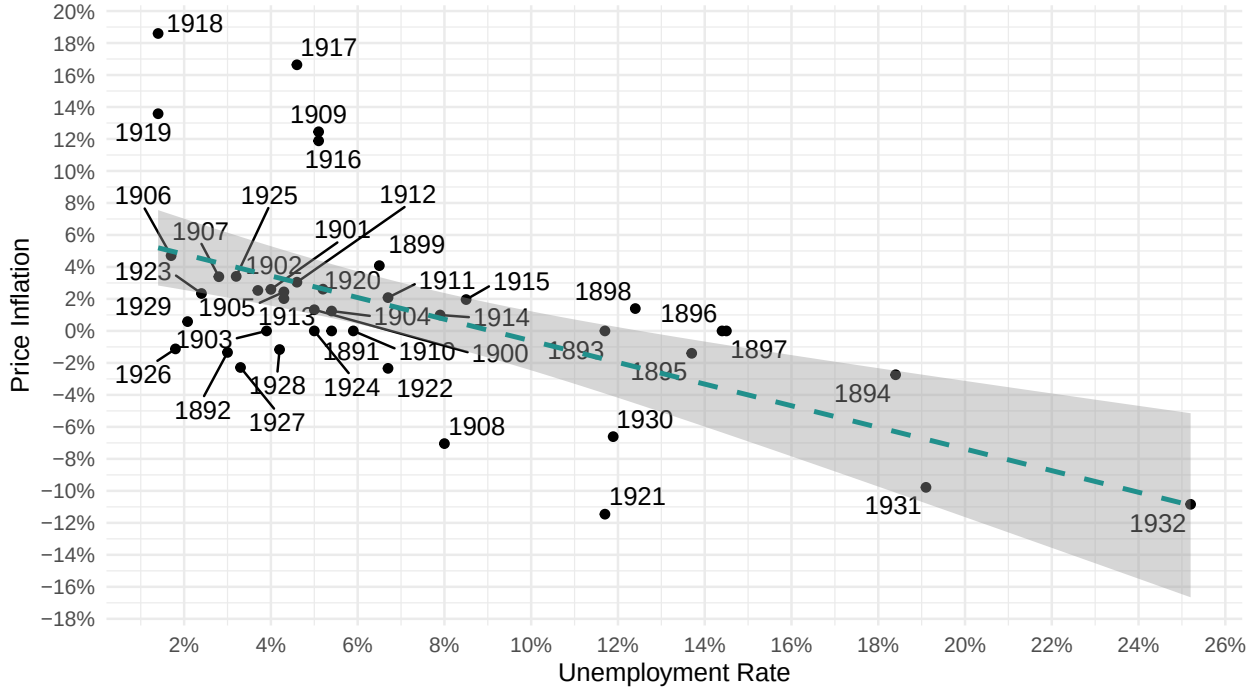


Figure 25: U.S. Price Phillips curve (1890-1933).

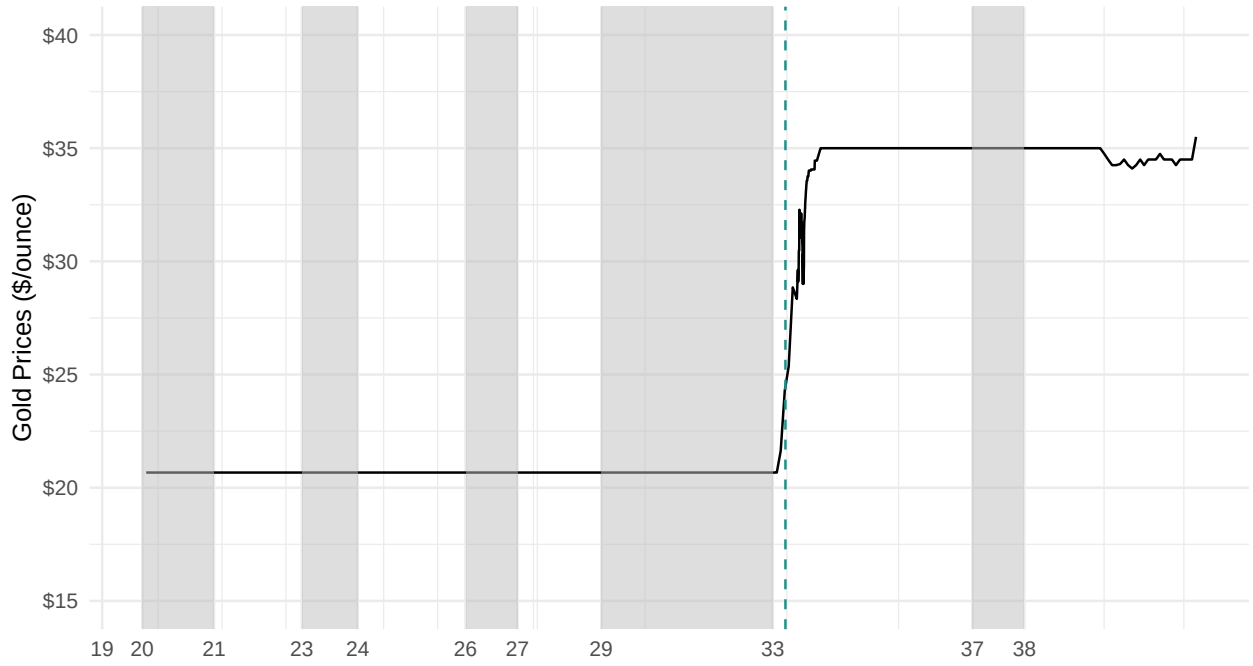


Figure 26: June 5, 1933: FDR takes U.S. off the Gold Standard

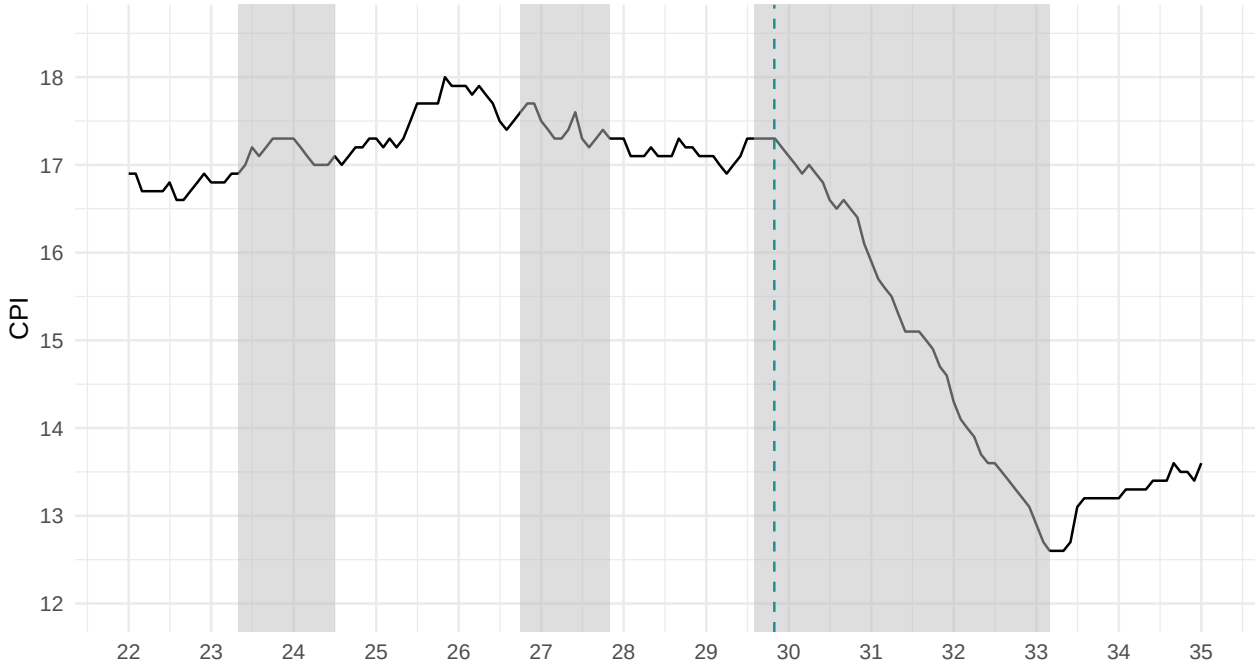


Figure 27: U.S. CPI (1922-1935)

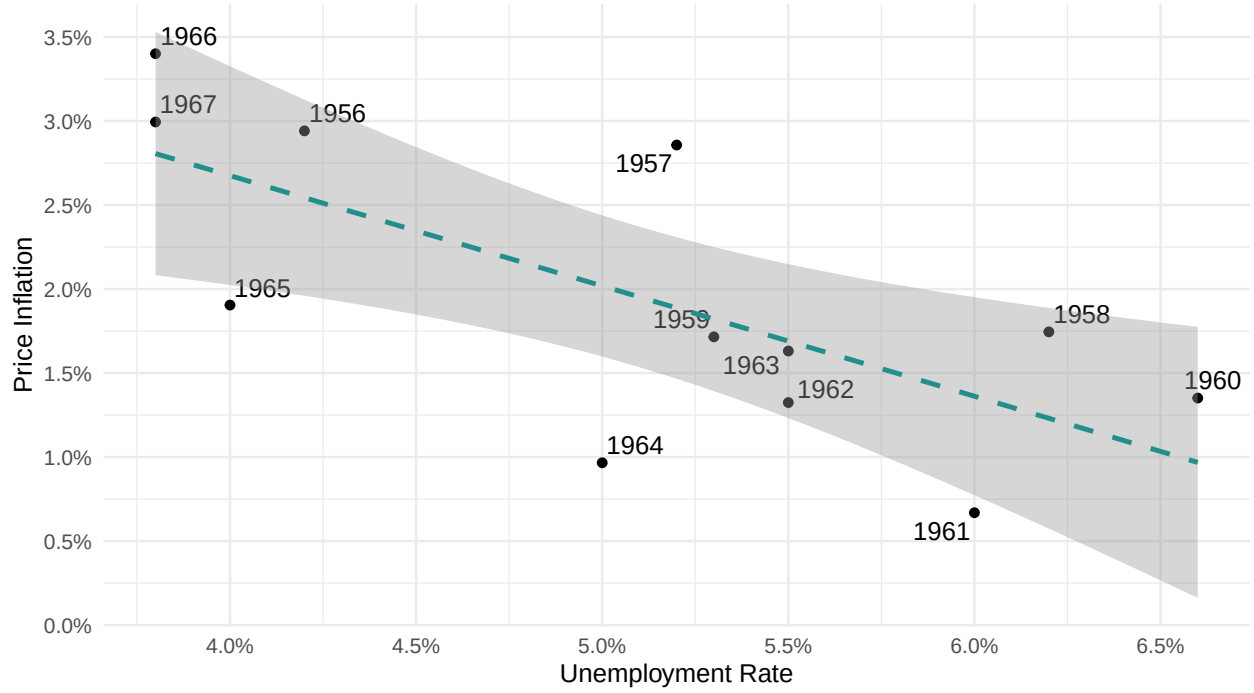


Figure 28: U.S. Price Phillips curve (1955-1968).

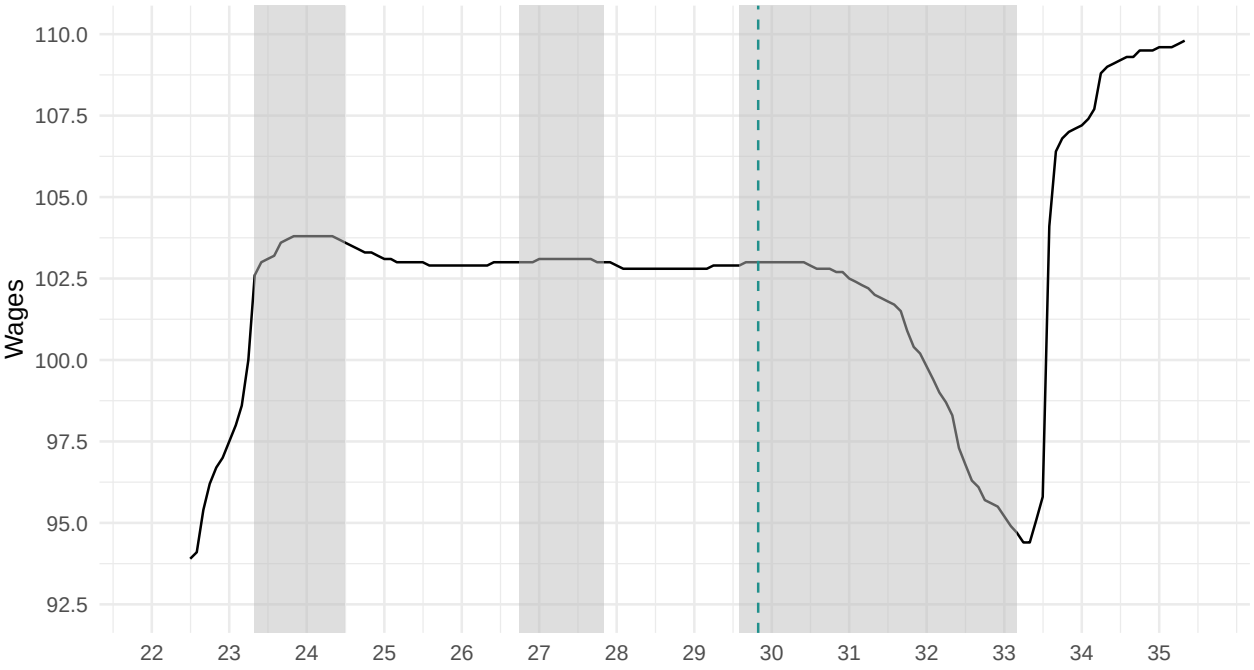


Figure 29: U.S. Index of Manufacturing Wage Rates (07/1922 - 07/1935)

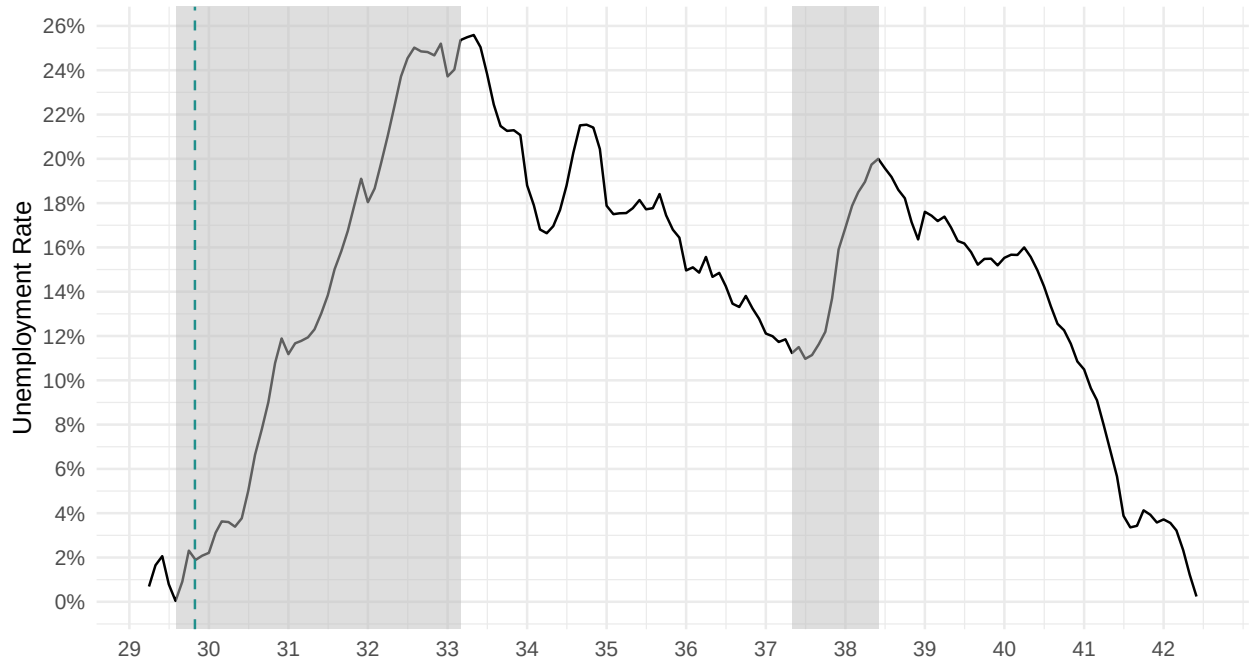


Figure 30: U.S. Unemployment (1929-1942)

Figure 31: U.S. Phillips curve (1890-1933): Unemployment and Price Inflation.

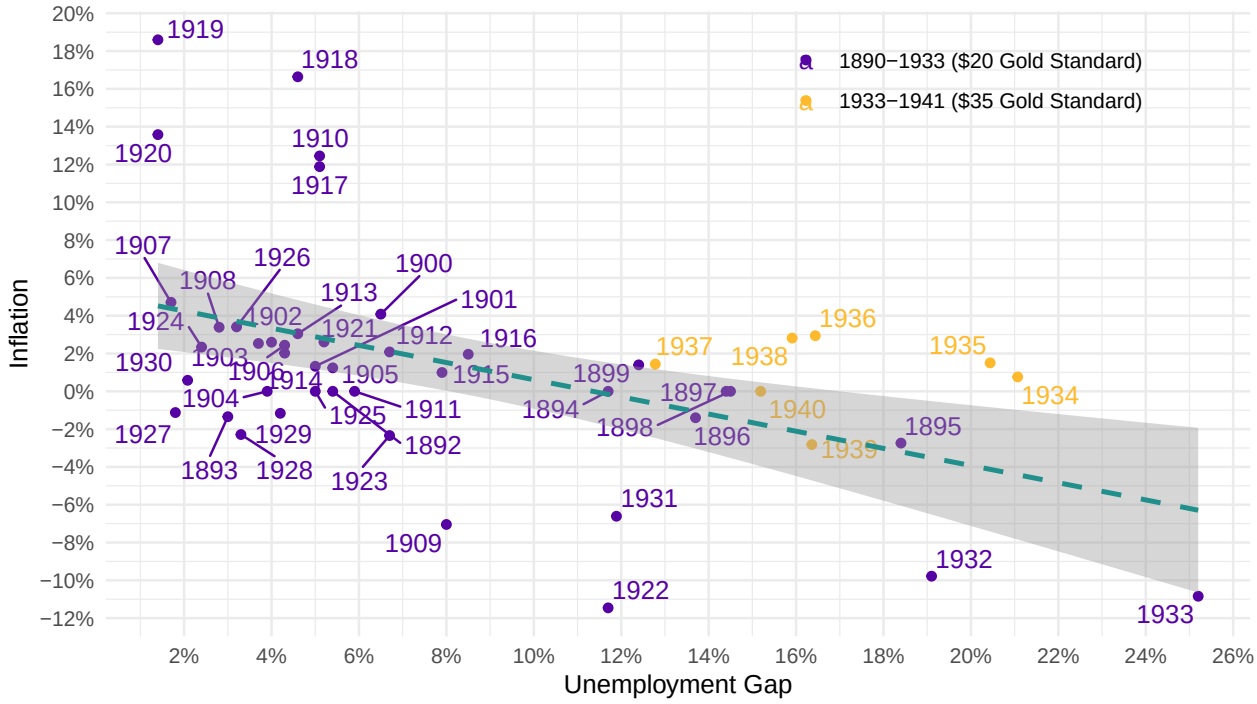


Figure 32: U.S. Phillips curve (1960-2019)

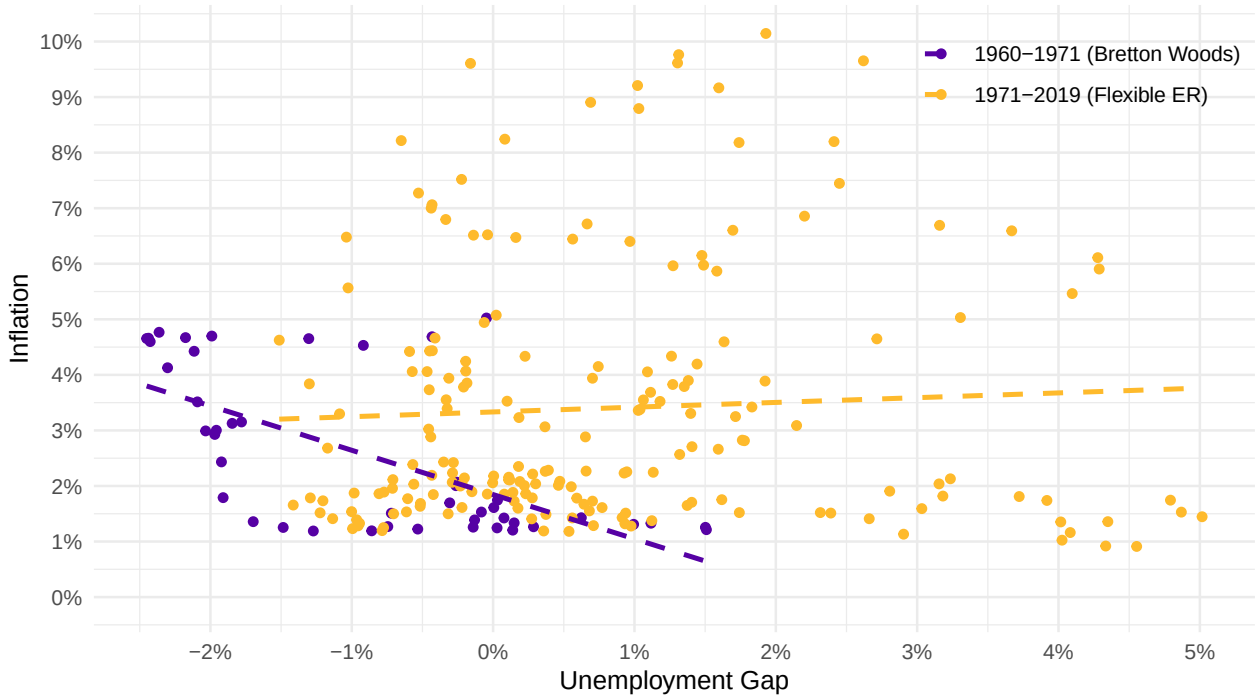


Figure 33: U.S. Phillips curve (1960-2019)

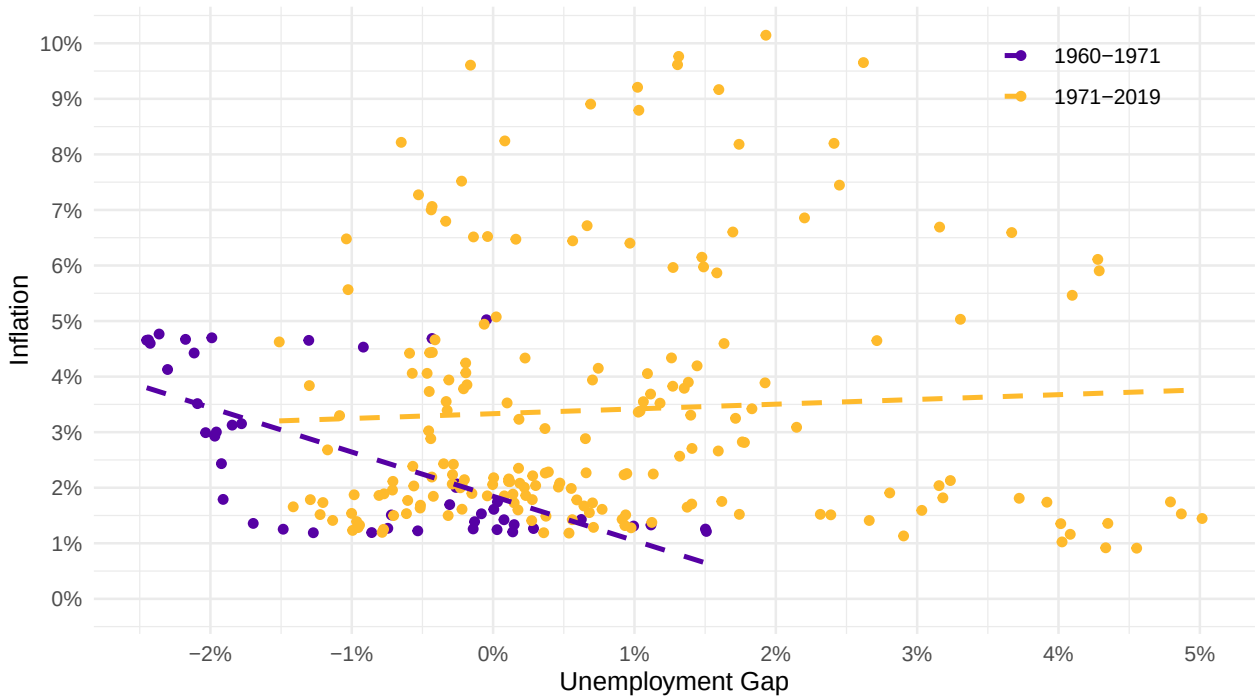


Figure 34: U.S. Phillips curve (1960-2019)

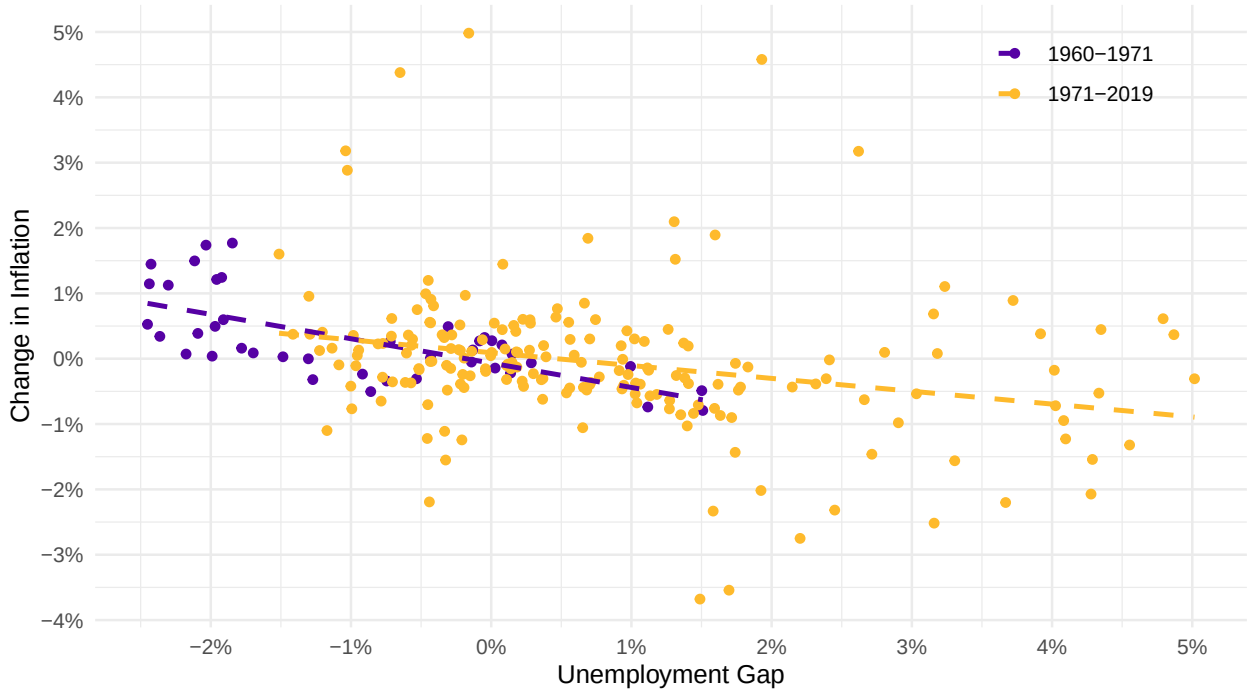


Figure 35: U.S. Accelerating Phillips curve (1960-2019)

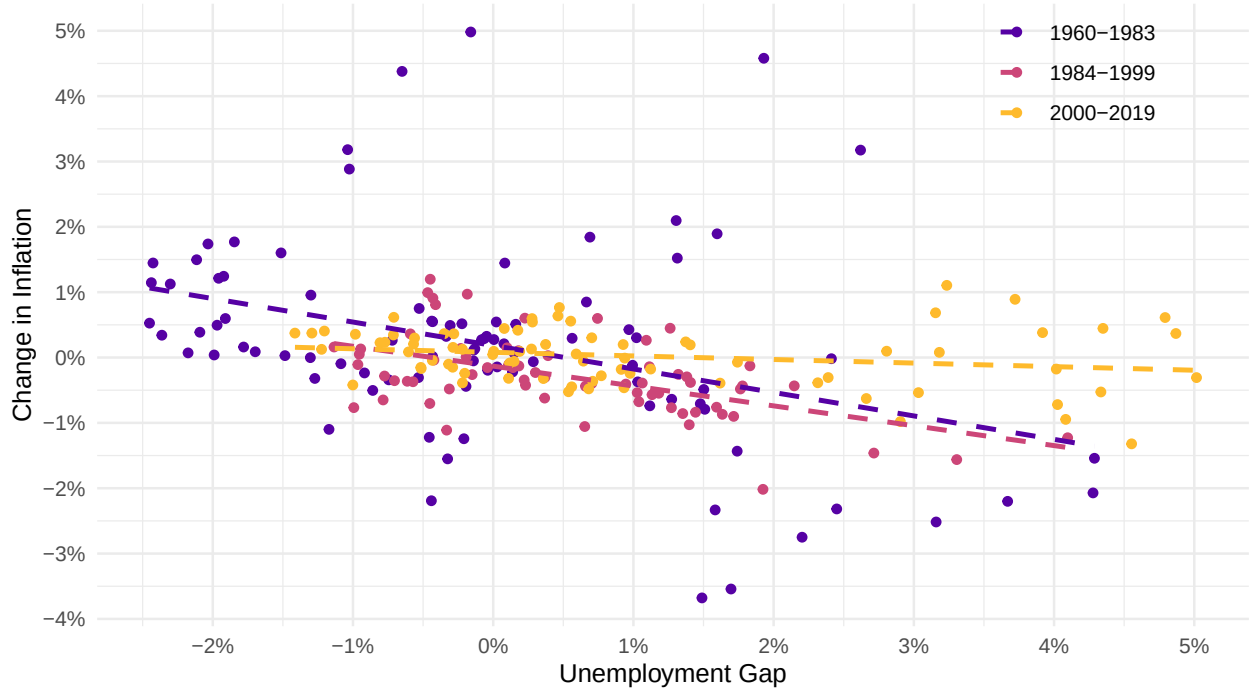


Figure 36: U.S. Flattening Accelerating Phillips curve? (1960-2019)

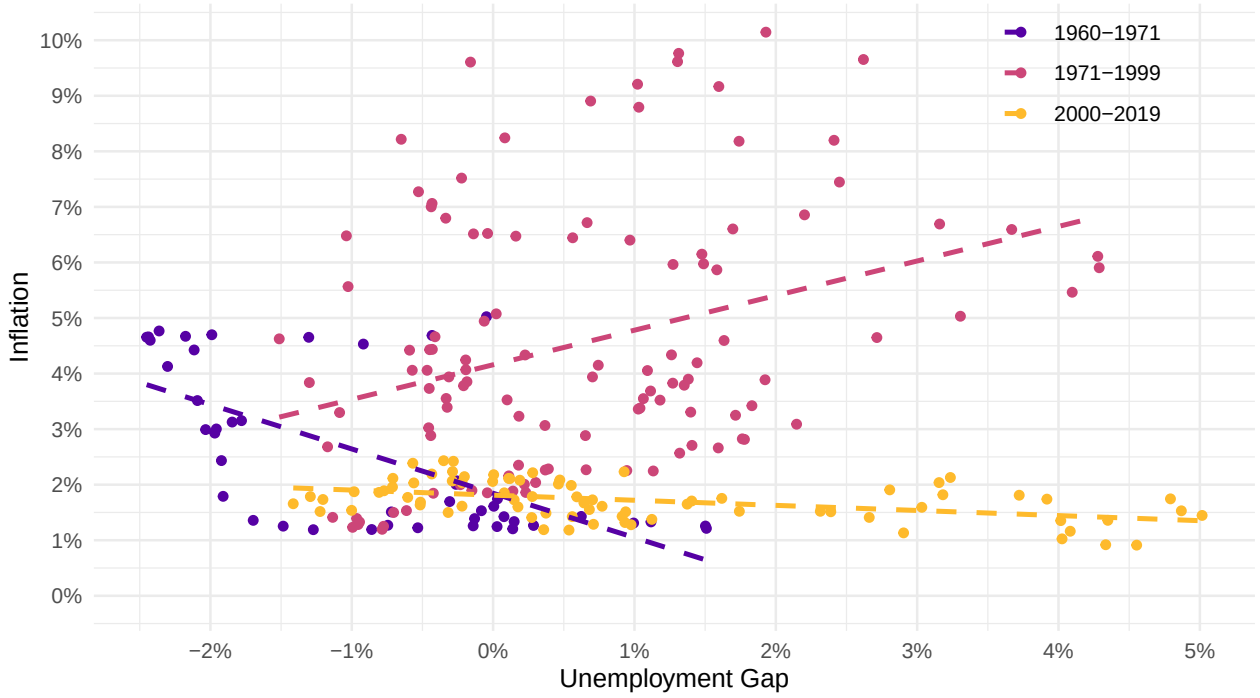


Figure 37: U.S. Original Phillips curve (1960-2019)

CPI Components.

Table 46: U.S. CPI Components (Source: FRED)

Sector	PC Slope
Lodging Away From Home in U.S. City Average	-0.84**
Owners' Equivalent Rent of Residences in U.S. City Average	-0.25*
Owners' Equivalent Rent of Primary Residence in U.S. City Average	-0.25*
Energy Services in U.S. City Average	0.86**
Electricity in U.S. City Average	0.88***
Water and Sewer and Trash Collection Services in U.S. City Average	0.43***
New Vehicles in U.S. City Average	0.8***
Used Cars and Trucks in U.S. City Average	2.03***

Table 47: Phillips curves on CPI Components, Before 1971

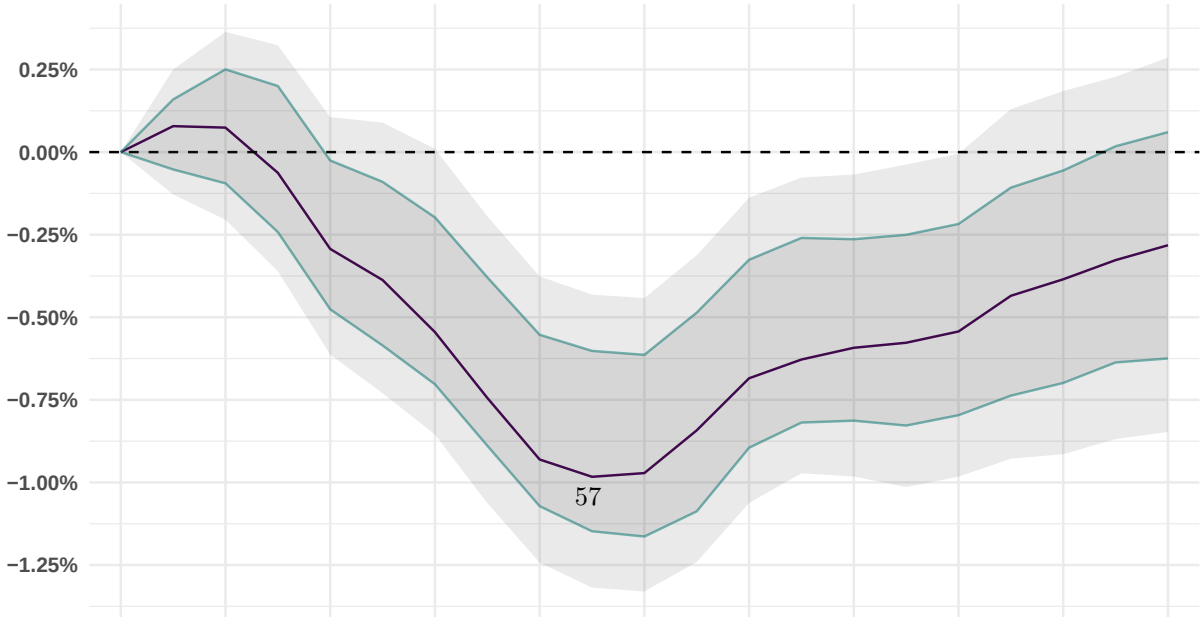
Item (U.S. City Average, All Urban consumers, SA)	PC Slope	t-stat	Adj. R2
Prescription drugs	-0.8**	-2.9	37.5%
Women's dresses	-3.47***	-7.6	82.7%
Furniture and bedding	-1.05***	-6.6	78.2%
Commodities less food	-0.78***	-9.8	36.3%
Energy commodities	-1.04***	-9.1	34.6%
Commodities less food and energy commodities	-0.73***	-8.0	28.9%
Fresh whole milk	-1.84***	-10.5	28.3%
All items less food and energy	-0.8***	-7.8	27.6%
Medical care services	-0.92***	-7.8	26.2%
Nondurables	-0.76***	-7.8	26%
All items less energy	-0.77***	-7.4	25.5%
Fuel oil	-1.46***	-8.6	25.1%
Meats, poultry, fish, and eggs	-2.77***	-3.6	24.9%
Commodities	-0.67***	-7.5	24.8%
Men's and boys' apparel	-1.16***	-9.5	24.4%
All items less food	-0.83***	-9.5	24.3%
Apparel less footwear	-1.3***	-9.4	24.1%
Women's and girls' apparel	-1.4***	-9.3	23.7%
Apparel	-1.23***	-9.1	22.8%
All items less medical care	-0.7***	-6.8	22.2%
All items	-0.93***	-8.6	21%
Fuel oil and other fuels	-1.45***	-8.5	20.6%
Household energy	1.71***	15.0	86.1%
Other food at home	2.57***	11.7	79.2%
Housekeeping supplies	1.38***	11.0	77%
Medical care commodities	0.97***	9.7	72.2%
All items less food, shelter, and energy	0.3***	6.9	56.4%
All items less food and shelter	0.35***	6.7	54.8%
Motor vehicle maintenance and repair	0.7***	5.1	41.2%
Services less energy services	0.86***	4.8	37.5%
Alcoholic beverages	0.54***	4.5	35.2%
All items less food, shelter, energy, and used cars and trucks	0.23***	4.4	33.6%
Housing	0.82***	3.7	26.1%
Other goods and services	0.33***	3.6	24.4%

Table 48: Phillips curves on CPI Components, After 1971

Item (U.S. City Average, All Urban consumers, SA)	PC Slope	t-stat	Adj. R2
Other recreation services	-0.5***	-15.1	48%
Rent of shelter	-0.4***	-17.5	47%
Information technology commodities	-0.7***	-7.5	35%
Club memberships	-0.6***	-11.3	34%
Moving, storage, freight expense	-0.9***	-9.7	28%
Televisions	-2.1***	-9.8	26%
Cigarettes	-0.4***	-5.3	21%
Admission to movies, theaters, and concerts	-0.4***	-8.0	21%
Lodging away from home	-0.8***	-8.2	21%
Personal care	-0.2***	-7.8	20%
Toys, games, hobbies and playground equipment	0.9***	11.7	52%
Transportation commodities less motor fuel	0.6***	10.2	50%
Parking fees and tolls	0.9***	9.1	48%
Water and sewerage maintenance	0.6***	16.4	41%
Water and sewer and trash collection services	0.4***	12.2	37%
Education and communication services	0.4***	7.0	32%
New cars and trucks	0.4***	10.6	31%
New motorcycles	1.2***	6.8	29%
Recreation commodities	0.2***	6.4	28%
Women's underwear, nightwear, sportswear and accessories	0.8***	9.4	26%
College tuition and fees	0.8***	13.2	26%
Lunchmeats	0.7***	5.8	25%
Inpatient hospital services	0.5***	8.6	22%
New trucks	0.7***	10.7	22%
Other recreational goods	0.5***	8.2	21%
Medical care commodities	0.8***	12.4	21%
Other uncooked poultry including turkey	0.8***	8.1	21%
Tuition, other school fees, and childcare	0.7***	11.3	21%
Educational books and supplies	0.7***	12.2	20%
Hospital and related services	0.8***	11.1	20%

C Identified Moments

C.1 U.S. Monetary Shocks (Romer and Romer (2004)): Response to a 1% Increase in the Federal Funds Rate



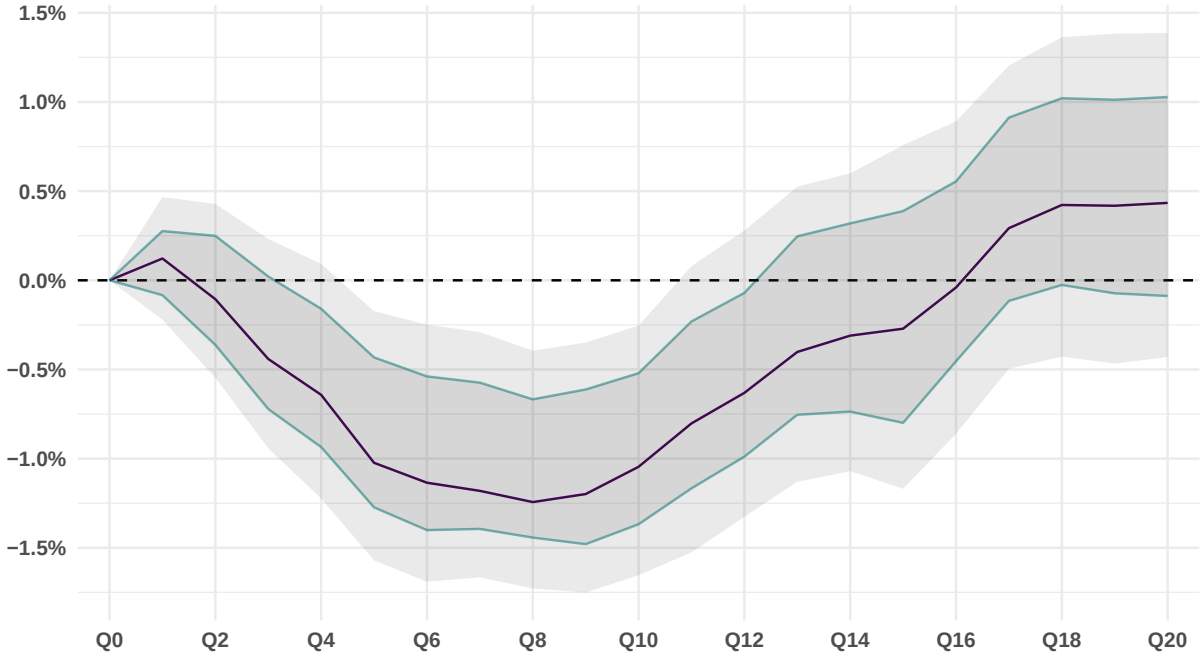


Figure 39: Real GDP

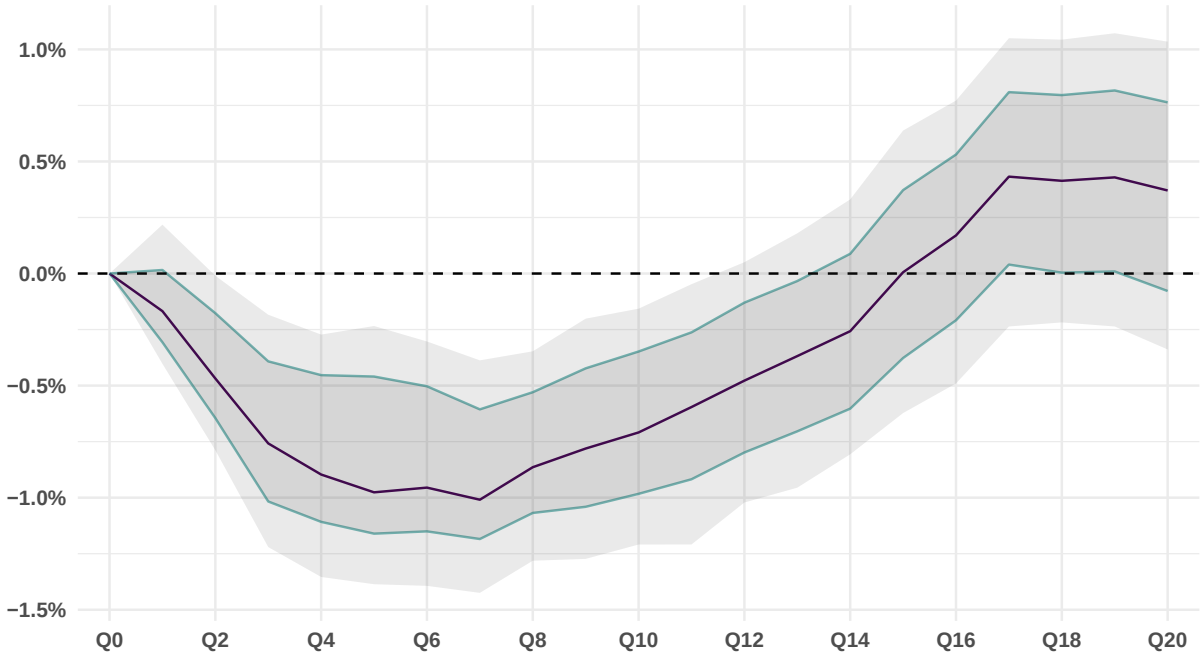


Figure 40: Real Consumption

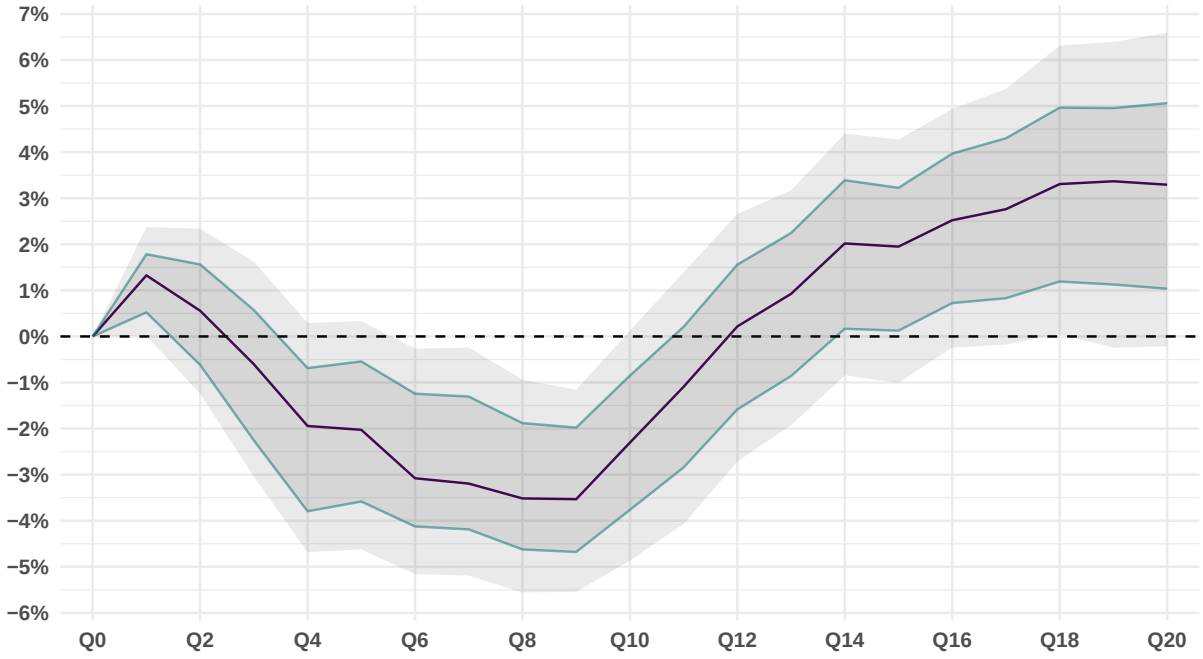


Figure 41: Real Imports

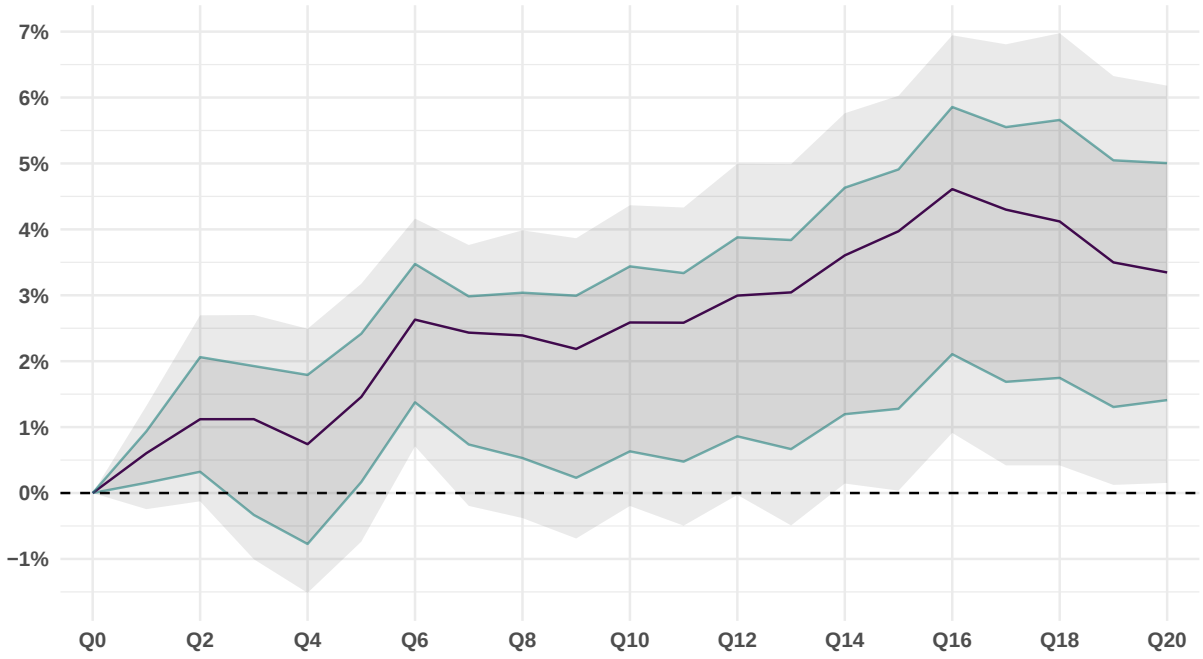


Figure 42: Unit Labor Costs

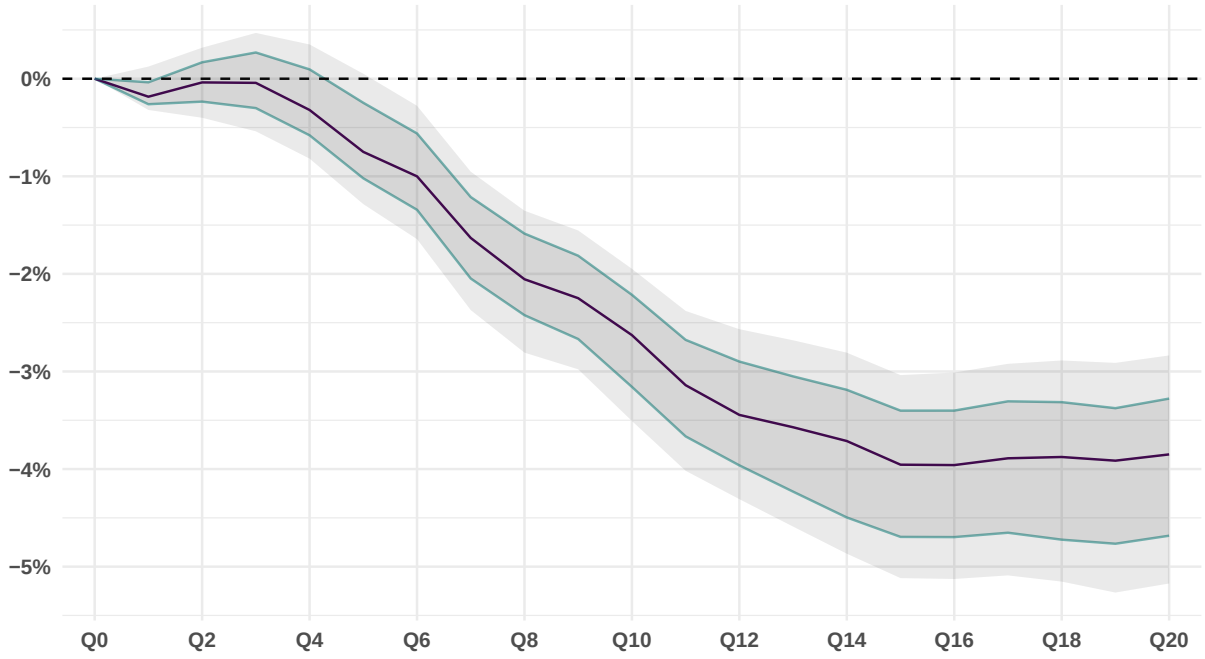


Figure 43: House Prices

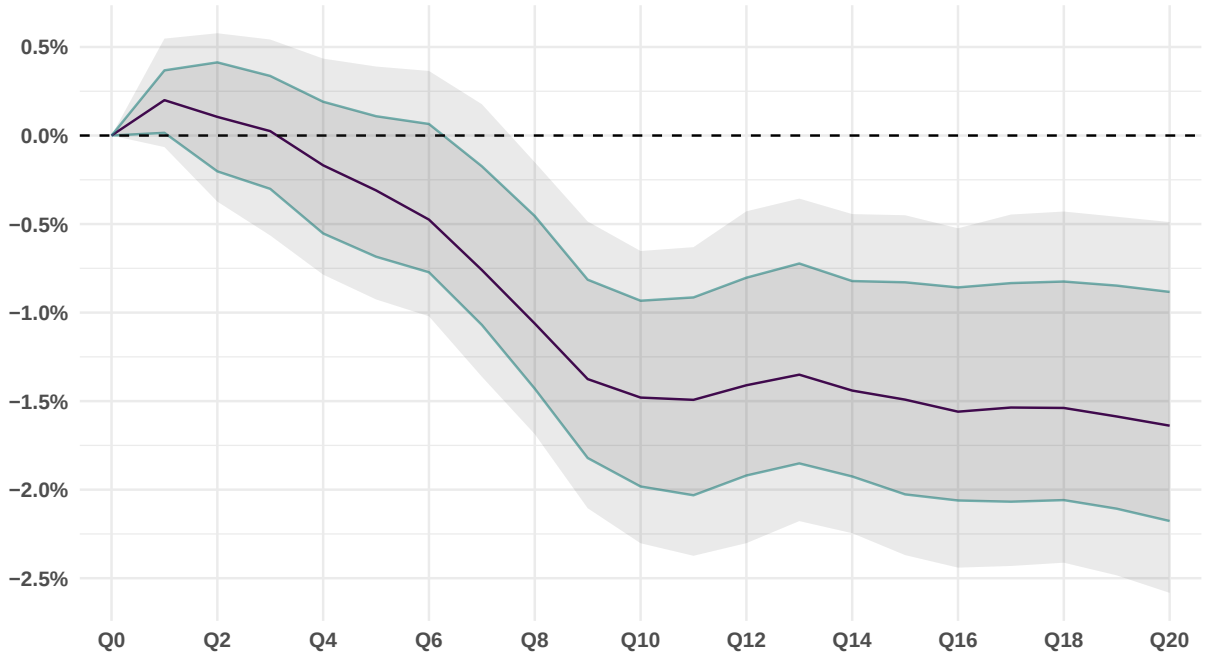


Figure 44: Average Nominal Wages

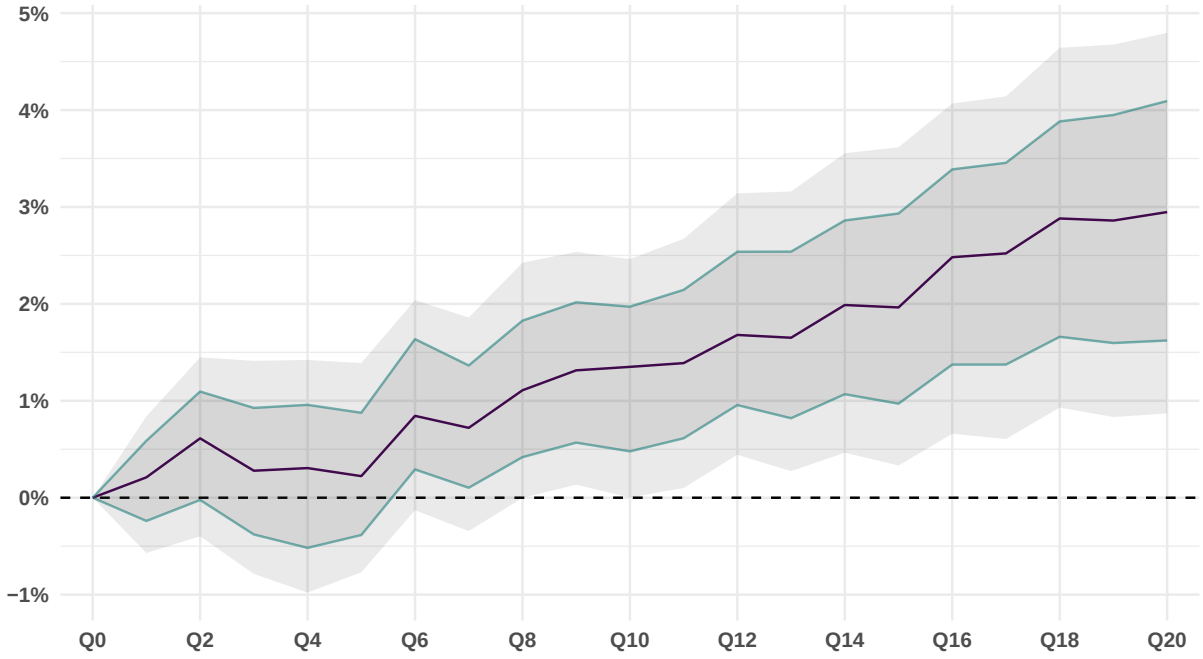


Figure 45: Men's Apparel Prices

C.2 U.S. Fiscal Shocks (Romer and Romer (2010)): Response to a 1% of GDP Tax Increase

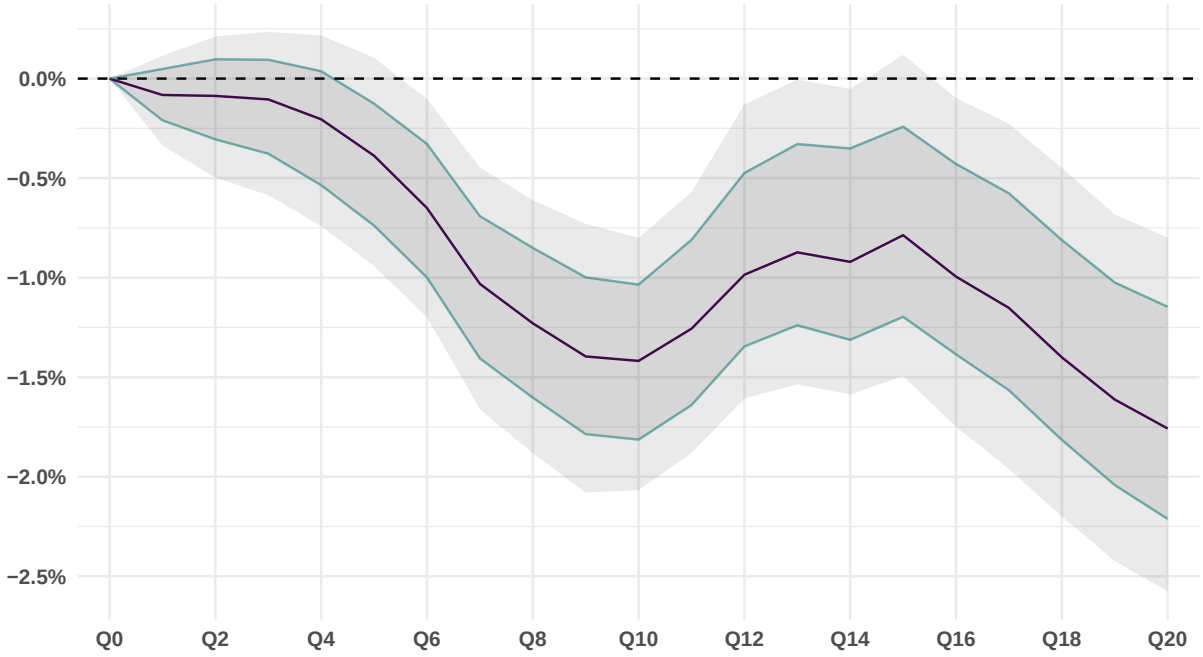


Figure 46: Employment

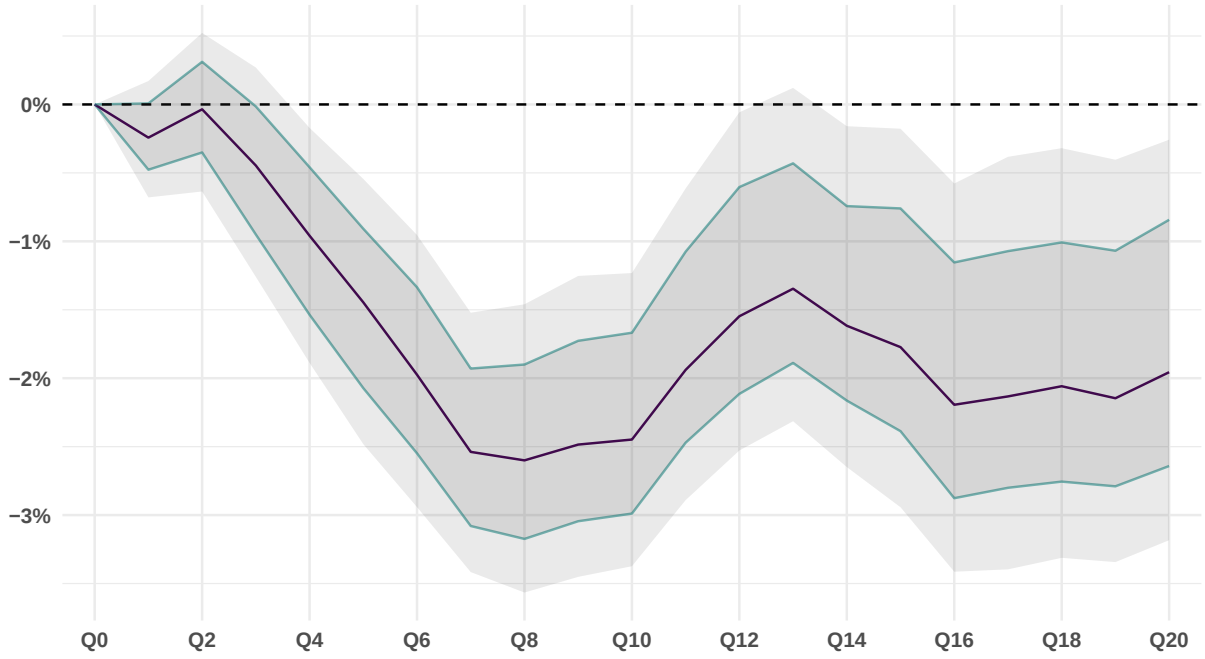


Figure 47: Real GDP

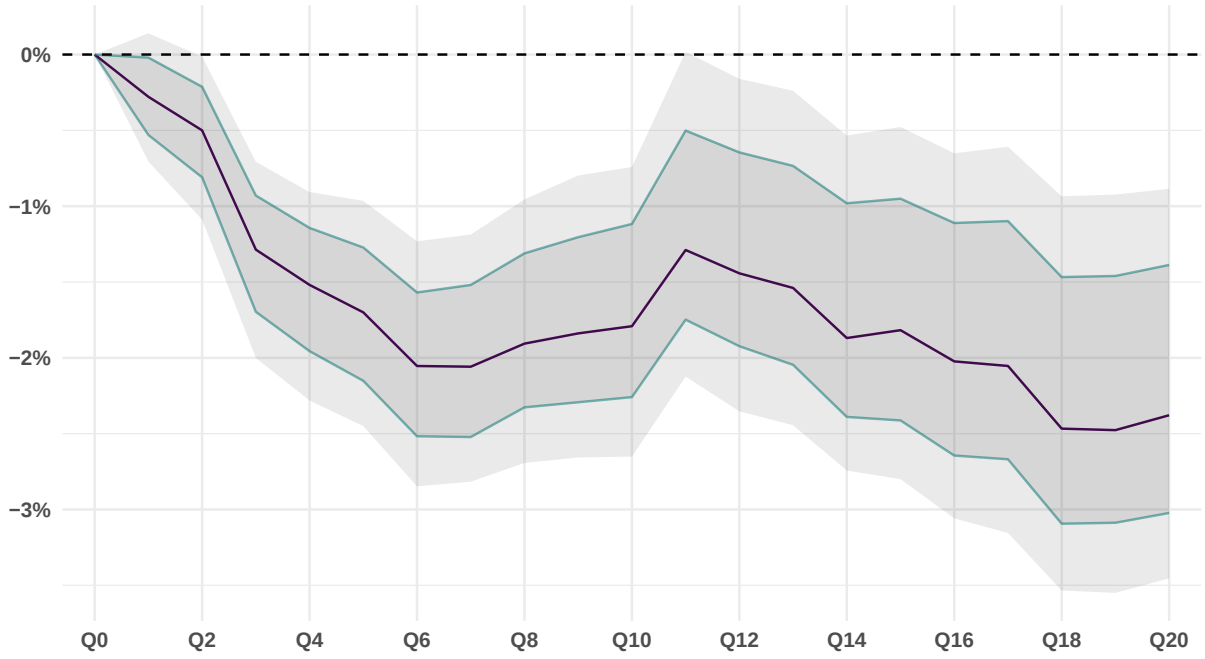


Figure 48: Real Consumption

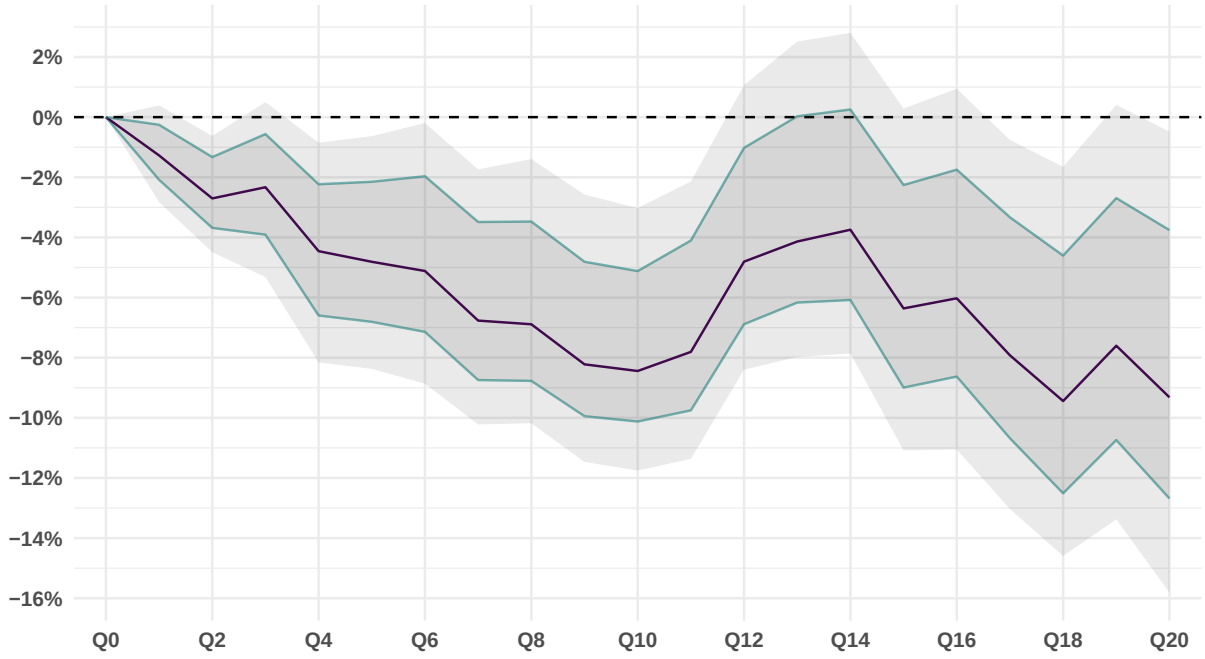


Figure 49: Real Imports

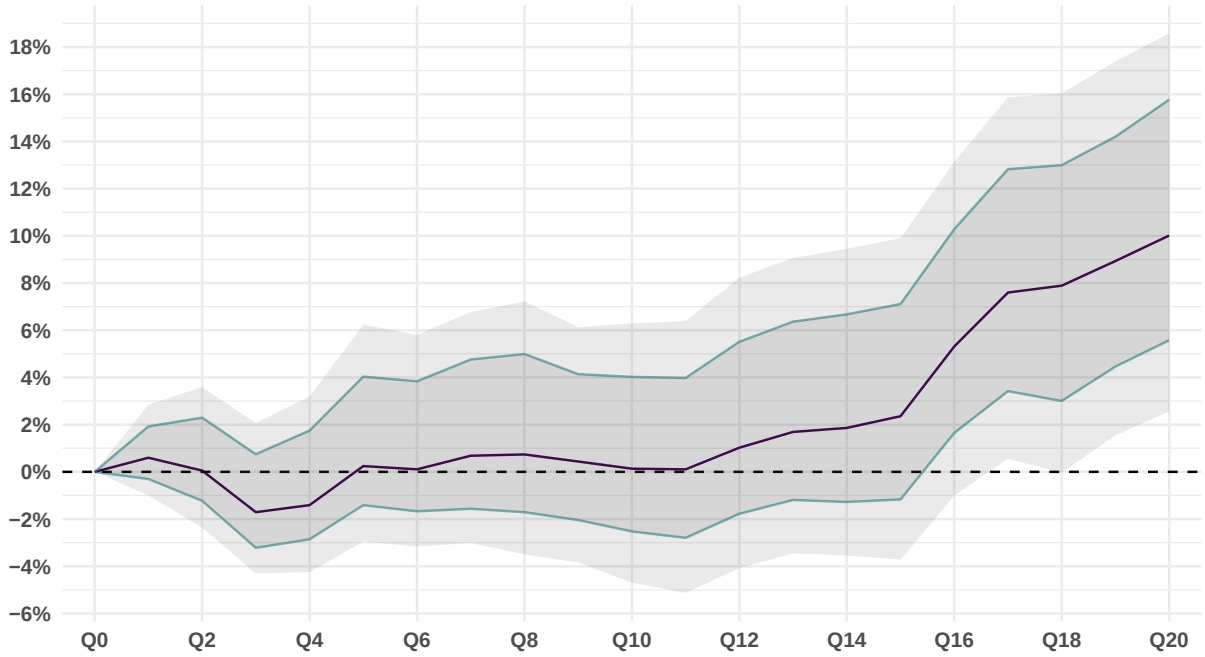


Figure 50: Unit Labor Costs

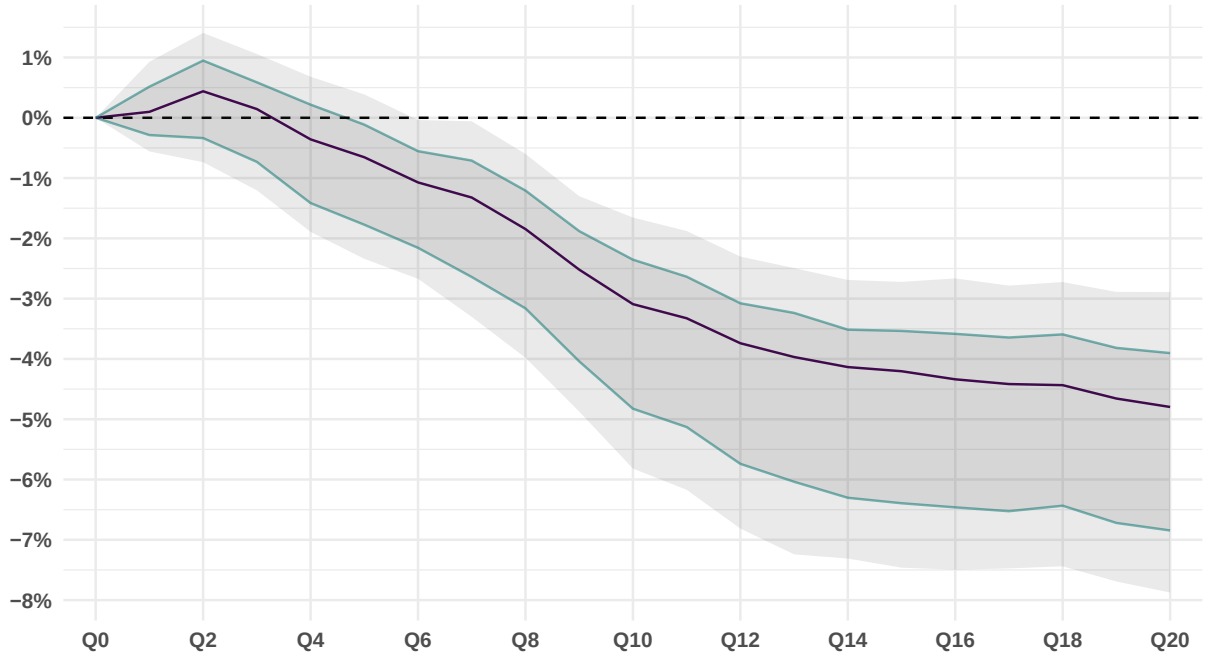


Figure 51: House Prices

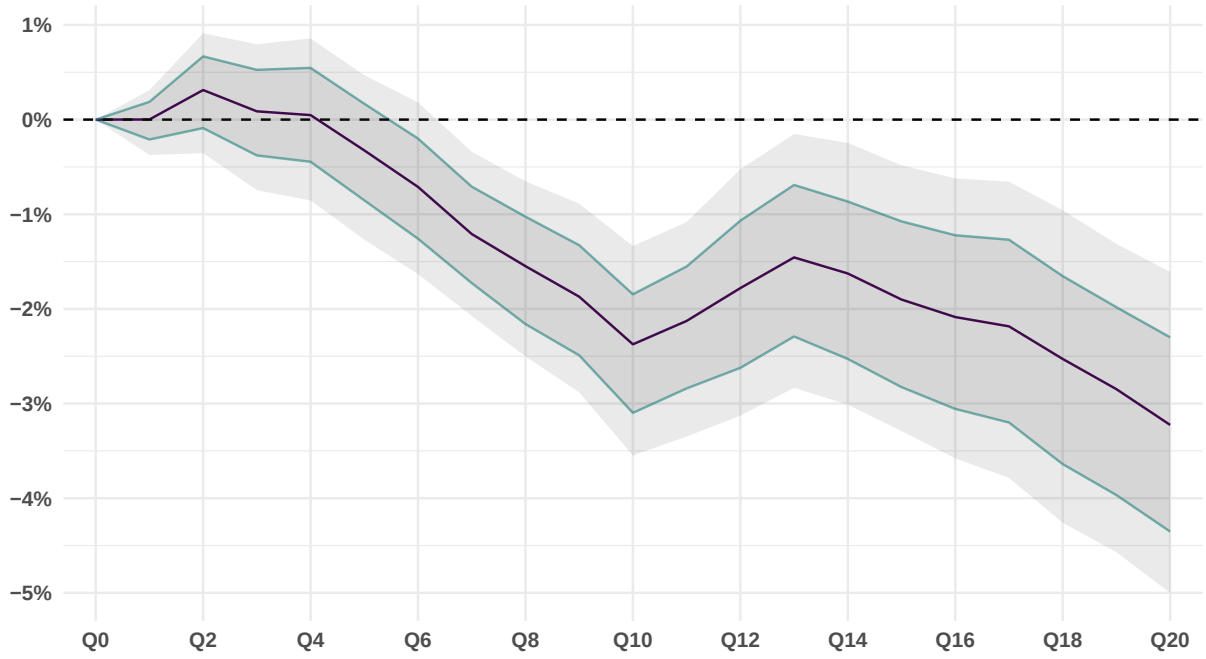


Figure 52: Average Nominal Wages

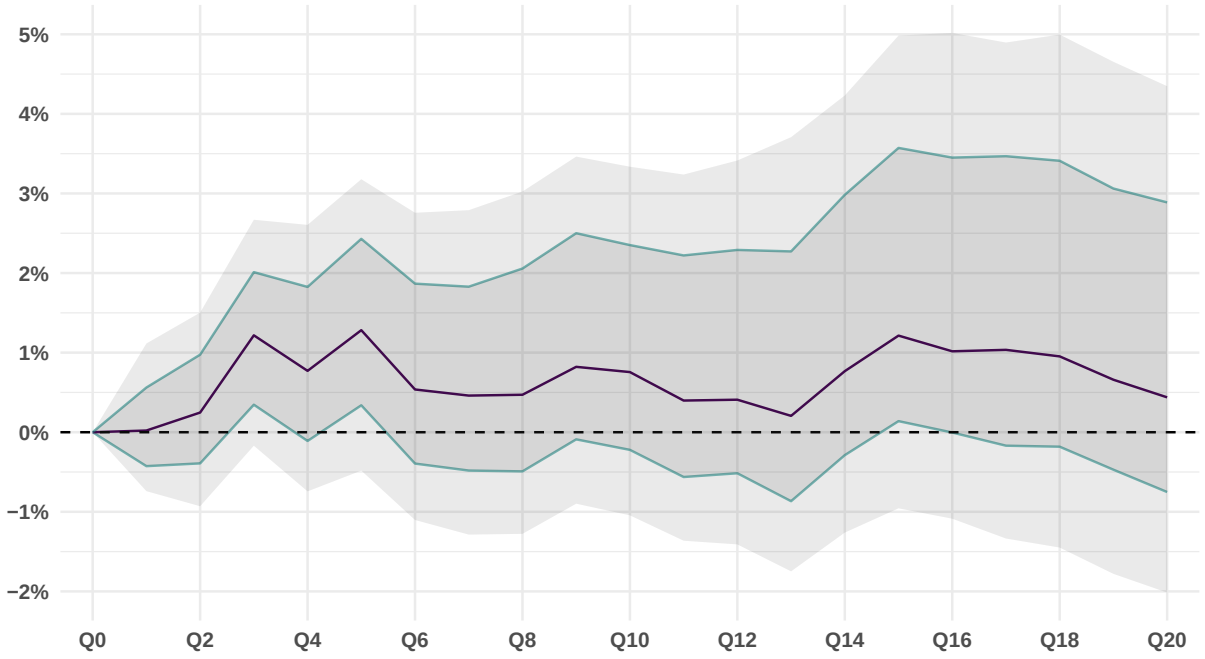


Figure 53: Men's Apparel Prices

D Regional Phillips curves

D.1 U.S. States

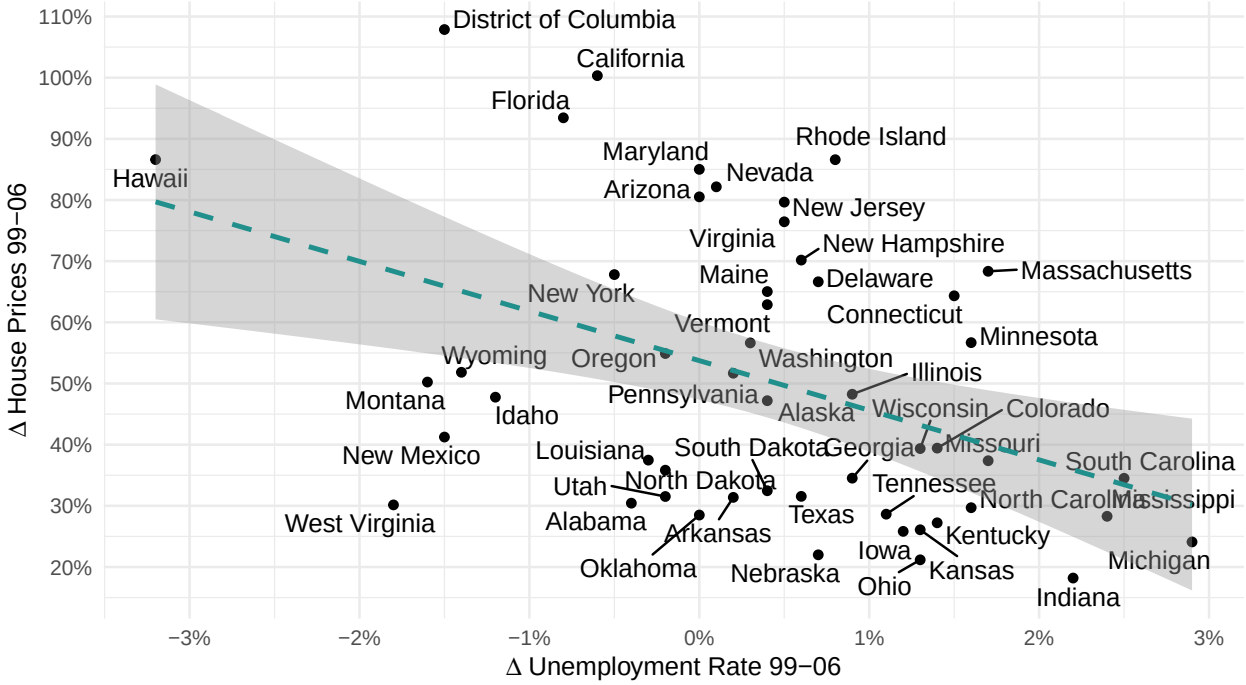


Figure 54: U.S. States Phillips curve (99-06)

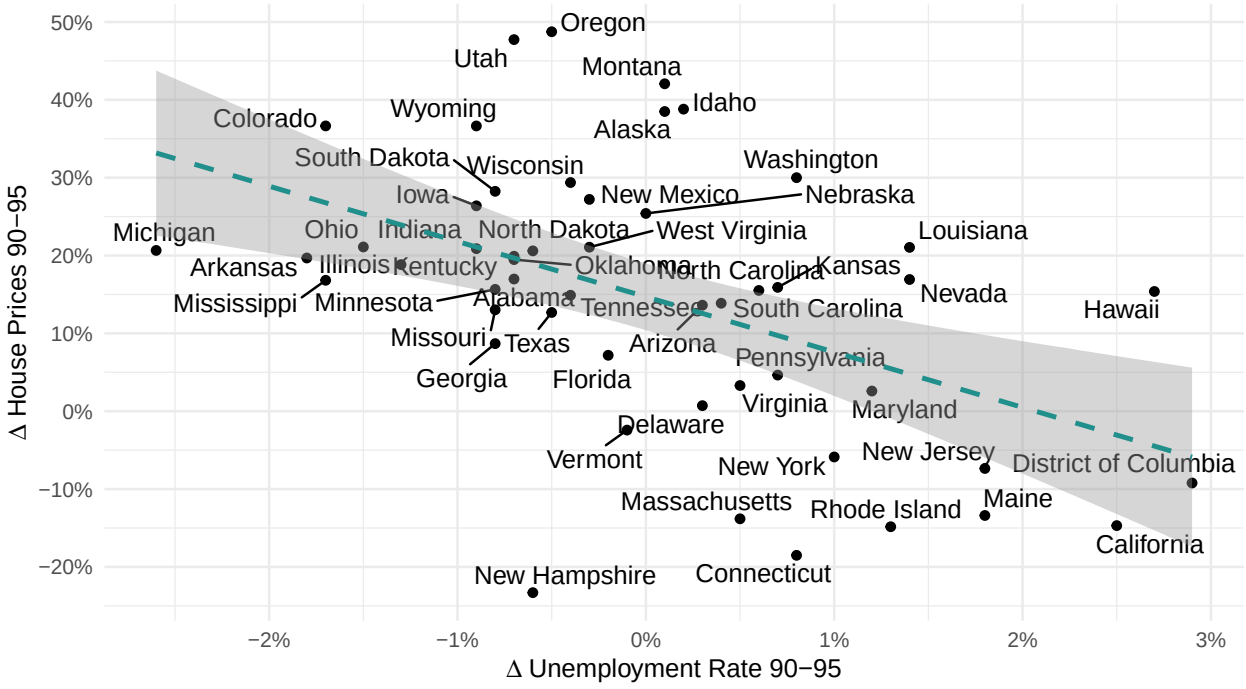


Figure 55: U.S. States Phillips curve (90-95)

D.2 U.S. MSAs

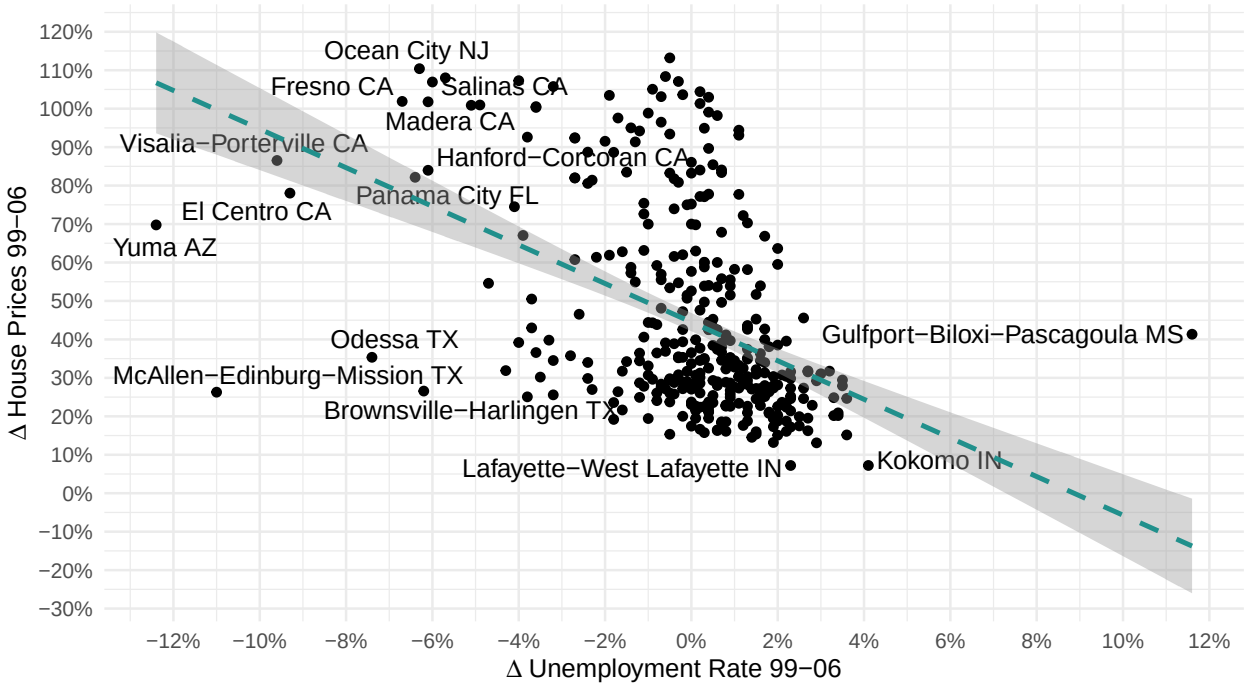


Figure 56: U.S. MSAs Phillips curve (99-06)

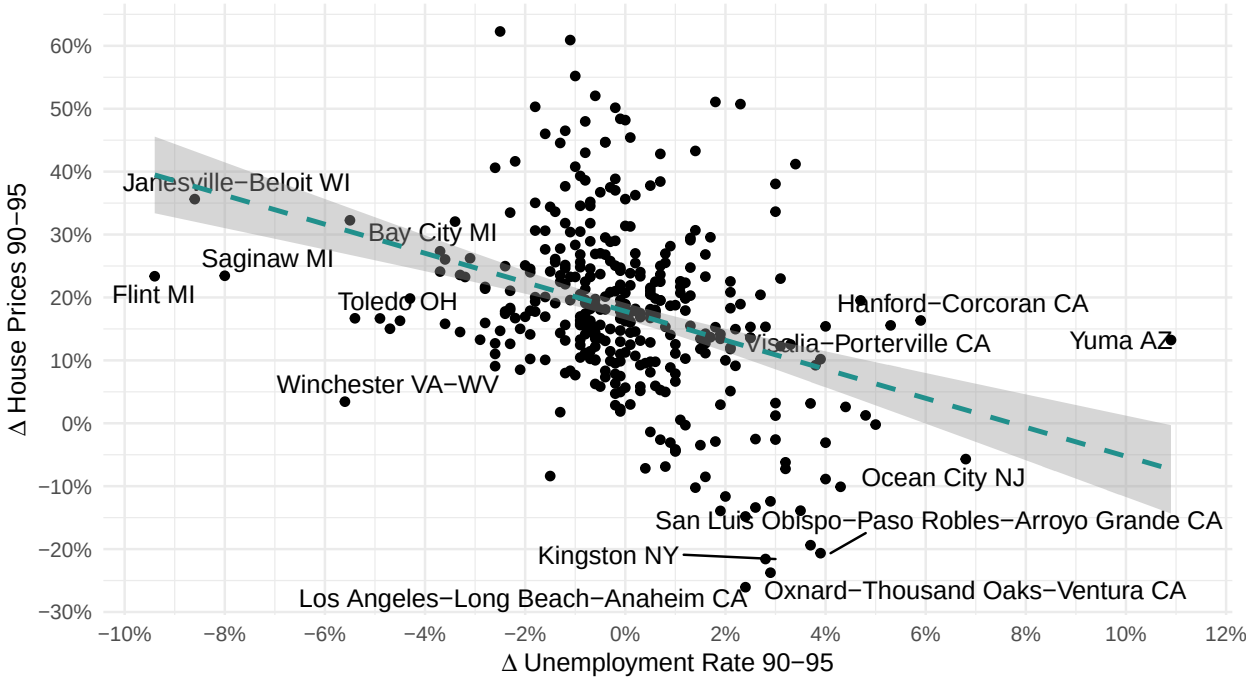


Figure 57: U.S. MSAs Phillips curve (90-95)

D.3 U.S. Counties

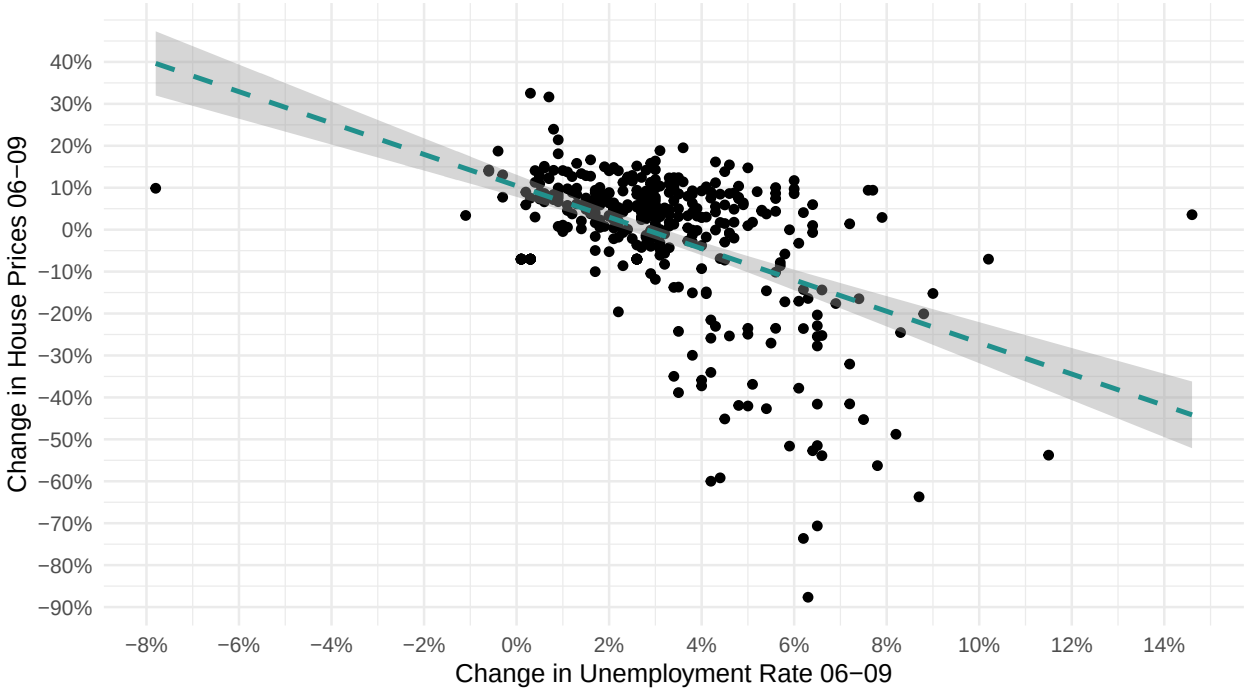


Figure 58: U.S. Regional Phillips curve (06-09)

D.4 Euro Area Countries

Figure 59: Euro Area Correlation (2001-2007)

E Theory

E.1 Marginal Product of Capital

In the case where $0 < K/AL \leq \bar{k}$, the marginal product of capital $\partial F/\partial K$ is:

$$\begin{aligned}
\frac{\partial F}{\partial K} &= \alpha K^{\alpha-1} (AL)^{1-\alpha} \left(1 - \frac{1}{2\bar{k}} \frac{K}{AL}\right)^{\alpha} - \frac{\alpha}{2\bar{k}AL} K^{\alpha} (AL)^{1-\alpha} \left(1 - \frac{1}{2\bar{k}} \frac{K}{AL}\right)^{\alpha-1} \\
&= \alpha K^{\alpha-1} (AL)^{1-\alpha} \left(1 - \frac{1}{2\bar{k}} \frac{K}{AL}\right)^{\alpha-1} \left[\left(1 - \frac{1}{2\bar{k}} \frac{K}{AL}\right) - \frac{1}{2\bar{k}} \frac{K}{AL}\right] \\
\frac{\partial F}{\partial K} &= \alpha \left(\frac{K}{AL}\right)^{\alpha-1} \left(1 - \frac{1}{2\bar{k}} \frac{K}{AL}\right)^{\alpha-1} \left(1 - \frac{1}{\bar{k}} \frac{K}{AL}\right)
\end{aligned}$$

You can note already that at the maximum level of capital, the marginal product of capital is equal to zero, as then:

$$MPK = 1 - \frac{1}{\bar{k}} \frac{K}{AL} = 0$$

Whenever $K/AL > \bar{k}$ the marginal product of capital is also equal to zero: there is satiation of capital in the production function.

To conclude, the gross Marginal Product of Capital is equal to:

$$MPK = \frac{\partial F}{\partial K} = \begin{cases} \alpha \left(\frac{K}{AL}\right)^{\alpha-1} \left(1 - \frac{1}{2\bar{k}} \frac{K}{AL}\right)^{\alpha-1} \left(1 - \frac{1}{\bar{k}} \frac{K}{AL}\right) & \text{if} \quad 0 < \frac{K}{AL} \leq \bar{k} \\ 0 & \text{if} \quad \frac{K}{AL} > \bar{k} \end{cases}$$

The Marginal Product of Capital can be expressed solely as a function of $k \equiv K/AL$, as:

$$MPK = \frac{\partial F}{\partial K} = \begin{cases} \alpha k^{\alpha-1} \left(1 - \frac{k}{2\bar{k}}\right)^{\alpha-1} \left(1 - \frac{k}{\bar{k}}\right) & \text{if} \quad 0 < k \leq \bar{k} \\ 0 & \text{if} \quad k \geq \bar{k}. \end{cases}$$

Note that we could have obtained this expression by differentiating the intensive form of the production function directly. The intensive form is:

$$y = f(k) = \begin{cases} k^{\alpha} \left(1 - \frac{1}{2\bar{k}} k\right)^{\alpha} & \text{if} \quad 0 < k \leq \bar{k} \\ \left(\frac{\bar{k}}{2}\right)^{\alpha} & \text{if} \quad k \geq \bar{k} \end{cases}$$

Therefore, when the k is below the threshold value $\bar{k}$, we can compute the marginal product of capital given by $f'(k)$:

$$\begin{aligned}
f'(k) &= \alpha k^{\alpha-1} \left(1 - \frac{k}{2\bar{k}}\right)^{\alpha} - \frac{\alpha}{2\bar{k}} k^{\alpha} \left(1 - \frac{k}{2\bar{k}}\right)^{\alpha-1} \\
&= \alpha k^{\alpha-1} \left(1 - \frac{k}{2\bar{k}}\right)^{\alpha-1} \left[\left(1 - \frac{k}{2\bar{k}}\right) - \frac{k}{2\bar{k}}\right] \\
f'(k) &= \alpha k^{\alpha-1} \left(1 - \frac{k}{2\bar{k}}\right)^{\alpha-1} \left(1 - \frac{k}{\bar{k}}\right)
\end{aligned}$$

Therefore:

$$f'(k) = \begin{cases} \alpha k^{\alpha-1} \left(1 - \frac{k}{2\bar{k}}\right)^{\alpha-1} \left(1 - \frac{k}{\bar{k}}\right) & \text{if} \quad 0 < k \leq \bar{k} \\ 0 & \text{if} \quad k \geq \bar{k}. \end{cases}$$

E.2 Elasticity of Substitution σ

By definition, the elasticity of substitution between capital and labor is the percentage change in the capital over labor ratio, when ratio of the price of capital over the wage rate (which is equal to the marginal rate of transformation) changes by 1%:

$$\sigma\left(\frac{K}{L}\right) = -\frac{d\log\left(\frac{K}{L}\right)}{d\log\left(\frac{\partial F/\partial K}{\partial F/\partial L}\right)} = -\frac{d\log\left(\frac{K}{AL}\right)}{d\log\left(\frac{\partial F/\partial K}{\partial F/\partial AL}\right)}.$$

We note that this elasticity is the same regardless of whether it is computed with labor L, or efficiency units of labor AL. The latter will prove more convenient. To compute the marginal rate of transformation $(\partial F/\partial K)/(\partial F/\partial AL)$, we first compute the marginal product of capital $\partial F/\partial K$ with:

$$Y = F(K,L) = \begin{cases} K^{\alpha}\left(AL\right)^{1-\alpha}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha} & \text{if} \quad 0 < \frac{K}{AL} \leq \bar{k} \\ \left(\frac{\bar{k}}{2}\right)^{\alpha} AL & \text{if} \quad \frac{K}{AL} > \bar{k} \end{cases}$$

We have already shown that the gross Marginal Product of Capital is equal to:

$$MPK = \frac{\partial F}{\partial K} = \begin{cases} \alpha\left(\frac{K}{AL}\right)^{\alpha-1}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha-1}\left(1-\frac{1}{\bar{k}}\frac{K}{AL}\right) & \text{if} \quad 0 < \frac{K}{AL} \leq \bar{k} \\ 0 & \text{if} \quad \frac{K}{AL} > \bar{k} \end{cases}$$

In case $0 < K/AL \leq \bar{k}$, the marginal product of efficiency units of labor $\partial F/\partial AL$ is:

$$\begin{aligned} \frac{\partial F}{\partial AL} &= (1-\alpha)K^{\alpha}\left(AL\right)^{-\alpha}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha} + K^{\alpha}\left(AL\right)^{1-\alpha}\frac{\alpha K}{2\bar{k}A^2L^2}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha-1} \\ &= K^{\alpha}\left(AL\right)^{-\alpha}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha-1}\left[(1-\alpha)\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)+\frac{\alpha}{2\bar{k}}\frac{K}{AL}\right] \\ \frac{\partial F}{\partial AL} &= \left(\frac{K}{AL}\right)^{\alpha}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha-1}\left[1-\alpha-(1-2\alpha)\frac{1}{2\bar{k}}\frac{K}{AL}\right]. \end{aligned}$$

The marginal rate of transformation is:

$$\begin{aligned} \frac{\frac{\partial F}{\partial K}}{\frac{\partial F}{\partial AL}} &= \frac{\alpha\left(\frac{K}{AL}\right)^{\alpha-1}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha-1}\left(1-\frac{1}{\bar{k}}\frac{K}{AL}\right)}{\left(\frac{K}{AL}\right)^{\alpha}\left(1-\frac{1}{2\bar{k}}\frac{K}{AL}\right)^{\alpha-1}\left[1-\alpha-(1-2\alpha)\frac{1}{2\bar{k}}\frac{K}{AL}\right]} \\ &= \frac{\alpha\left(1-\frac{1}{\bar{k}}\frac{K}{AL}\right)}{\frac{K}{AL}\left[1-\alpha-(1-2\alpha)\frac{1}{2\bar{k}}\frac{K}{AL}\right]} \\ \frac{\frac{\partial F}{\partial K}}{\frac{\partial F}{\partial AL}} &= \frac{2\alpha\left(\bar{k}-\frac{K}{AL}\right)}{\frac{K}{AL}\left[(2-2\alpha)\bar{k}-(1-2\alpha)\frac{K}{AL}\right]} \end{aligned}$$

Expressing everything as a function of:

$$k \equiv \frac{K}{AL}.$$

we get:

$$\frac{\partial F/\partial K}{\partial F/\partial AL} = \frac{2\alpha\left(\bar{k}-k\right)}{k\left[(2-2\alpha)\bar{k}-(1-2\alpha)k\right]}$$

We can now compute the inverse of the elasticity of substitution:

$$\begin{aligned}
\frac{1}{\sigma} &= -\frac{d\log\left(\dfrac{\partial F/\partial K}{\partial F/\partial AL}\right)}{d\log k} \\
&= -\left(-\frac{d\log k}{d\log k}+\frac{d\log(\bar{k}-k)}{d\log k}-\frac{d\log\left[(2-2\alpha)\bar{k}-(1-2\alpha)k\right]}{d\log k}\right) \\
&= -\left(-1-\frac{k}{\bar{k}-k}+\frac{(1-2\alpha)k}{(2-2\alpha)\bar{k}-(1-2\alpha)k}\right) \\
&= \frac{\bar{k}}{\bar{k}-k}-\frac{k}{\dfrac{2-2\alpha}{1-2\alpha}\bar{k}-k} \\
\frac{1}{\sigma} &= 1+\frac{\bar{k}}{\bar{k}-k}-\frac{\bar{k}}{\bar{k}-\dfrac{1-2\alpha}{2-2\alpha}k}
\end{aligned}$$

There, we get the elasticity of substitution as a function of k, which is given by:

$$\sigma(k) = \begin{cases} \dfrac{1}{1+\dfrac{\bar{k}}{\bar{k}-k}-\dfrac{\bar{k}}{\bar{k}-\dfrac{1-2\alpha}{2-2\alpha}k}} & \text{if} \quad 0<k\leq\bar{k} \\ 0 & \text{if} \quad k\geq\bar{k} \end{cases}$$

For example, with $\bar{k}=1$, and $\alpha=1/3$, we arrive at the following elasticity of substitution:

$$\sigma(k) = \begin{cases} \dfrac{(4-k)(1-k)}{(1-k)^2+3} & \text{if} \quad 0<k\leq\bar{k} \\ 0 & \text{if} \quad k\geq\bar{k} \end{cases}$$

E.3 An alternative Model

The lifetime utility of the representative individual is given by:

$$\int_0^\infty \left[\gamma\log\left(c_t^T\right)+(1-\gamma)\log\left(c_t^N\right)\right]e^{-\beta t}dt$$

The flow constraint of the consumer is given by:

$$\dot{b}_t = rb_t + y_t^T + p_t y_t^N - c_t^T - p_t c_t^N$$

Imposing the transversality condition:

$$\lim_{t\to\infty} e^{-rt}b_t = 0,$$

we obtain the intertemporal budget constraint:

$$\int_0^\infty \left(c_t^T + p_t c_t^N\right)e^{-rt}dt = b_0 + \int_0^\infty \left(y_t^T + p_t y_t^N\right)e^{-rt}dt.$$

where y_t^T and y_t^N denote the production of tradable and nontradable goods, respectively.

Production takes place according to the following technologies:

$$y_t^T = Z_t^T \left(n_t^T\right)^\alpha, \quad 0 < \alpha < 1$$
$$y_t^N = Z_t^N n_t^N$$

We may set up the Lagrangian as such:

$$\mathcal{L} = \int_0^\infty u\left(c_t^T, c_t^N\right) e^{-\beta t} dt + \lambda \left[b_0 + \int_0^\infty \left(y_t^T + p_t y_t^N\right) e^{-rt} dt - \int_0^\infty \left(c_t^T + p_t c_t^N\right) e^{-rt} dt \right]$$

We have the following:

$$u_{c^T}\left(c_t^T, c_t^N\right) = \lambda$$
$$u_{c^N}\left(c_t^T, c_t^N\right) = \lambda p_t$$

Example. With log utility:

$$\frac{\gamma}{c_t^T} = \lambda$$
$$\frac{1-\gamma}{c_t^N} = \lambda p_t$$

Therefore:

$$\frac{c_t^N}{c_t^T} = \left(\frac{1-\gamma}{\gamma}\right) \frac{1}{p_t}.$$

As will become clear below, this condition can be interpreted as a demand function for nontradable goods relative to tradable goods. As in standard consumer theory, this demand function depends negatively on the relative price of nontradables, p_t.

E.4 A trade-off between unemployment and competitiveness?

Figure 60: Japan Net Exports (1980-2005)

Argentina 1982		
Variable	*Before*	*After*
p	100	49.6
TB/GDP	0.6%	3.8%
CA/GDP	−2.7%	−1.9%

Chile 1982		
Variable	*Before*	*After*
p	100	70.1
TB/GDP	−3.4%	2.1%
CA/GDP	−7.3%	−7.6%

Uruguay 1982		
Variable	*Before*	*After*
p	100	49.2
TB/GDP	−4.3%	3.8%
CA/GDP	−5.6%	−3.0%

Mexico 1994		
Variable	*Before*	*After*
p	100	77.9
TB/GDP	−4.0%	1.5%
CA/GDP	−6.5%	−1.0%

Indonesia 1997		
Variable	*Before*	*After*
p	100	53.2
TB/GDP	1.6%	14.4%
CA/GDP	−2.8%	4.5%

Korea 1997		
Variable	*Before*	*After*
p	100	73.7
TB/GDP	−1.5%	7.9%
CA/GDP	−2.6%	−7.1%

Malaysia 1997		
Variable	*Before*	*After*
p	100	71.6
TB/GDP	2.6%	25.4%
CA/GDP	−6.7%	12.8%

Thailand 1997		
Variable	*Before*	*After*
p	100	74.1
TB/GDP	−6.9%	7.7%
CA/GDP	−5.9%	10.2%

Turkey 2001		
Variable	*Before*	*After*
p	100	84.4
TB/GDP	−7.8%	−4.3%
CA/GDP	−1.5%	−0.6%

Figure 61: Crises episodes: Relative price of nontradable goods, trade balance, and current account (from Vegh (2013))

F Data

F.1 Definitions of Exchange Rate Regimes

Table 49: Coarse Classification of Exchange Rates (Source: Ilzetzki, Reinhart, and Rogoff (2019))

Coarse Class.	Detailed Classification
Fixed / Peg	No separate legal tender
Fixed / Peg	Pre announced peg or currency board arrangement
Fixed / Peg	Pre announced horizontal band that is narrower than or equal to +/-2%
Fixed / Peg	De facto peg
Crawling Peg	Pre announced crawling peg
Crawling Peg	Pre announced crawling band that is narrower than or equal to +/-2%
Crawling Peg	De factor crawling peg
Crawling Peg	De facto crawling band that is narrower than or equal to +/-2%
Crawling Band	Pre announced crawling band that is wider than or equal to +/-2%
Crawling Band	De facto crawling band that is narrower than or equal to +/-5%
Crawling Band	Moving band that is narrower than or equal to +/-2% (
Crawling Band	Managed floating
Floating	Freely floating

F.2 Samples

Table 50: Summary Statistics (Country Observations)

Country Name	Sample Period	# of obs
Belgium	1960-2019	240
Canada	1960-2019	240
Finland	1960-2019	240
France	1960-2019	240
Italy	1960-2019	240
Japan	1960-2019	240
Netherlands	1960-2019	240
New Zealand	1960-2019	240
OECD - Total	1960-2019	240
Portugal	1960-2019	240
Sweden	1960-2019	240
United States	1960-2019	240
South Korea	1963-2019	228
Australia	1964-2019	224
Iceland	1964-2019	224
Austria	1969-2019	204
Denmark	1969-2019	204
United Kingdom	1971-2019	196
Norway	1972-2019	192
Switzerland	1975-2019	180
Spain	1976-2019	174
Luxembourg	1985-2019	140
Estonia	1989-2019	124
Ireland	1990-2019	120
Euro area (17 countries)	1991-2019	116
Mexico	1991-2019	116
NA	1991-2019	116
Germany	1992-2019	112
Hungary	1992-2019	112
Poland	1992-2019	111
Czech Republic	1993-2019	108
Slovak Republic	1993-2019	107
Israel	1995-2019	100
South Africa	2000-2019	78
Lithuania	2002-2019	72