The Phillips Curve: Price Levels or Real Exchange Rates?*

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Abstract

This paper argues that the Phillips Curve is driven by a correlation between real exchange rates and economic activity, which leads to a correlation between inflation and economic activity in fixed exchange rate regimes. According to this interpretation, the Phillips Curve is a correlation between relative prices and economic activity, and does not result from a monetary phenomenon. Three new facts are put forward to support that hypothesis. First, the original Phillips relation is valid only in fixed exchange rate regimes, less valid in intermediate regimes between flexible and fixed exchange rates, and does not function in flexible exchange rate regimes. Second, when nominal or real exchange rates are used instead inflation, the Phillips relation is restored in floating exchange rate regimes. Third, identified aggregate demand shocks (tax cuts) drive a positive relation between real exchange rates and economic activity in the reduced form. A textbook international finance model helps rationalize these findings. The fact that the Phillips curve is a relative price phenomenon does not necessarily imply a classical dichotomy. If prices are more sticky than nominal exchange rates, then the classical dichotomy does not hold, and monetary policy may work through the exchange rate channel.

Keywords: Phillips curve, unemployment, inflation
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Introduction

The path of inflation during the crisis and post-crisis era has not been consistent with the view that inflation is systematically tied to unemployment, or any other measures of economic slack, a relation that is usually referred to as the Phillips (1958) curve. There was no significant desinflation during the Great Recession, so much that Hall (2011) talked about the "near-exogeneity of the rate of inflation".[1] 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)). Strikingly, the reality of the Phillips curve has been questioned before. In the 1970s, "stagflation", a coexistence of both high inflation and high unemployment in the US and many advanced economies, also started to erode faith in the Phillips curve. This reappraisal ultimately led to the rational expectations revolution, and a critical reassessment of the Phillips curve, which was augmented with a role for expectations. However, the reality of the Phillips curve was reaffirmed for the short-run: Friedman (1968) argued that "there is always a temporary trade-off between inflation and unemployment". Unfortunately, this expectations-augmented form never had strong empirical support, at least in terms of forecasting (Atkeson and Ohanian (2001), Stock and Watson (2003), Uhlig (2012)). Yet despite its poor empirical fit and forecasting performance, the Phillips curve still plays an important role in undergraduate teaching, as reflected in the main undergraduate textbooks, most of which devote at least a chapter to the Phillips curve: for example, Mankiw (2015), Abel et al. (2016), Blanchard (2016) and Jones (2017). In research and policy analysis, macroeconomic models based on the Phillips curve, such as DSGE models with price stickiness (Smets and Wouters (2007)), still play an important role, at least in research departments of major central banks. In his 2001 Nobel Prize acceptance speech, George Akerlof said: "Probably the single most important macroeconomic relationship is the Phillips curve." The reason is perhaps a lack of a better alternative: "so long as no clearly better organizing device presents itself, economists will argue about the Phillips curve" (Solow (1976)).

The thesis developed in this paper is that the Phillips Curve, may in fact well exist but not as a correlation between unemployment, or any measure of economic slack, and absolute price inflation. Instead, the Phillips curve may represent a correlation between unemployment and real exchange rates, that is the relative price of traded and non-traded goods. Real exchange rates exactly coincide with price inflation in fixed exchange rate regimes, which provides a new interpretation Phillips (1958)'s original evidence, much of which pertains to a time when the UK was operating under the Gold

[1] 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."

standard. Similarly, much of Samuelson and Solow (1960)'s evidence corresponds to the Bretton Woods system of fixed exchange rates. This account provides an alternative interpretation of the Phillips Curve's failure after the end of the Bretton Woods system in the 1971 (the so-called stagflation), but also for its relative failure in the United States and Japan, which are one of the few countries in the world with flexible exchange rate regimes towards most of tehir trading partners. In contrast, the Phillips curve survives even now in many countries with fixed exchange rate regimes. This paper thus argues that there might be no trade-off between unemployment and inflation after all, but rather one between unemployment and competitiveness (the external balance), which the Phillips curve captures in fixed exchange rate regimes.

This paper gives three facts in support of this hypothesis, some of which are new. A first novel observation is that across a broad sample of countries, the original Phillips relation is valid only in fixed exchange rate regimes, and becomes flatter as the exchange rate regime moves continuously from fixed to floating. In fact, the original evidence put forward by Samuelson and Solow (1960) for the United States, and Phillips (1958) for the United Kingdom did partly pertain to a time in which these countries were operating under a fixed exchange rate, or even under a Gold standard. The accelerationist version of the Phillips curve, which uses the change in inflation instead of its level, is similarly stronger in fixed exchange rate regimes than they are under flexible exchange rates. This fact is consistent with the evidence in Beraja et al. (2016), who find that the Phillips curve hold quite strongly across US regions, but not at the aggregate level for the US economy.[2]

A second observation is that when nominal or real exchange rate are used in place of inflation, the Phillips relation remains valid both in fixed and flexible exchange rate regimes. This second fact is in line with the first, and adds further support to the hypothesis. For countries with fixed exchange rates, the only way that real exchange rates may move is through price inflation, occuring through the change in the price of non-traded goods. In contrast, in flexible exchange rate regimes, the real exchange rate can change either through changes in the nominal exchange rate, or through price inflation. In turn, the contribution of both may depend on the hawkishness of monetary authorities. With strong inflation-targeting central banks, the adjustment takes place through nominal exchange rates. In contrast, more dovish central banks may let inflation wander somewhat off target. In the limit with fixed exchange rate, the central bank targets the exchange rate and so inflation adjusts. It should also be noted that although the link between exchange rate regimes and the Phillips curve has not been noted before, the correlation between real exchange rates and aggregate consumption

[2]Beraja et al. (2016) explain this failure of the Phillips curve at the aggregate level by the fact that different shocks hit the US economy in the aggregate, which are differenced out when computing cross-regional covariances. In contrast, I argue that it may be because US regions share the same currency, while the US dollar floats against most of the currencies of its trading partners.

is well-known in the international real business cycle literature as the Backus-Smith puzzle (Backus and Smith (1993)).

A third and final suggestive piece of evidence is that identified aggregate demand shocks (such as tax cuts) drive a positive relation between real exchange rates and economic activity. I show this using four methods which have been used before in the literature: the structural VAR method of Blanchard and Perotti (2002) which identifies tax shocks as deviations from a log linear relationship between tax revenues and GDP, narrative shocks identified in the United States by Romer and Romer (2010), those identified by Cloyne (2013) in the United Kingdom, and finally tax shocks identified in OECD economies in Grjebine and Geerolf (2016). These types of shocks generate a correlation between real exchange rates and economic activity, that reduced form regressions capture. The textbook international finance model helps rationalize these findings. The Phillips trade-off may not be so much about inflation and output, but rather between competitiveness and output. Through the exchange rate channel, the monetary policy stance can determine how much real exchange rate appreciation occurs through price inflation and how much of it takes place through the nominal exchange rate. In fact, the argument that one limit to expansionary policy was the trade balance was very well known by

Although this paper argues that the Phillips curve may not be driven by a monetary phenomenon, but may instead be a relative price phenomenon, it does not necessarily imply that the monetary dichotomy holds. For example, this hypothesis gives the central bank some room for choosing how much of an aggregate demand shock results in a real exchange rate appreciation through nominal exchange rates and how much of it goes to CPI inflation, through the choice of monetary policy. If one thinks that prices may adjust slower than nominal exchange rates to shocks, then monetary policy could impact how fast the terms of trade respond to real shocks. For example, this would determine how fast do tax cuts result in a loss of competitiveness. This would provide a rationale for the Mussa (1986) observation that under flexible exchange rate regimes, real exchange rates are far more volatile than under fixed exchange rate regimes.

1 Literature

Fisher (1926) first: "And yet, in the significant period 1915-1925, analysis shows a Pearsonian correlation as high as 90 per cent, between the rate of change in the value of the dollar and unemployment in the United States."

"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, Czecho- slovakia, or Norway"

That is, by correlating the volume of trade3 with the changes in the price level, not with the price level itself, and assuming a certain "distributed lag" between the two, we obtain this high correlation of 94.1 per cent. (+ 941). This correlation is so high as largely to explain the major fluctuations of the so-called business cycle without reference to any of the conventional explanations.

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 fluctua- tions 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.

The empirical failure of the Phillips curve is an old theme in empirical macroeconomics (Stock and Watson (2008), Stock and Watson (2010), Dotsey et al. (2017)).

This paper also relates to a very large literature in international macroeconomics and finance, which is concerned with the behavior of exchange rates.

The closest to this paper is probably Reis and Watson (2010), who, to the best of my knowledge, first showed using US data that the Phillips curve may be about relative price inflation, instead of absolute price inflation. However, they did not relate this to real exchange rates, or exchange rate regimes. The fact that the trade-off between inflation and economic activity in New Keynesian is perhaps not the key trade-off has been suggested by Nakamura et al. (2016) before, who document that the variance of price inflation does not seem to be so large even in episodes with very large price inflation.

Effects of monetary policy on exchange rates: Mueller et al. (2017). Note that the premium is higher on days of monetary easing.

Andy's advice: Eichenbaum et al. (2017), Flood and Rose (1995)

Traded goods and non-traded goods: Burstein et al. (2006) and Burstein and Gopinath (2014)

The paper is related to sticky price models which are used in policy circles, such as Mundell (1963) and Fleming (1962). It is also related to the Mussa (1986) observation, who argues that a convincing evidence in factor of monetary non neutrality is that real exchange rates are far more volatile in flexible exchange rate regimes than they are in fixed exchange rate regimes.

Other related literature: Stock and Watson (2009), Sargent (1982), Obstfeld and Rogoff (1995), Backus and Smith (1993), Corsetti et al. (2008), Canova and Ravn (1996), Engel (1999), Chari et al. (2002), Mendoza (2005), Burstein et al. (2003), Burstein et al. (2006), Engel (2014a), **?**, Mendoza et al. (2009), Mendoza (2010), Dornbusch (1987), Krugman (1994), Thurow (1993), Rodrik (2008), Corden and Neary (1982), Reis (2013), Benigno and Fornaro (2014), Benigno et al. (2015), Rebelo and Vegh (1995), Cochrane (1994). Blanchard (1993), Hall (1993), Atkeson and Ohanian (2001), Lucas (1973),

Exchange rates: Engel and West (2005), Engel (2014b).

Another: Clarida et al. (1998)

Lucas and Sargent (1979)

Idea that exchange rates appreciate when there is a shock to inflation (they call it "cost-push shock": how about this is just a change between the relative price of non-tradables and tradables): Clarida and Waldman (2008)

Finally, I shall conclude by citing an interesting and provocative hypothesis put forward by Sleeman (2011). Starting from the observation that Phillips had not actually submitted the paper himself, and "based on admittedly circumstantial evidence", Sleeman (2011) argues that "Bill Phillips was not satisfied with the paper and had not intended to publish it in 1958."

2 Main Results

2.1 Data

The data is taken from the OECD Main Economic Indicators database, and the data on exchange rate regimes comes from the database attached to Ilzetzki et al. (2017). The database was taken as is. In particular, no country was removed in the sample, for the purpose of improving statistical fit.

2.2 Results

A novel empirical fact in this paper is that the Phillips curve holds only in fixed exchange rate regimes.

Table 1: Regression Results on : CPI-CPIH-YTYPCT = UNR

	Estimate	t value	R^2	Adj R^2	Nobs
Fixed	-0.219	-7.399	11.700	11.500	416
Peg	-0.301	-2.854	3.800	3.300	208
Band	-0.026	-0.326	0	-0.200	428
Floating	0.409	3.424	9.100	8.300	119

Table 2: Regression Results on : CPI-CPIH-YTYPCT = UNR + factor(countryname)

	Estimate	t value	R^2	Adj R^2	Nobs
Fixed	-0.232	-7.414	67.200	64.900	416
Peg	-0.284	-1.446	30.500	23.100	208
Band	-0.718	-4.071	26.400	22.200	428
Floating	0.048	0.324	30.100	27	119

Table 3: Regression Results on : CPI-CPIH-YTYPCT-d1 = UNR-d1

	Estimate	t value	R^2	Adj R^2	Nobs
Fixed	-0.446	-5.734	7.600	7.400	401
Peg	0.601	1.669	1.400	0.900	195
Band	-0.387	-1.769	0.700	0.500	419
Floating	-0.681	-3.881	11.600	10.800	117

2.3 Fit

The real exchange rate does not only move because of movements in the home countries' prices, but also sometimes because the fireign countries price is also changing. I test for this in this sectioj

One particular regression:

2.4 By Country

3 Model

See Appendix

4 Conclusion

This paper hypothesizes that the Phillips (1958) and Samuelson and Solow (1960) correlations may never have been so much be about absolute price inflation as it has been about the real exchange rate. The implications of that observation are potentially important for thinking about monetary policy.

Table 4: Inflation on Unemployment by countryname

	period	Regime	ERregime	est	p	R2	Adj.R
1	Australia 1964-1974	Fixed / Peg	1	6.61 ***	0	61 %	56.6 %
2	Australia 1975-1982	Crawling Peg	2	-1.99 *	0.080	43.1 %	33.6 %
3	Australia 1984-2016	Floating	4	0.05	0.820	0.2 %	-3 %
4	Austria 1981-2016	Fixed / Peg	1	-0.39 *	0.080	12.3 %	8.6 %
5	Belgium 1960-2016	Fixed / Peg	1	-0.48 **	0.030	20 %	16.5 %
6	Brazil 1995-1998	Crawling Peg	2	-4.35	0.410	63.6 %	27.2 %
7	Brazil 2000-2016	Crawling Band	3	0.58	0.140	13.9 %	8.2 %
8	Canada 1970-2001	Crawling Peg	2	-0.26	0.160	25.6 %	15 %
9	Canada 2002-2016	Crawling Band	3	-0.31	0.290	8.7 %	1.6 %
10	Chile 1986-2016	Crawling Band	3	0.64	0.420	2.3 %	-1.1 %
11	Colombia 2001-2016	Crawling Band	3	0.46 **	0.050	24.8 %	19.4 %
12	Costa Rica 2010-2016	Crawling Peg	2	-0.29	0.890	0.4 %	-19.5
13	Czech Republic 1993-1995	Crawling Peg	2	3.84 NA		100 %	NaN
14	Czech Republic 1997-2016	Crawling Peg	2	-0.31	0.500	2.5 %	-2.9 %
15	Denmark 1969-1971	Fixed / Peg	1	-7.15	0.450	57.8 %	15.6 %
16	Denmark 1972-1998	Crawling Peg	2	-0.84 **	0.020	20.8 %	17.6 %
17	Denmark 1999-2016	Fixed / Peg	1	-0.23	0.180	11.1 %	5.5 %
18	Estonia 2000-2016	Fixed / Peg	1	-0.15	0.450	3.9 %	-2.5 %
19	Finland 1973-1994	Crawling Peg	2	-0.21	0.180	67.3 %	51 %
20	Finland 1995-2016	Fixed / Peg	1	-0.17 *	0.060	17 %	12.8 %
21	France 1987-2016	Fixed / Peg	1	-0.58 ***	0	47 %	44 %
22	Germany 1992-1998	Floating	4	0.11	0.950	0.7 %	-98.6
23	Germany 1999-2016	Fixed / Peg	1	0.11	0.240	8.7 %	3 %
24	Greece 1995-2016	Fixed / Peg	1	-0.27 ***	0	62.6 %	60.6 %
25	Hungary 1992-1993	Crawling Band	3	-0.56 NA		100 %	NaN
26	Hungary 1994-1998	Crawling Peg	2	2.94	0.220	44.5 %	26 %
27	Hungary 1999-2008	Crawling Band	3	-0.53	0.630	3 %	-9.2 %
28	Hungary 2009-2016	Crawling Peg	2	0.88 ***	0.010	72.8 %	68.2 %
29	Iceland 1964-1972	Crawling Peg	2	4.45 *	0.090	36 %	26.9 %
30	Iceland 1973-1975	Freely Floating	5	190.15	0.560	40.1 %	-19.8
31	Iceland 1977-1983	Freely Floating	5	47.37 **	0.040	60.2 %	52.3 %
32	Iceland 1984-1986	Crawling Band	3	12.85	0.460	56.1 %	12.2 %
33	Iceland 1987-2000	Crawling Peg	2	-4.12 ***	0.010	44.9 %	40.3 %
34	Iceland 2001-2016	Crawling Band	3	0.27	0.570	2.4 %	-4.6 %
35	Ireland 1997-2016	Fixed / Peg	1	-0.36 ***	0	53.4 %	50.8 %
36	Israel 1995-2016	Crawling Band	3	0.13	0.680	0.9 %	-4.1 %
37	Italy 1983-1996	Crawling Peg	2	-0.38	0.210	35.8 %	19.8 %
38	Italy 1997-2016	Fixed / Peg	1	-0.28 **	0.010	29.8 %	25.8 %
39	Japan 1978-2016	Floating	4	-0.84 ***	0	54.8 %	53.2 %
40	Korea 1964-1973	Crawling Band	3	2.72 *	0.080	33.5 %	25.2 %
41	Korea 1974-1979	Fixed / Peg	1	10.41	0.220	35.1 %	18.9 %
42	Korea 1980-1997	Crawling Peg	2	3.75 **	0.030	26.8 %	22.2 %
43	Korea 1999-2016	Crawling Band	3	-0.53	0.170	11.3 %	5.8 %
44	Latvia 1996-2001	Crawling Band	3	2.02	0.220	44.1 %	25.4 %
45	Latvia 2002-2004	Crawling Peg	2	-3.53	0.550	42.1 %	-15.7
46	Latvia 2005-2009	Crawling Band	3	-0.73	0.190	49.5 %	32.6 %
47	Latvia 2010-2016	Fixed / Peg	1	0.09	0.680	3.7 %	-15.6
48	Lithuania 2002-2016	Fixed / Peg	1	-0.33	0.130	17.1 %	10.7 %
49	Luxembourg 1985-2016	Fixed / Peg	1	-0.22	0.230	7.4 %	2.5 %
50	Mexico 1992-1993	Fixed / Peg	1	-56.74 NA		100 %	NaN
51	Mexico 1996-2016	Crawling Band	3	0.44	0.820	0.3 %	-5 %

Table 5: extscInflation on Activity by countryname

	countryname	est	t.stat	p.value	R2	Adj.R2
1	Australia	0.390	2.600	0.010	11.2 %	9.5 %
2	Austria	0.030	0.700	0.490	1.8 %	-1.9 %
3	Belgium	0.040	1.210	0.240	5.3 %	1.7 %
4	Brazil	-0.040	-0.320	0.750	0.5 %	-4 %
5	Canada	0.050	1.910	0.070	12.7 %	9.2 %
6	Chile	-0.350	-2.750	0.010	19.1 %	16.6 %
7	Colombia	-0.130	-0.760	0.460	3.3 %	-2.4 %
8	Costa Rica	0.600	0.460	0.650	2.6 %	-9.5 %
9	Czech Republic	0.110	0.760	0.460	2.4 %	-1.8 %
10	Denmark	-0.160	-1.310	0.200	3.4 %	1.4 %
11	Estonia	0.150	2.440	0.030	24.9 %	20.8 %
12	Finland	0.030	1.200	0.240	5.1 %	1.6 %
13	France	0.040	2.110	0.050	17.5 %	13.6 %
14	Germany	0.190	2.640	0.020	24 %	20.6 %
15	Greece	0.040	1.140	0.270	5.6 %	1.3 %
16	Hungary	-0.390	-1.360	0.190	6.6 %	3 %
17	Iceland	1.100	4.540	0	27.6 %	26.3 %
18	Ireland	0.110	3.940	0	41.4 %	38.7 %
19	Israel	-0.050	-0.130	0.890	0.1 %	-4.3 %
20	Italy	0.080	5.060	0	48.6 %	46.7 %
21	Japan	0.010	1.270	0.210	4.8 %	1.8 %
22	Korea	-0.050	-1.140	0.260	2.3 %	0.6 %
23	Latvia	0.250	5.050	0	54.8 %	52.7 %
24	Lithuania	0.310	4.370	0	54.4 %	51.6 %
25	Luxembourg	0.090	2.490	0.020	22 %	18.5 %
26	Mexico	-1.200	-2.200	0.040	15.2 %	12 %
27	Netherlands	0.070	2.930	0.010	24.1 %	21.3 %
28	New Zealand	0.120	0.980	0.330	1.7 %	-0.1 %
29	Norway	0.100	2.140	0.040	7.4 %	5.8 %
30	Poland	-1.360	-2.280	0.030	17.2 %	13.9 %
31	Portugal	0.090	3.970	0	36.9 %	34.6 %
32	Russia	-0.830	-1.970	0.060	17 %	12.6 %
33	Slovak Republic	-0.110	-0.710	0.490	2.2 %	-2.2 %
34	Slovenia	-0.010	-0.060	0.950	0 %	-5.2 %
35	South Africa	0.130	1.050	0.310	6 %	0.5 %
36	Spain	0.120	4.780	0	52.1 %	49.9 %
37	Sweden	0.410	4.400	0	25.4 %	24.1 %
38	Switzerland	0.370	2.690	0.010	14.4 %	12.4 %
39	Turkey	0.380	0.570	0.570	0.6 %	-1.2 %
40	United Kingdom	-0.040	-0.800	0.430	2.3 %	-1.3 %
41	United States	0.150	2.380	0.020	9.1 %	7.5 %

Table 6: Inflation on Lagged Inflation and Activity by countryname

	countryname	est	t.stat	p.value	R2	Adj.R2
1	Australia	0.200	2.290	0.030	77.1 %	76.2 %
2	Austria	0.020	0.600	0.560	17.7 %	11.1 %
3	Belgium	0.040	1.130	0.270	5.1 %	-2.8 %
4	Brazil	-0.020	-0.190	0.850	8.7 %	-0.4 %
5	Canada	0.050	1.860	0.080	13.2 %	5.6 %
6	Chile	-0.070	-1.020	0.320	81.1 %	79.9 %
7	Colombia	0.120	0.790	0.440	35.8 %	27.2 %
8	Costa Rica	1.100	1.250	0.260	60.5 %	47.3 %
9	Czech Republic	0.160	1.470	0.160	51.7 %	47.4 %
10	Denmark	0.010	0.100	0.920	80.7 %	79.9 %
11	Estonia	0.170	2.590	0.020	33.5 %	25.2 %
12	Finland	0.020	1.180	0.250	34 %	28.8 %
13	France	0.040	1.750	0.100	21.6 %	13.3 %
14	Germany	0.200	2.960	0.010	37.5 %	31.3 %
15	Greece	0.040	2.020	0.060	65 %	61.5 %
16	Hungary	0.030	0.260	0.800	85.5 %	84.3 %
17	Iceland	0.270	1.370	0.180	69.9 %	68.7 %
18	Ireland	0.070	2.110	0.050	52.6 %	47.9 %
19	Israel	-0.070	-0.340	0.740	58.1 %	54.1 %
20	Italy	0.030	2.090	0.050	63.1 %	60.2 %
21	Japan	0	0.520	0.600	33.7 %	29.3 %
22	Korea	0	-0.100	0.920	55.1 %	53.4 %
23	Latvia	0.260	5.250	0	69.5 %	66.3 %
24	Lithuania	0.320	4.790	0	72.5 %	68.6 %
25	Luxembourg	0.070	2	0.060	25.2 %	17.7 %
26	Mexico	-1.160	-3.430	0	68 %	65.4 %
27	Netherlands	0.040	1.840	0.080	39 %	34.1 %
28	New Zealand	0.140	2.190	0.030	75.8 %	74.9 %
29	Norway	0.010	0.350	0.730	61 %	59.6 %
30	Poland	0	0	1	95.2 %	94.8 %
31	Portugal	0.030	1.770	0.090	74.6 %	72.6 %
32	Russia	0.070	0.580	0.570	40.4 %	33.3 %
33	Slovak Republic	-0.010	-0.050	0.960	52.2 %	47.4 %
34	Slovenia	0.050	0.680	0.510	67.6 %	63.8 %
35	South Africa	0.160	1.150	0.270	16.1 %	4.9 %
36	Spain	0.120	3.280	0	52.2 %	47.1 %
37	Sweden	0.200	3.220	0	74.5 %	73.5 %
38	Switzerland	0.270	3.020	0	59.7 %	57.7 %
39	Turkey	0.560	1.820	0.070	80 %	79.2 %
40	United Kingdom	-0.010	-0.360	0.720	43 %	38.4 %
41	United States	0.070	1.750	0.090	69.1 %	67.9 %

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A Comparing Models

Mundell Fleming / IS-LM: with rise in taxes, IS shifts outwards and the interest rate increases this model: also

Mundell Fleming: interest rate increases which appreciated the exchange rate, so much that the balance of trade goes in the opposite direction of the balance of trade. Back to old equilibrium because interest rates need to be equalized.

B Data

B.1 Summary Statistics

Table 7: Summary statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	
CPI	892	0.717	0.465	0.00000	0.336	1.000	
CPI_YTYPCT	882	7.703	12.605	−1.363	1.974	8.034	
CPIDR	1,514	98.758	16.344	47.474	90.918	104.806	
CPIH	465	0.902	0.163	0.453	0.771	1.041	
CPIH_YTYPCT	450	2.404	2.066	−1.693	1.250	3.116	
EXCH	1,670	405.157	5,063.313	0.0003	0.155	1.255	9
EXCHEB	1,460	52,735.040	624,339.500	12.765	85.766	105.264	11,
EXCHER	924	0.989	0.157	0.358	0.923	1.047	
IRL	1,387	6.702	4.079	−0.362	4.102	8.765	
IRS	1,415	6.227	5.587	−0.784	2.185	9.124	
UNR	1,690	6.772	4.451	0.043	3.781	8.808	
ERregime	1,567	2.173	1.093	1.000	1.000	3.000	
EXCHEBCPI	754	74.330	38.393	9.874	44.627	99.432	
CPI_CPIH_YTYPCT	1,332	5.913	10.625	−1.693	1.620	5.949	
UNR_log	1,690	167.004	79.691	−315.021	132.997	217.565	
GDPV_log	1,686	2,775.278	246.546	2,301.305	2,606.617	2,852.008	
CPIDR_log	1,514	457.877	16.881	386.018	450.996	465.211	
CPI_log	892	−105.042	241.252	−1,435.046	−109.171	0.000	
CPIH_log	465	−12.106	19.300	−79.295	−25.996	4.041	
EXCH_log	1,670	−99.505	245.285	−802.270	−186.469	22.729	
EXCHEB_log	1,460	474.999	128.716	254.667	445.163	465.647	
EXCHER_log	924	−2.386	16.320	−102.687	−8.022	4.605	
EXCHEBCPI_log	754	414.594	62.259	228.991	379.834	459.947	
GDPV_log_f	1,686	0.000	9.451	−58.612	−4.275	5.107	
UNR_log_f	1,690	0.000	39.168	−193.183	−23.553	21.716	
UNR_f	1,690	0.000	2.151	−8.275	−1.203	0.998	

B.2 Sample

B.3 Number of Years for each exchange rate regime

B.4 Sources

The abreviations used in the paper correspond to the following economic time series.

The classification of exchange rate regimes comes from Ilzetzki et al. (2017).

Table 8: Data Sample

	countryname	nobs	period 1
1	Australia	53	1964-2016
2	Austria	48	1969-2016
3	Belgium	57	1960-2016
4	Brazil	22	1995-2016
5	Canada	57	1960-2016
6	Chile	31	1986-2016
7	Colombia	16	2001-2016
8	Costa Rica	7	2010-2016
9	Czech Republic	24	1993-2016
10	Denmark	48	1969-2016
11	Estonia	17	2000-2016
12	Finland	57	1960-2016
13	France	57	1960-2016
14	Germany	25	1992-2016
15	Greece	22	1995-2016
16	Hungary	25	1992-2016
17	Iceland	53	1964-2016
18	Ireland	27	1990-2016
19	Israel	22	1995-2016
20	Italy	57	1960-2016
21	Japan	57	1960-2016
22	Korea	54	1963-2016
23	Latvia	21	1996-2016
24	Lithuania	15	2002-2016
25	Luxembourg	32	1985-2016
26	Mexico	26	1991-2016
27	Netherlands	57	1960-2016
28	New Zealand	57	1960-2016
29	Norway	57	1960-2016
30	Poland	24	1993-2016
31	Portugal	57	1960-2016
32	Russia	18	1999-2016
33	Slovak Republic	23	1994-2016
34	Slovenia	18	1999-2016
35	South Africa	16	2001-2016
36	Spain	40	1977-2016
37	Sweden	57	1960-2016
38	Switzerland	42	1975-2016
39	Turkey	57	1960-2016
40	United Kingdom	57	1960-2016
41	United States	57	1960-2016

Table 9: Exchange Rate Regime by type

	countryname	ER1	ER2	ER3	ER4	ER5	ER6
1	Australia	11	8	1	33	0	0
2	Austria	39	9	0	0	0	0
3	Belgium	57	0	0	0	0	0
4	Brazil	0	4	17	0	1	0
5	Canada	10	32	15	0	0	0
6	Chile	0	0	31	0	0	0
7	Colombia	0	0	16	0	0	0
8	Costa Rica	0	7	0	0	0	0
9	Czech Republic	0	23	1	0	0	0
10	Denmark	21	27	0	0	0	0
11	Estonia	17	0	0	0	0	0
12	Finland	35	22	0	0	0	0
13	France	32	24	1	0	0	0
14	Germany	18	0	0	7	0	0
15	Greece	22	0	0	0	0	0
16	Hungary	0	13	12	0	0	0
17	Iceland	0	23	20	0	10	0
18	Ireland	20	7	0	0	0	0
19	Israel	0	0	22	0	0	0
20	Italy	33	17	7	0	0	0
21	Japan	1	17	0	39	0	0
22	Korea	6	19	28	0	1	0
23	Latvia	7	3	11	0	0	0
24	Lithuania	15	0	0	0	0	0
25	Luxembourg	32	0	0	0	0	0
26	Mexico	2	1	22	0	1	0
27	Netherlands	45	12	0	0	0	0
28	New Zealand	14	0	43	0	0	0
29	Norway	13	0	44	0	0	0
30	Poland	0	5	17	0	0	2
31	Portugal	36	13	8	0	0	0
32	Russia	0	9	6	0	3	0
33	Slovak Republic	8	14	1	0	0	0
34	Slovenia	15	3	0	0	0	0
35	South Africa	0	0	16	0	0	0
36	Spain	23	17	0	0	0	0
37	Sweden	13	30	14	0	0	0
38	Switzerland	3	0	39	0	0	0
39	Turkey	1	0	36	0	20	0
40	United Kingdom	12	0	37	8	0	0
41	United States	12	0	1	44	0	0

C Empirical Results

C.1 Replicating Fisher (1926) and Phillips (1958)

Table 10: Phillips Curve in UK Millenium Macro Database

	CPIIUKA All	wages_log_d1
	(1)	(2)
UNRTUKA	-0.626^{**}	-0.788^{***}
	(0.239)	(0.112)
Observations	53	53
Adjusted R^2	0.101	0.484

Table 11: Regression Results on : CPI-CPIH-YTYPCT = UNR

	Estimate	t value	R^2	Adj R^2	Nobs
Fixed	-0.219	-7.399	11.700	11.500	416
Peg	-0.301	-2.854	3.800	3.300	208
Band	-0.026	-0.326	0	-0.200	428
Floating	0.409	3.424	9.100	8.300	119

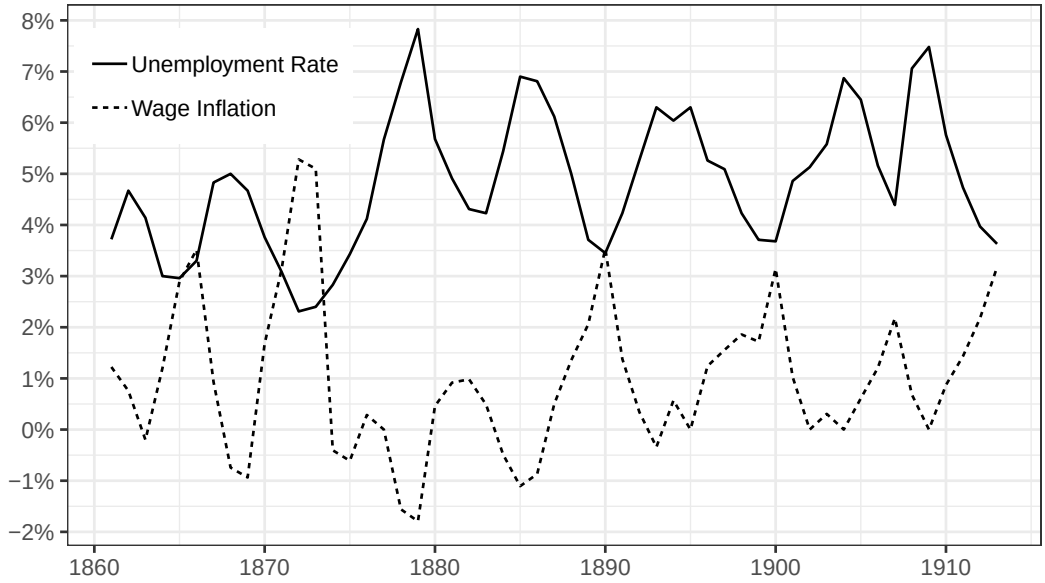
D Figures

D.1 Phillips (1958)'s original relation

Figure 1: The Original Phillips (1958) Curve: 1861-1913

Note: Source: Phillips (1958).

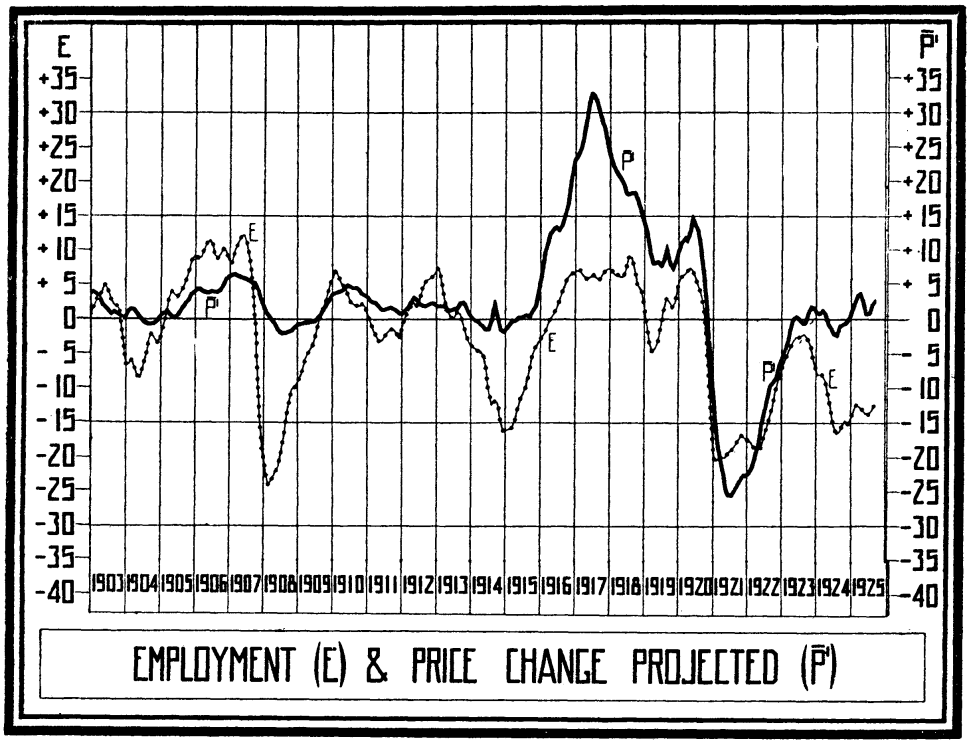
Figure 2: Replicating the Phillips Curve



Note:

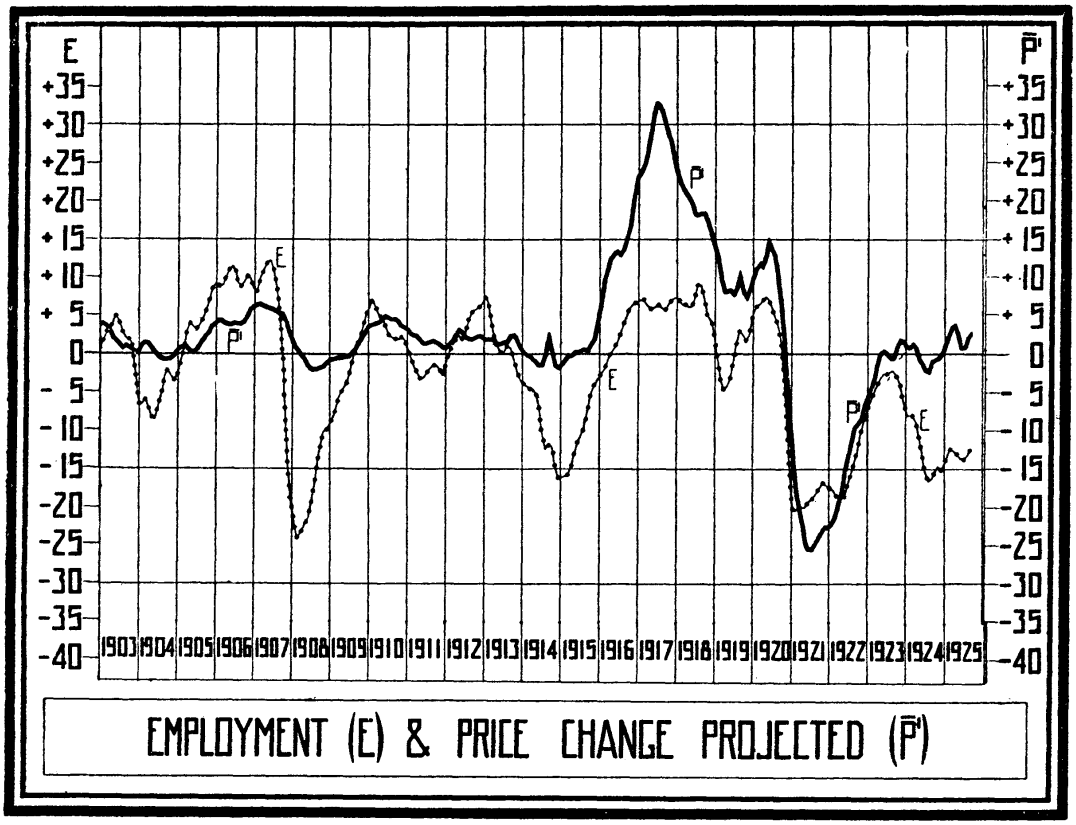
D.2 Fisher (1926)'s seminal work

Figure 3: The Original Phillips (1958) Curve: 1861-1913



Note: Source: Phillips (1958).

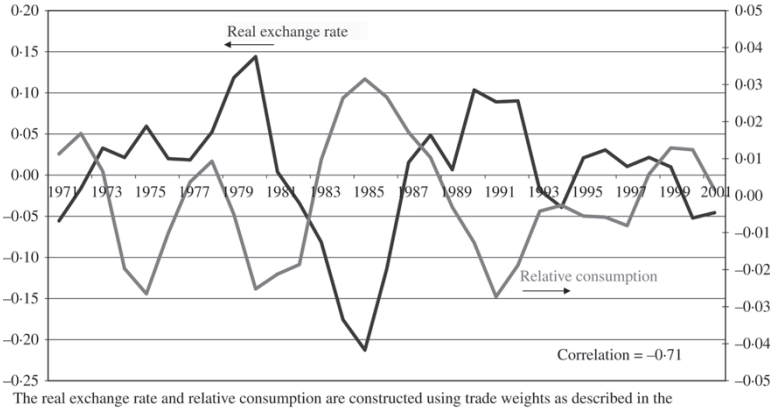
Figure 4: Replicating Fisher (1926)



Note: Replicating Fish

D.3 Prior evidence

Figure 5: Consumption and Real Exchange Rates From Corsetti et al. (2008)



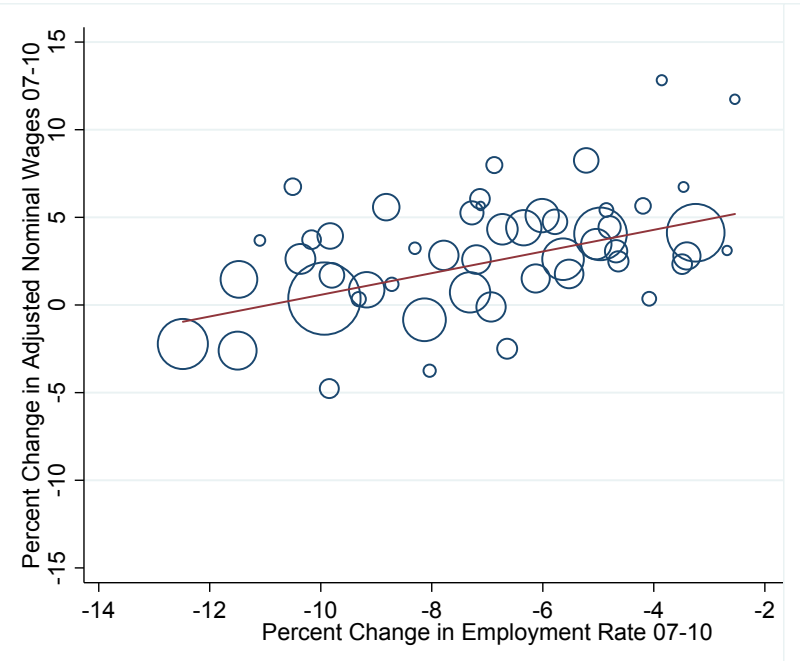
The real exchange rate and relative consumption are constructed using trade weights as described in the data appendix. Both series are logged and HP-filtered.

Figure 1

U.S. real exchange rate and relative consumption

Note: Source: Corsetti et al. (2008)

Figure 6: Phillips Curve Across US Regions From Beraja et al. (2016)



Note: Source: Beraja et al. (2016)

E Correlations

Consumption (mean: 0.6)

CPV	AUS	CAN	DEU	ESP	FRA	GBR	ITA	JPN	KOR	MEX	USA
AUS	1	0.89	0.1	0.58	0.35	0.65	0.21	-0.01	0.15	0.19	0.56
CAN	0.89	1	-0.04	0.73	0.58	0.71	0.45	0.28	0.4	0.46	0.65
DEU	0.1	-0.04	1	0.18	0.09	0.43	0.12	0.02	0.18	0.02	0.45
ESP	0.58	0.73	0.18	1	0.93	0.91	0.89	0.75	0.82	0.77	0.93
FRA	0.35	0.58	0.09	0.93	1	0.81	0.98	0.91	0.93	0.86	0.87
GBR	0.65	0.71	0.43	0.91	0.81	1	0.76	0.6	0.74	0.65	0.98
ITA	0.21	0.45	0.12	0.89	0.98	0.76	1	0.96	0.95	0.86	0.84
JPN	-0.01	0.28	0.02	0.75	0.91	0.6	0.96	1	0.95	0.83	0.7
KOR	0.15	0.4	0.18	0.82	0.93	0.74	0.95	0.95	1	0.77	0.81
MEX	0.19	0.46	0.02	0.77	0.86	0.65	0.86	0.83	0.77	1	0.72
USA	0.56	0.65	0.45	0.93	0.87	0.98	0.84	0.7	0.81	0.72	1

GDP (mean: 0.72)

GDPV	AUS	CAN	DEU	ESP	FRA	GBR	ITA	JPN	KOR	MEX	USA
AUS	1	0.84	0.26	0.79	0.64	0.87	0.62	0.39	0.59	0.47	0.82
CAN	0.84	1	0.32	0.92	0.91	0.93	0.89	0.74	0.85	0.8	0.97
DEU	0.26	0.32	1	0.21	0.18	0.38	0.15	0.04	0.07	0.18	0.29
ESP	0.79	0.92	0.21	1	0.9	0.89	0.89	0.74	0.83	0.76	0.91
FRA	0.64	0.91	0.18	0.9	1	0.78	0.99	0.94	0.97	0.94	0.92
GBR	0.87	0.93	0.38	0.89	0.78	1	0.76	0.57	0.7	0.63	0.92
ITA	0.62	0.89	0.15	0.89	0.99	0.76	1	0.95	0.98	0.94	0.91
JPN	0.39	0.74	0.04	0.74	0.94	0.57	0.95	1	0.95	0.95	0.78
KOR	0.59	0.85	0.07	0.83	0.97	0.7	0.98	0.95	1	0.92	0.87
MEX	0.47	0.8	0.18	0.76	0.94	0.63	0.94	0.95	0.92	1	0.83
USA	0.82	0.97	0.29	0.91	0.92	0.92	0.91	0.78	0.87	0.83	1

Investment (mean: 0.47)

ITV	AUS	CAN	DEU	ESP	FRA	GBR	ITA	JPN	KOR	MEX	USA
AUS	1	0.74	-0.32	0.1	0.01	-0.22	0.06	-0.56	-0.45	0.2	0.01
CAN	0.74	1	-0.2	0.58	0.57	0.33	0.55	-0.08	-0.02	0.62	0.42
DEU	-0.32	-0.2	1	-0.2	-0.01	0.1	-0.2	0.07	-0.05	0.1	-0.02
ESP	0.1	0.58	-0.2	1	0.92	0.77	0.96	0.5	0.55	0.66	0.78
FRA	0.01	0.57	-0.01	0.92	1	0.78	0.93	0.61	0.62	0.73	0.67
GBR	-0.22	0.33	0.1	0.77	0.78	1	0.75	0.69	0.66	0.58	0.78
ITA	0.06	0.55	-0.2	0.96	0.93	0.75	1	0.62	0.68	0.64	0.75
JPN	-0.56	-0.08	0.07	0.5	0.61	0.69	0.62	1	0.97	0.35	0.47
KOR	-0.45	-0.02	-0.05	0.55	0.62	0.66	0.68	0.97	1	0.32	0.49
MEX	0.2	0.62	0.1	0.66	0.73	0.58	0.64	0.35	0.32	1	0.55
USA	0.01	0.42	-0.02	0.78	0.67	0.78	0.75	0.47	0.49	0.55	1

Unemployment (mean: 0.42)

UNR	AUS	CAN	DEU	ESP	FRA	GBR	ITA	JPN	KOR	MEX	USA
AUS	1	0.93	-0.36	0.41	0.95	0.57	0.81	0.25	-0.51	0.19	0.02
CAN	0.93	1	-0.36	0.54	0.89	0.74	0.71	0.2	-0.58	0.36	0.32
DEU	-0.36	-0.36	1	-0.64	-0.15	-0.49	-0.49	0.59	0.2	-0.08	-0.13
ESP	0.41	0.54	-0.64	1	0.35	0.75	0.64	-0.26	-0.34	0.55	0.5
FRA	0.95	0.89	-0.15	0.35	1	0.55	0.78	0.38	-0.48	0.26	-0.02
GBR	0.57	0.74	-0.49	0.75	0.55	1	0.44	-0.08	-0.56	0.56	0.65
ITA	0.81	0.71	-0.49	0.64	0.78	0.44	1	0.1	-0.29	0.22	-0.14
JPN	0.25	0.2	0.59	-0.26	0.38	-0.08	0.1	1	0.05	-0.07	0.02
KOR	-0.51	-0.58	0.2	-0.34	-0.48	-0.56	-0.29	0.05	1	-0.51	-0.3
MEX	0.19	0.36	-0.08	0.55	0.26	0.56	0.22	-0.07	-0.51	1	0.44
USA	0.02	0.32	-0.13	0.5	-0.02	0.65	-0.14	0.02	-0.3	0.44	1

F Model

There are two countries: 1 and 2, and two goods: tradable (T) and non-tradable (N).

Output is "demand determined": if consumption is higher, then labor follows. (is it because of fixed wages?)

F.1 Set-up

Unknowns: y_T, y_N, w, l_T,l_N, p_T, p_N, C_T, C_N,

Normalization: $p_T = 1$, the tradable good is a numeraire good.

Labor demand program of firm producing a tradable good in a home country:

$$\begin{aligned} \max_{l_T} \quad & p_T y_T - w l_T \\ \text{s.t.} \quad & y_T = A_T l_T^{\alpha} \end{aligned}$$

In the foreign country:

$$\begin{aligned} \max_{l_T^*} \quad & p_T y_T^* - w^* l_T^* \\ \text{s.t.} \quad & y_T^* = A_T^* \left(l_T^*\right)^{\alpha} \end{aligned}$$

Non-tradable good in a home country:

$$\begin{aligned} \max_{l_N} \quad & p_N y_N - w l_N \\ \text{s.t.} \quad & y_N = A_N l_N^{\alpha} \end{aligned}$$

In the foreign country:

$$\begin{aligned} \max_{l_N^*} \quad & p_N^* y_N^* - w^* l_N^* \\ \text{s.t.} \quad & y_N^* = A_N^* \left(l_N^*\right)^{\alpha} \end{aligned}$$

Now production of non-tradables is given by:

$$y_N = A_N \left(\frac{\alpha p_N A_N}{w}\right)^{\frac{\alpha}{1-\alpha}}, \quad y_N^* = A_N^* \left(\frac{\alpha p_N^* A_N^*}{w^*}\right)^{\frac{\alpha}{1-\alpha}}$$

I can only consume the non-traded good that I have ay home, thus:

$$C_N = y_N \quad \Rightarrow \quad C_N = A_N \left(\frac{\alpha p_N A_N}{w}\right)^{\frac{\alpha}{1-\alpha}}$$

$$C_N^* = y_N^* \quad \Rightarrow \quad C_N^* = A_N^* \left(\frac{\alpha p_N^* A_N^*}{w^*}\right)^{\frac{\alpha}{1-\alpha}}$$

The production of tradables is given by:

$$y_T = A_T \left(\frac{\alpha p_T A_T}{w}\right)^{\frac{\alpha}{1-\alpha}}, \quad y_T^* = A_T^* \left(\frac{\alpha p_T A_T^*}{w^*}\right)^{\frac{\alpha}{1-\alpha}}$$

Of course, one **does not need to consume their own production**. But the market for tradables must clear, since by assumption tradables may not be stored:

$$C_T + C_T^* = y_T + y_T^*$$

$$\Rightarrow \quad \boxed{C_T + C_T^* = A_T \left(\frac{\alpha p_T A_T}{w}\right)^{\frac{\alpha}{1-\alpha}} + A_T^* \left(\frac{\alpha p_T A_T^*}{w^*}\right)^{\frac{\alpha}{1-\alpha}}}$$

What determines how much i buy of each? Well, the amount of public debt B of the home country, with respect to the foreign country. The foreign country thus either consumes its tradables or buys public debt with an amount B, which translates into an amount of tradables which must be shipped to the home country:

$$C_T = y_T + B \quad \Rightarrow \quad C_T^* + B = y_T^*$$

Thus:

$$C_T = A_T \left(\frac{\alpha p_T A_T}{w} \right)^{\frac{\alpha}{1-\alpha}} + B$$

Consumption choice between tradables and non-tradables is given by:

$$\begin{aligned} \max_{C_T, C_N} \quad & \left(\gamma^{\frac{1}{\theta}} (C_T)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} (C_N)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \\ \text{s.t.} \quad & p_T C_T + p_N C_N = p_T (y_T + B) + p_N y_N \end{aligned}$$

$$\begin{aligned} \max_{C_T^*, C_N^*} \quad & \left(\gamma^{\frac{1}{\theta}} (C_T^*)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} (C_N^*)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \\ \text{s.t.} \quad & p_T C_T^* + p_N^* C_N^* = p_T^* (y_T^* - B) + p_N^* y_N^* \end{aligned}$$

If $p_T = 1$ then:

$$\begin{aligned} \frac{(1-\gamma)^{\frac{1}{\theta}} (C_N)^{-\frac{1}{\theta}}}{\gamma^{\frac{1}{\theta}} (C_T)^{-\frac{1}{\theta}}} = p_N \quad & \Rightarrow \quad \frac{C_N}{C_T} = (p_N)^{-\theta} \frac{1-\gamma}{\gamma} \\ \frac{(1-\gamma)^{\frac{1}{\theta}} (C_N^*)^{-\frac{1}{\theta}}}{\gamma^{\frac{1}{\theta}} (C_T^*)^{-\frac{1}{\theta}}} = p_N^* \quad & \Rightarrow \quad \frac{C_N^*}{C_T^*} = (p_N^*)^{-\theta} \frac{1-\gamma}{\gamma} \end{aligned}$$

Market clearing for labor:

$$\begin{aligned} l_T + l_N = L \quad & \Rightarrow \quad \left(\frac{\alpha p_T A_T}{w} \right)^{\frac{1}{1-\alpha}} + \left(\frac{\alpha p_N A_N}{w} \right)^{\frac{1}{1-\alpha}} = L \\ & \Rightarrow \quad \boxed{\alpha^{\frac{1}{1-\alpha}} \left[A_T^{\frac{1}{1-\alpha}} p_T^{\frac{1}{1-\alpha}} + A_N^{\frac{1}{1-\alpha}} p_N^{\frac{1}{1-\alpha}} \right] = L w^{\frac{1}{1-\alpha}}} \end{aligned}$$

$$l_T^* + l_N^* = L^* \quad \Rightarrow \quad \boxed{\alpha^{\frac{1}{1-\alpha}} \left[(A_T^*)^{\frac{1}{1-\alpha}} (p_T)^{\frac{1}{1-\alpha}} + (A_N^*)^{\frac{1}{1-\alpha}} (p_N^*)^{\frac{1}{1-\alpha}} \right] = L^* (w^*)^{\frac{1}{1-\alpha}}}$$

The solution gives labor demand:

$$\begin{aligned} l_T &= \left(\frac{\alpha p_T A_T}{w} \right)^{\frac{1}{1-\alpha}} \qquad l_T^* = \left(\frac{\alpha p_T^* A_T^*}{w^*} \right)^{\frac{1}{1-\alpha}} \\ l_N &= \left(\frac{\alpha p_N A_N}{w} \right)^{\frac{1}{1-\alpha}} \qquad l_N^* = \left(\frac{\alpha p_N^* A_N^*}{w^*} \right)^{\frac{1}{1-\alpha}} \end{aligned}$$

F.2 Solving the Model

Using:

$$\begin{aligned} & C_T = C_N (p_N)^{\theta} \frac{\gamma}{1-\gamma}, \quad C_N = A_N \left(\frac{\alpha p_N A_N}{w} \right)^{\frac{\alpha}{1-\alpha}} \\ \Rightarrow \quad & C_T = A_N \left(\frac{\alpha p_N A_N}{w} \right)^{\frac{\alpha}{1-\alpha}} (p_N)^{\theta} \frac{\gamma}{1-\gamma} \end{aligned}$$

$$C_T = \frac{\gamma}{1-\gamma} A_N^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} \frac{p_N^{\frac{\alpha}{1-\alpha}+\theta}}{w^{\frac{\alpha}{1-\alpha}}}$$

Simple equations:

$$p_T (y_T + B) = p_T C_T$$

$$p_T (y_T + B) = p_T \frac{\gamma}{1-\gamma} A_N^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} \frac{p_N^{\frac{\alpha}{1-\alpha}+\theta}}{w^{\frac{\alpha}{1-\alpha}}}$$

Now:

$$p_T (y_T + B) = p_T \left[A_T \left(\frac{\alpha p_T A_T}{w} \right)^{\frac{\alpha}{1-\alpha}} + B \right]$$

Finally:

$$\frac{\gamma}{1-\gamma} A_N^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} \frac{p_N^{\frac{\alpha}{1-\alpha}+\theta}}{w^{\frac{\alpha}{1-\alpha}}} = A_T \left(\frac{\alpha p_T A_T}{w} \right)^{\frac{\alpha}{1-\alpha}} + B$$

Symmetrically:

$$\frac{\gamma}{1-\gamma} (A_N^*)^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} \frac{(p_N^*)^{\frac{\alpha}{1-\alpha}+\theta}}{(w^*)^{\frac{\alpha}{1-\alpha}}} = A_T^* \left(\frac{\alpha p_T A_T^*}{w^*} \right)^{\frac{\alpha}{1-\alpha}} - B$$

F.3 Collecting the equations

$$\frac{\gamma}{1-\gamma} A_N^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} p_N^{\frac{\alpha}{1-\alpha}+\theta} - A_T (\alpha p_T A_T)^{\frac{\alpha}{1-\alpha}} = B w^{\frac{\alpha}{1-\alpha}}$$

$$\frac{\gamma}{1-\gamma} (A_N^*)^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} (p_N^*)^{\frac{\alpha}{1-\alpha}+\theta} - A_T^* (\alpha p_T A_T^*)^{\frac{\alpha}{1-\alpha}} = -B (w^*)^{\frac{\alpha}{1-\alpha}}$$

$$\alpha^{\frac{1}{1-\alpha}} \left[A_T^{\frac{1}{1-\alpha}} p_T^{\frac{1}{1-\alpha}} + A_N^{\frac{1}{1-\alpha}} p_N^{\frac{1}{1-\alpha}} \right] = L w^{\frac{1}{1-\alpha}}$$

$$\alpha^{\frac{1}{1-\alpha}} \left[(A_T^*)^{\frac{1}{1-\alpha}} (p_T)^{\frac{1}{1-\alpha}} + (A_N^*)^{\frac{1}{1-\alpha}} (p_N^*)^{\frac{1}{1-\alpha}} \right] = L^* (w^*)^{\frac{1}{1-\alpha}}$$

Therefore, there is an autonomous equation in p_N:

$$\frac{\gamma}{1-\gamma} A_N^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} p_N^{\frac{\alpha}{1-\alpha}+\theta} - A_T (\alpha p_T A_T)^{\frac{\alpha}{1-\alpha}} = B \alpha^{\frac{1}{1-\alpha}} \left[A_T^{\frac{1}{1-\alpha}} p_T^{\frac{1}{1-\alpha}} + A_N^{\frac{1}{1-\alpha}} p_N^{\frac{1}{1-\alpha}} \right] \tag{1}$$

And an autonomous equation in p_N^*:

$$\frac{\gamma}{1-\gamma} (A_N^*)^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} (p_N^*)^{\frac{\alpha}{1-\alpha}+\theta} - A_T^* (\alpha p_T A_T^*)^{\frac{\alpha}{1-\alpha}} = -B \alpha^{\frac{1}{1-\alpha}} \left[(A_T^*)^{\frac{1}{1-\alpha}} (p_T)^{\frac{1}{1-\alpha}} + (A_N^*)^{\frac{1}{1-\alpha}} (p_N^*)^{\frac{1}{1-\alpha}} \right] \tag{2}$$

Higher wages at home:

$$w = \alpha L^{1-\alpha} \left[A_T^{\frac{1}{1-\alpha}} p_T^{\frac{1}{1-\alpha}} + A_N^{\frac{1}{1-\alpha}} p_N^{\frac{1}{1-\alpha}} \right]^{1-\alpha} \tag{3}$$

Lower wages abroad:

$$w^* = \alpha (L^*)^{1-\alpha} \left[(A_T^*)^{\frac{1}{1-\alpha}} (p_T)^{\frac{1}{1-\alpha}} + (A_N^*)^{\frac{1}{1-\alpha}} (p_N^*)^{\frac{1}{1-\alpha}} \right]^{1-\alpha} \tag{4}$$

F.4 Characteristics of the equilibrium

The share of tradables relative to non-tradables depends on the relative price of non tradables in the home country

$$\boxed{\frac{l_T}{l_N} = \left(\frac{A_T}{A_N}\right)^{\frac{1}{1-\alpha}} \left(\frac{1}{p_N}\right)^{\frac{1}{1-\alpha}}}$$

The elasticity of this ratio is given by $1/(1-\alpha)$, so that when there is an appreciation of 1%, the share of tradables to non tradables falls by $1/(1-\alpha)$. When returns are approximately constant returns to scale, then this ratio needs to fall infinitely importantly.

$$\boxed{\frac{l_T^*}{l_N^*} = \left(\frac{A_T^*}{A_N^*}\right)^{\frac{1}{1-\alpha}} \left(\frac{1}{p_N^*}\right)^{\frac{1}{1-\alpha}}}$$

Thus, the real exchange rate

Note that something that is important is γ.

Of course, the argument is always that consumption will increase at some point? Well not in an OLG model: public debt is pushed back further.

Here is

F.5 With labor supply, balanced trade (no borrowing)

9 variables: C_N, C_T, C_N^*, C_T^*, w, w^*,p_T, p_N, p_N^*

Labor supply program:

$$\begin{aligned} \max \quad & \left(\gamma^{\frac{1}{\theta}} (C_T)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} (C_N)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \frac{L^{1+\frac{1}{\epsilon}}}{1+\frac{1}{\epsilon}} \\ \text{s.t.} \quad & wL = p_T C_T + p_N C_N \end{aligned}$$

Also gives labor supply:

$$\begin{aligned} L &= w^{\epsilon} \\ L^* &= (w^*)^{\epsilon} \end{aligned}$$

Market clearing for labor:

$$l_T + l_N = L \quad \Rightarrow \quad \left(\frac{\alpha p_T A_T}{w}\right)^{\frac{1}{1-\alpha}} + \left(\frac{\alpha p_N A_N}{w}\right)^{\frac{1}{1-\alpha}} = L w^{\epsilon}$$

$$\Rightarrow \quad \boxed{L w^{\frac{1}{1-\alpha}+\epsilon} = \alpha^{\frac{1}{1-\alpha}} \left[A_T^{\frac{1}{1-\alpha}} p_T^{\frac{1}{1-\alpha}} + A_N^{\frac{1}{1-\alpha}} p_N^{\frac{1}{1-\alpha}}\right]}$$

$$l_T^* + l_N^* = L^* \quad \Rightarrow \quad \boxed{L^* (w^*)^{\frac{1}{1-\alpha}+\epsilon} = \alpha^{\frac{1}{1-\alpha}} \left[(A_T^*)^{\frac{1}{1-\alpha}} (p_T)^{\frac{1}{1-\alpha}} + (A_N^*)^{\frac{1}{1-\alpha}} (p_N^*)^{\frac{1}{1-\alpha}}\right]}$$

Collecting equations:

$$\frac{\gamma}{1-\gamma} A_N^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} p_N^{\frac{\alpha}{1-\alpha}+\theta} - A_T (\alpha p_T A_T)^{\frac{\alpha}{1-\alpha}} = B w^{\frac{\alpha}{1-\alpha}}$$

$$\frac{\gamma}{1-\gamma} (A_N^*)^{\frac{1}{1-\alpha}} \alpha^{\frac{\alpha}{1-\alpha}} (p_N^*)^{\frac{\alpha}{1-\alpha}+\theta} - A_T^* (\alpha p_T A_T^*)^{\frac{\alpha}{1-\alpha}} = -B (w^*)^{\frac{\alpha}{1-\alpha}}$$

New equation (3):

$$L w^{\frac{1}{1-\alpha}+\epsilon} = \alpha^{\frac{1}{1-\alpha}} \left[A_T^{\frac{1}{1-\alpha}} p_T^{\frac{1}{1-\alpha}} + A_N^{\frac{1}{1-\alpha}} p_N^{\frac{1}{1-\alpha}}\right]$$

New equation (4):

$$L^* \left(w^*\right)^{\frac{1}{1-\alpha}+\epsilon} = \alpha^{\frac{1}{1-\alpha}} \left[\left(A_T^*\right)^{\frac{1}{1-\alpha}} \left(p_T\right)^{\frac{1}{1-\alpha}} + \left(A_N^*\right)^{\frac{1}{1-\alpha}} \left(p_N^*\right)^{\frac{1}{1-\alpha}} \right]$$

F.6 With capital

Normalization: $p_T = 1$, the tradable good is a numeraire good.

Labor demand program of firm producing a tradable good in a home country:

$$\begin{aligned} \max_{l_T, k_T} \quad & p_T y_T - w l_T - r k_T \\ \text{s.t.} \quad & y_T = A_T l_T^{\alpha} k_T^{\beta} \end{aligned}$$

In the foreign country:

$$\begin{aligned} \max_{l_T^*, k_T^*} \quad & p_T y_T^* - w^* l_T^* - r^* k_T^* \\ \text{s.t.} \quad & y_T^* = A_T^* \left(l_T^*\right)^{\alpha} \left(k_T^*\right)^{\beta} \end{aligned}$$

Non-tradable good in a home country:

$$\begin{aligned} \max_{l_N, k_N} \quad & p_N y_N - w l_N - r k_N \\ \text{s.t.} \quad & y_N = A_N l_N^{\alpha} k_N^{\beta} \end{aligned}$$

In the foreign country:

$$\begin{aligned} \max_{l_N^*, k_N^*} \quad & p_N^* y_N^* - w^* l_N^* - r^* k_N^* \\ \text{s.t.} \quad & y_N^* = A_N^* \left(l_N^*\right)^{\alpha} \left(k_N^*\right)^{\beta} \end{aligned}$$

G Basic Derivations

G.1 Aggregating T and N goods

Consumption choice between tradables and non-tradables is given by:

$$\begin{aligned} \max_{C_T, C_N} \quad & C = \left(\gamma^{\frac{1}{\theta}} \left(C_T\right)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} \left(C_N\right)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \\ \text{s.t.} \quad & p_T C_T + p_N C_N = PC \end{aligned}$$

Optimality requires:

$$\frac{(1-\gamma)^{\frac{1}{\theta}} \left(C_N\right)^{-\frac{1}{\theta}}}{\gamma^{\frac{1}{\theta}} \left(C_T\right)^{-\frac{1}{\theta}}} = p_N \quad \Rightarrow \quad \frac{C_N}{C_T} = \left(\frac{p_N}{p_T}\right)^{-\theta} \frac{1-\gamma}{\gamma}$$

Thus:

$$C = \left[\gamma^{\frac{1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} \left(\frac{p_N}{p_T}\right)^{1-\theta} \right] C_T$$

Budget:

$$\begin{aligned} p_T C_T + p_N C_N &= p_T C_T + p_N \left(\frac{p_N}{p_T}\right)^{-\theta} \frac{1-\gamma}{\gamma} C_T \\ &= p_T C_T \left[1 + \left(\frac{p_N}{p_T}\right)^{1-\theta} \frac{1-\gamma}{\gamma} \right] \end{aligned}$$

$$p_T C_T + p_N C_N = PC$$

Thus finally:

$$P\left[\gamma^{\frac{1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}}\left(\frac{p_N}{p_T}\right)^{1-\theta}\right] C_T = p_T C_T\left[1 + \left(\frac{p_N}{p_T}\right)^{1-\theta}\frac{1-\gamma}{\gamma}\right]$$

And:

$$P = p_T \frac{1 + \left(\frac{p_N}{p_T}\right)^{1-\theta}\frac{1-\gamma}{\gamma}}{\gamma^{\frac{1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}}\left(\frac{p_N}{p_T}\right)^{1-\theta}}$$

G.2 Aggregating T and N Goods

Labor supply program:

$$\begin{aligned} \max \quad & \left(\gamma^{\frac{1}{\theta}}(C_T)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}}(C_N)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \frac{L^{1+\frac{1}{\epsilon}}}{1+\frac{1}{\epsilon}} \\ \text{s.t.} \quad & wL = p_T C_T + p_N C_N \end{aligned}$$

If $p_T = 1$ then:

$$\frac{(1-\gamma)^{\frac{1}{\theta}}(C_N)^{-\frac{1}{\theta}}}{\gamma^{\frac{1}{\theta}}(C_T)^{-\frac{1}{\theta}}} = p_N \quad \Rightarrow \quad \frac{C_N}{C_T} = (p_N)^{-\theta}\frac{1-\gamma}{\gamma}$$

Also gives labor supply:

$$L = w^{\epsilon}$$